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Book Of Abstracts

LOC Institutes and Organisations

ICRC 2021

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Branch 1_Plenary

Subcategory Highlight

Physics of gamma-ray burst afterglow: implications of H.E.S.S. observations

Time 13 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 02
Presenter Forum Table

Presenter
Dmitry Khangulyan
Author and Co-Author
Felix Aharonian | Dmitry Khangulyan | Carlo Romoli | Edna Loredana Ruiz Velasco | Fabian Schussler | Andrew Taylor | Sylvia Jiechen Zhu | for the H.E.S.S. collaboration,

Abstract
'Recently, the observational study of gamma-ray bursts (GRBs) in the very-high-energy (VHE) regime has quickly advanced with three successful detections. Currently, the list of published VHE GRBs contains GRB 180720B, GRB 190114C, and GRB 190829A. The fortunate proximity of the last event observed with H.E.S.S. (GRB 190829A occurred at z~0.08) allowed an unexpectedly long signal detection, up to 56 hours after the trigger, and accurate spectral determination in a broad energy interval, spanning between 0.18 and 3.3TeV. The obtained temporal and spectral properties of the VHE emission appeared to be remarkably similar to those seen in the X-ray band with Swift-XRT. However, in frameworks of the standard synchrotron-self-Compton (SSC) scenario such a coherent behavior is expected only during the early period of the afterglow phase, when the forward shock propagates with large bulk Lorentz factor, \\(\\Gamma>100\\). SSC models are able to render VHE spectra compatible with the H.E.S.S. measurements only under extreme assumptions on the properties of the circumburst medium. We discuss the implications of the GRB 190829A detection for afterglow modeling and GRB physics.'

Collaborations
H.E.S.S.,

Keywords and Comments
'GRB; VHE;', ''

Branch 1_Plenary

Subcategory Highlight

The Radio Neutrino Observatory Greenland (RNO-G)

Time 21 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Theater of Dreams
Presenter Forum Table

Presenter
Stephanie Wissel
Author and Co-Author
Stephanie Wissel, for the RNO-G Collaboration

Abstract
'The Radio Neutrino Observatory Greenland (RNO-G) is scheduled for deployment in the summer of 2021. It will target the detection of astrophysical and cosmogenic neutrinos above 10 PeV. With 35 autonomous stations, it will be the largest implementation of a radio neutrino detector to date. The stations combine best-practice instrumentation from all previous radio neutrino arrays, such as a deep phased-array trigger and surface antennas. \r\nThese proceedings describe the experimental considerations that have driven the design of RNO-G and the current progress in deployment, as well as discuss the projected sensitivity of the instrument. RNO-G will provide a unique view of the Northern Sky and will also inform the design of the radio component of IceCube-Gen2.'

Collaborations
other (fill field below), RNO-G

Keywords and Comments
'Radio detection; instrumentation;', ''

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Branch 1_Plenary

Subcategory Highlight

Atmospheric neutrino oscillations with Super-Kamiokande and prospects for SuperK-Gd

Time 20 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 08
Presenter Forum Table

Presenter
Pablo Fernandez Menendez
Author and Co-Author
Pablo Fernandez Menendez,

Abstract
'The Super-Kamiokande (SK) experiment is a 50 kton water-Cherenkov detector located in Kamioka, Japan. Instrumented with more than 11000 PMTs, \r\nit has been collecting data since 1996 and has been responsible for the very first observation of neutrino oscillations through the analysis\r\nof atmospheric neutrinos. Nowadays, the analysis of SK atmospheric neutrino data keeps providing some of the most precise measurements for \r\nneutrino oscillation parameters such as θ23, the neutrino mass ordering, Δm^2_32, and, to a lesser extent, the δCP phase.\r\n\r\nIn this presentation, an overview of the most recent atmospheric neutrino oscillation analysis results will be given, as well as, a glimpse \r\nof what is to come, concerning atmospheric neutrinos, in the recently started Gd-doped phase of the detector. This detector upgrade (SuperK-Gd), \r\nprovides an efficient neutron tagging via Gd-neutron capture, potentially enhancing the sensitivty of the atmospheric neutrino oscillation analysis.'

Collaborations
, Super-Kamiokande

Keywords and Comments
'neutrino; oscillations; experiment;', ''

Branch 1_Plenary

Subcategory Highlight

Galactic Cosmic Ray Acceleration with Steep Spectra

Time 20 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 08
Presenter Forum Table

Presenter
Rebecca Diesing
Author and Co-Author
Rebecca Diesing | Damiano Caprioli,

Abstract
'Galactic cosmic rays (CRs) are accelerated by astrophysical shocks, primarily supernova remnants (SNRs), via diffusive shock acceleration (DSA), an efficient mechanism that predicts power-law energy distributions of CRs. However, observations of both nonthermal SNR emission and Galactic CRs imply CR spectra that are steeper than the standard DSA prediction, $\\propto E^{-2}$. Recent kinetic hybrid simulations suggest that such steep spectra may be the result of a ``postcursor", or drift of CRs and magnetic structures with respect to the thermal plasma behind the shock. Using a semi-analytic model of non-linear DSA, we generalize this result to a wide range of astrophysical shocks. By accounting for the presence of a postcursor, we produce CR energy distributions that are substantially steeper than E^{-2} and consistent with observations. Our formalism reproduces both modestly steep spectra of Galactic SNRs ($\\propto E^{-2.2}$) and the very steep spectra of young radio supernovae ($\\propto E^{-3}$).'

Collaborations

Keywords and Comments
'particle acceleration; SNR; steep spectra; postcursor', ''

Branch 1_Plenary

Subcategory Highlight

A tidal disruption event coincident with a high-energy neutrino

Time 13 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 02
Presenter Forum Table

Presenter
Robert Stein
Author and Co-Author
Robert Stein,

Abstract
'IceCube discovered a diffuse flux of high-energy neutrinos in 2013, and recently identified the flaring gamma-ray blazar TXS 0506+056 as a likely neutrino source. However, a combined analysis of the entire resolved gamma-ray blazar population limited the contribution of such objects to no more than 27% of the total neutrino flux, leaving the vast majority of the neutrino flux unexplained. Here we present the identification of a second probable neutrino source, the Tidal Disruption Event (TDE) AT2019dsg, found as part of a systematic search for optical counterparts to high-energy neutrinos using the Zwicky Transient Facility. The probability of finding such a TDE with our follow-up program by chance is just 0.2%. Multi-wavelength observations reveal the presence of a central engine powering particle acceleration in AT2019dsg, and confirm that this object can satisfy necessary conditions for PeV neutrino production.'

Collaborations
other (fill field below), Zwicky Transient Facility (ZTF)

Keywords and Comments
'Neutrino; TDE; optical follow-up', ''

Branch 1_Plenary

Subcategory Highlight

High-energy neutrino emission from blazars

Time 16 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Highlight 05
Presenter Forum Table

Presenter
Foteini Oikonomou
Author and Co-Author
Foteini Oikonomou, Maria Petropoulou Petropoulou | Kohta Murase

Abstract
'Active galactic nuclei (AGN) with relativistic jets are the most\r\npowerful persistent astrophysical sources of electromagnetic radiation\r\nin the Universe. Blazars are the most extreme subclass of AGN with\r\njets directed along our line of sight and emission relativistically\r\nbeamed in our direction. Their high-energy photon emission dominates\r\nthe extragalactic gamma-ray sky and reaches multi-TeV energies. This\r\ndemonstrates that they accelerate electrons to very high energies. It\r\nhas long been suspected that blazars may also accelerate protons to\r\nvery high energies and thus be cosmic neutrino sources. Being\r\nextremely rare objects in addition to being bright, blazars are among\r\nthe most readily testable neutrino candidate source classes.\r\n\r\nA number of multi-messenger monitoring campaigns have recently been\r\ntriggered in response to high-energy neutrinos observed with the\r\nIceCube Neutrino Observatory from the direction of blazars. In this\r\ntalk, I will discuss the theoretical interpretation of these\r\nobservations and give an overview of the possible role of blazars as\r\nneutrino sources in light of the experimental results. Finally, I will\r\ndiscuss the prospects of confirming blazars as high-energy hadron\r\naccelerators with future neutrino observations based on theoretical\r\nexpectations.'

Collaborations

Keywords and Comments
'blazars; high-energy neutrinos; leptohadronic modelling', ''

Branch 1_Plenary

Subcategory Highlight

New Results from the first 5 years of CALET observations on the International Space Station

Time 16 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Highlight 05
Presenter Forum Table

Presenter
Pier Simone Marrocchesi
Author and Co-Author
Pier Simone Marrocchesi | for the CALET collaboration,

Abstract
'The CALorimetric Electron Telescope (CALET), developed and operated by Japan in collaboration with Italy and the United States, is a high-energy astroparticle physics experiment installed on the International Space Station (ISS). Its mission goals include investigating the possible presence of nearby sources of high-energy electrons, performing direct measurements of observables sensitive to the details of the acceleration and propagation of galactic particles, and detecting potential dark matter signatures. \r\nCALET measures cosmic-ray electron+positron flux up to 20 TeV, gamma rays up to 10 TeV, and nuclei up to 1,000 TeV. Charge measurements cover from Z=1 to 40 allowing to study the more abundant elements and to extend the range of long-term observations above iron. CALET is collecting science data on the International Space Station since October 2015 with excellent and continuous performance with no major interruptions. Approximately 20 million triggered events per month are recorded with energies > 10 GeV. Here, we present the highlights of CALET observations carried out during the first 5.5 years of operation, including the electron+positron energy spectrum, the spectra of protons and other nuclei, gamma-ray observations, as well as the characterization of on-orbit performance. Some results on the electro-magnetic counterpart search for LIGO/Virgo gravitational wave events and the observations of solar modulation and gamma-ray bursts are also included.'

Collaborations
CALET,

Keywords and Comments
'Cosmic-rays; Direct CR measurements; International Space Station', 'This talk is proposed as candidate for a possible Highlight Talk'

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Branch 1_Plenary

Subcategory Highlight

Highlights of LHAASO science results

Time 19 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 07
Presenter Forum Table

Presenter
Zhen Cao
Author and Co-Author
Zhen Cao,

Abstract
'LHAASO is a large hybrid extensive air shower (EAS) array being constructed at Haizi Mountain, 4410 m a.s.l., in China. It is composed of three sub-arrays: a 1.3 km array (KM2A) for gamma-ray astronomy above 10 TeV and cosmic ray physics, a 78000 m water Cherenkov detector array (WCDA) for TeV gamma-ray astronomy, and 18 wide field-of-view air Cherenkov/fluorescence telescopes (WFCTA) for cosmic ray physics from 10 TeV to 1 EeV. A considerable proportion of the LHAASO detectors have been operating since 2019 and the whole array will be completed in June 2021. LHAASO has became the most sensitive detector at UHE in the world with detecting many UHE gamma-ray sources. Some important progresses and new discoveries have been made in the gamma-ray astronomy. In this work, we will report the status of LHAASO and the achieved important progresses in both gamma-ray and cosmic-ray observations.'

Collaborations
Lhaaso,

Keywords and Comments
'LHAASO; UHE gamma-ray; Cosmic ray', 'Apply highlight talk for the LHAASO collaboration.'

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Branch 1_Plenary

Subcategory Highlight

Neutrino Telescope in Lake Baikal: Present and Nearest Future

Time 12 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 01
Presenter Forum Table

Presenter
Zhan-Arys Dzhilkibaev
Author and Co-Author
Zhan-Arys Dzhilkibaev | for Baikal-GVD collaboration,

Abstract
'The progress in the construction and operation of the Baikal Gigaton Volume Detector inLake Baikal is reported. The detector is designed for search for high energy neutrinos whose sources are not yet reliably identified. It currently includes over 2000 optical modules arranged on 56 strings, providing an effective volume of 0.35 km3 for cascades with energy above 100 TeV. We review the scientific case for Baikal-GVD, the construction plan, and first results from the partially built experiment which is currently the largest neutrino telescope in the Northern Hemisphere and still growing up.'

Collaborations
other (fill field below), Baikal-GVD

Keywords and Comments
'astrophysics; cherenkov telescope', ''

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Branch 1_Plenary

Subcategory Highlight

IceCube: The Window to the Extreme Universe

Time 16 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 06
Presenter Forum Table

Presenter
Marek Kowalski
Author and Co-Author
Marek Kowalski | Albrecht Karle,

Abstract
'The discovery of cosmic neutrinos of TeV-PeV energies, announced by IceCube in 2013, has opened a new window to the high energy Universe. The observations made to date have already brought us closer to answering key questions, such as: what are the sources of the observed cosmic neutrinos and how do they drive particle acceleration; where are cosmic rays of extreme energies produced and how do they propagate through the universe; and are there signatures of new physics at TeV---EeV energies?\r\n IceCube-Gen2, a next generation neutrino observatory, is designed to address these questions. In conjunction with continued progress in multi-messenger astrophysics, IceCube-Gen2 promises to elevate the field of cosmic neutrinos from the discovery realm to the era of surveys of the neutrino sky.\r\nIceCube-Gen2 will greatly enhance the existing IceCube detector at the South Pole. It will increase the annual rate of observed cosmic neutrinos by an order of magnitude, and will be able to detect sources five times fainter. Furthermore, through the addition of a radio array, IceCube-Gen2 will extend the sensitive energy range beyond EeV energies. The design of IceCube-Gen2 greatly profits from the available experience gained through IceCube and from additional improvements in technology.'

Collaborations
IceCube-Gen2,

Keywords and Comments
'Neutrino astronomy; neutrino physics; future projects', ''

Branch 1_Plenary

Subcategory Highlight

Polarized muons and the origin of biological homochirality

Time 19 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 07
Presenter Forum Table

Presenter
Noemie Globus
Author and Co-Author
Noemie Globus | Anatoli Fedynitch,

Abstract
'While biologists have not yet reached a consensus on the definition of life, biological homochirality seems to be strongly linked to life’s emergence. The unraveling of its origin require interdisciplinary research, by exploring each of fundamental physics, chemistry, astrophysics and biology. In this talk, I will focus on the origin of biological homochirality in the context of astrophysics and particle physics. The weak force, one of the fundamental forces operating in nature, is parity-violating. Cosmic rays, high energy particles coming from outer space, induce showers of billions of secondary particles when they interact with atoms in the atmosphere. On Earth, at ground level, most of our cosmic radiation dose comes from polarized muons formed in a decay involving the weak force. I will show how the spin-polarization is transmitted in cosmic showers in several different environments where life could have started. I will also show how this polarization could have induced a biological chiral preference and I will discuss the implications for the search of life in other worlds.'

Collaborations

Keywords and Comments
'astrobiology', 'cosmic-rays and the origin of life'

Branch 1_Plenary

Subcategory Highlight

Highlights from the Telescope Array experiment

Time 14 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 03
Presenter Forum Table

Presenter
Grigory Rubtsov
Author and Co-Author
Grigory Rubtsov | for the Telescope Array collaboration,

Abstract
"The Telescope Array (TA) is the largest cosmic ray observatory in the Northern Hemisphere. It is designed to measure the properties of cosmic rays over a wide range of energies. TA with it's low energy extension (TALE) observe cosmic ray induced extensive air showers between 2x10^15 and 2x10^20eV in hybrid mode using multiple instruments, including an array of scintillator detectors at the Earth's surface and telescopes to measure the fluorescence and Cerenkov light. The statistics at the highest energies are being enhanced with the ongoing construction of the TAx4 experiment which will quadruple the surface area of the detector. We review the present status of the experiments and most recent physics results on the cosmic ray anisotropy, chemical composition and energy spectrum. Notable highlights include a new feature in the energy spectrum at about 10^19.2 eV., and a new clustering of events in their arrival directions above this energy. We also report on a new spectrum and composition results in the lower energy range from the TALE extension."

Collaborations
Telescope Array,

Keywords and Comments
'ultra-high energy cosmic rays; cosmic ray anisotropy; UHECR spectrum; UHECR chemical composition', ''

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Branch 1_Plenary

Subcategory Highlight

The Southern Wide-field Gamma-ray Observatory: Status and Prospects

Time 21 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Theater of Dreams
Presenter Forum Table

Presenter
Jim Hinton
Author and Co-Author
Jim Hinton, for the SWGO Collaboration

Abstract
'The Southern Wide-field Gamma-ray Observatory (SWGO) Collaboration is currently engaged in design and prototyping work towards the realisation of this future gamma-ray facility. SWGO will complement CTA and the existing ground-particle based-detectors of the Northern Hemisphere (HAWC and LHAASO) with a very wide field and high duty cycle view of the southern sky. In this talk I will present the status of the project and plans for the future, including expectations for sensitivity and science targets as well as the status of the site search and technological developments.'

Collaborations
SWGO,

Keywords and Comments
'ground particle-based gamma-ray observatory', ''

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Branch 1_Plenary

Subcategory Highlight

Recent status and results of the Dark Matter Particle Explorer

Time 16 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Highlight 05
Presenter Forum Table

Presenter
Xiang Li
Author and Co-Author
Xiang Li | On behalf of the DAMPE collaboration,

Abstract
'The DArk Matter Particle Explorer (DAMPE) is a satellite-borne, calorimetric type, high-energy-resolution space cosmic ray and gamma-ray detector. It was launched in December 2015 and has been stably operating for more than five years. Its three major scientific objectives are dark matter indirect detection, cosmic ray physics and gamma-ray astronomy. Precise measurements of the all-electron, proton and Helium spectra in wide energy ranges have been obtained, shedding new light on the research of cosmic ray physics and dark matter properties. We will also present the current status of the mission and its recent physical results.'

Collaborations
DAMPE,

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Highlight

The Pacific Ocean Neutrino Experiment at Ocean Networks Canada

Time 21 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Theater of Dreams
Presenter Forum Table

Presenter
Elisa Resconi
Author and Co-Author
Juan-Pablo Yanez | Elisa Resconi | For the P-ONE Collaboration,

Abstract
'Neutrino telescopes are unrivaled tools to explore the Universe at its most extreme. The current generation of telescopes has shown that very high energy neutrinos are produced in the cosmos, even with hints of their possible origin, and that these neutrinos can be used to probe our understanding of particle physics at otherwise inaccessible regimes. The fluxes, however, are low, which means newer, larger telescopes are needed. Here we present the Pacific Ocean Neutrino Experiment, a proposal to build a multi-cubic-kilometer neutrino telescope off the coast of Canada. The idea builds on the experience accumulated by previous sea-water missions, and the technical expertise of Ocean Networks Canada that would facilitate deploying such a large infrastructure. The design and physics potential of the first stage and a full-scale P-ONE are discussed.'

Collaborations
, P-ONE

Keywords and Comments
'Neutrino astronomy; neutrino telescope; photodetection; high energy physics; Pacific Ocean Neutrino Experiment', ''

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Branch 1_Plenary

Subcategory Highlight

The Askaryan Radio Array (ARA)

Time 21 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Highlight 09
Presenter Forum Table

Presenter
Kara Hoffman
Author and Co-Author
Kara Hoffman | For the ARA Collaboration,

Abstract
'The Askaryan Radio Array (ARA) is an in-ice radio array near the South Pole designed to detect ultra-high energy (UHE) neutrinos via Askaryan radio emission, induced by their interactions in the ice. ARA has accumulated a dataset with the world's best sensitivity to neutrinos above 10^{18} eV. I will review the status of ARA, results from neutrino searches to date, outlook for the future, and implications for future arrays.'

Collaborations
other (fill field below), ARA (The Askaryan Radio Array)

Keywords and Comments
'Askaryan; neutrinos; ultra high energy', ''

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Branch 1_Plenary

Subcategory Highlight

Highlights from gamma-ray observation by the Tibet ASgamma experiment.

Time 15 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 04
Presenter Forum Table

Presenter
Masato Takita
Author and Co-Author
Masato Takita,

Abstract
'The Tibet ASgamma experiment is located at 4,300m above sea level, in Tibet, China.\r\n The experiment is composed of a 65,000 m2 surface air shower array and 3,400 m2\r\n underground water Cherenkov muon detectors. The surface air shower array is used\r\n for reconstructing the primary particle energy and direction, while the underground\r\n muon detectors are used for discriminating gamma-ray induced muon-poor air showers from \r\n cosmic-ray (proton, helium,...) induced muon-rich air showers.Recently,the Tibet ASgamma\r\n experiment successfully observed gamma rays in the 100 TeV region from some \r\n point/extended sources as well as sub-PeV diffuse gamma rays along the Galactic disk.\r\n In this talk, The observational results as well as their interpretations will be presented,\r\n followed by some future prospect.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Highlight

Future Missions for MeV Gamma-Ray Astrophysics

Time 15 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 04
Presenter Forum Table

Presenter
Andreas Zoglauer
Author and Co-Author
Andreas Zoglauer,

Abstract
"The Universe in the MeV gamma-ray range is characterized by the most violent explosions, such as mergers, and supernovae, as well as the most powerful and dynamic sources such as pulsars, and black holes. The next generation of gamma-ray telescopes will be tasked with unraveling the life cycle of the elements by observing the de-excitation of newly generated nuclei from supernovae and mergers, gaining insight into the evolution and acceleration mechanisms in jets of, e.g., blazars, contributing to multi-messenger astrophysics by studying astrophysical events that produce gravitational waves and neutrinos, better understanding the physics in the most extreme environments such as neutron stars and near black holes, searching for signatures of dark matter in the MeV band, solving mysteries such as the Fermi bubbles and the origin of the Galactic positrons, and many more. These discoveries will be enabled by the groundbreaking new capabilities of the next generation of MeV gamma-ray telescopes.\r\nCOSI, the Compton Spectrometer and Imager, is a 0.2-5 MeV Compton telescope capable of imaging, spectroscopy, and polarimetry of astrophysical sources. Such capabilities are made possible by COSI's germanium cross-strip detectors, which provide high efficiency, high resolution spectroscopy and precise 3D positioning of photon interactions. COSI is currently in a competitive Phase A concept study to consider COSI as a Small Explorer (SMEX) satellite mission. As a proof-of-concept of this new generation of telescopes, COSI had a successful 42-day stratospheric balloon flight in 2016, and was able to observe the 511-keV emission near the Galactic center region as well as several other astrophysical sources such as Crab, Cen-A, and Cyg X-1.\r\n\r\nThe All-sky Medium-Energy Gamma-ray Observatory Explorer (AMEGO-X) is an envisioned combined Compton-scattering and pair-creation telescope operating in the 200 keV to 20 GeV energy range. It will consist of an electron tracker made of Silicon detectors and a CsI calorimeter. In the Compton regime it will enable Compton recoil-electron tracking and thus enable unprecedented background reductions.\r\n\r\nGECCO, the Galactic Explorer with Coded aperture mask Compton telescope, is a mission concept which will operate in the 100 keV to 10 MeV range, and will combine the background reduction and sensitivity of a Compton telescope with the angular resolution of a coded mask.\r\n\r\nIn the presentation, we will discuss and compare the science goals, designs, and current status of these and a few more future MeV gamma-ray telescope projects, and present the latest results of the analysis of the 2016 COSI balloon flight."

Collaborations

Keywords and Comments

",
"

Branch 1_Plenary

Subcategory Highlight

Nearly a Decade of Cosmic Ray Observations in the Very Local Interstellar Medium

Time 16 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 06
Presenter Forum Table

Presenter
J.S. Rankin
Author and Co-Author
J.S. Rankin,

Abstract
'In 2012, the centennial year of the discovery of cosmic rays, Voyager 1 crossed the heliopause and began making the very first in-situ observations of the surrounding interstellar medium. Joined by Voyager 2 in 2018, these twin spacecraft continue to provide critical measurements of cosmic rays in a surprising, previously-unexplored plasma regime. This highlight talk will review the insights, discoveries, and open questions that have emerged from nearly a decade of cosmic ray observations in the very local interstellar medium, including: i) characteristics of the low-energy spectrum (down to a few MeV/nuc) and implications for propagation models, ii) the discovery of transient, anisotropic cosmic ray disturbances, and iii) cosmic rays in the context of our time-varying, global heliosphere.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Highlight

Highlights from the GRAPES-3 experiment

Time 16 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 06
Presenter Forum Table

Presenter
Pravata Mohanty
Author and Co-Author
Pravata Mohanty, On behalf of the GRAPES-3 collaboration

Abstract
'The GRAPES-3 experiment located in Ooty, India is designed to observe cosmic rays and gamma rays in the TeV-PeV energy range from a near-equatorial location through a dense array of scintillator detectors and a large area muon telescope. Here, we will discuss the recent measurements on the cosmic ray energy spectrum and mass composition, (1) between 10 and 100 TeV while providing a comparison with the direct measurements, and (2) in the knee region between 100 TeV and 10 PeV by comparing with other ground based measurements. Results on diffuse and point source gamma ray studies above 30 TeV performed by leveraging an excellent angular resolution achieved recently and by using the muon content measurements in each shower will be discussed. A large number of atmospheric events recorded by the muon telescope associated with thunderstorm electric field acceleration, an azimuthal asymmetry observed in the direction of these events and understanding of this asymmetry through muon charge ratio will be discussed. The status of the upgrade of the experiment with the installation of another muon telescope of similar area and advanced new electronics to enhance its physics potential will be presented.'

Collaborations
other (fill field below), GRAPES-3

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Highlight

The advantages of making science accessible

Time 20 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 08
Presenter Forum Table

Presenter
Erika Labbé
Author and Co-Author
Erika Labbé,

Abstract
'At first it was a challenge of scientific communication, now it is a way of life. Making science accessible to people with disabilities holds a potential that goes beyond social responsibility or empathy. It is also about making diversity an integral part of scientific development, incorporating people full of curiosity with new approaches to face problems.\r\nWe propose to start by reviewing our own perception of disability, giving people with disabilities and people involved in their education and caretaking the opportunity to tell us about it, and by opening our minds to new ways of doing science.\r\nInclusive astronomy drives us to be creative, to generate networks and to collaborate in an interdisciplinary way. We hope that this initiative will extend to other areas of scientific research.'

Collaborations

Keywords and Comments
'', ''

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Branch 1_Plenary

Subcategory Highlight

Transition from Galactic to Extragalactic Cosmic Rays

Time 13 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 02
Presenter Forum Table

Presenter
Alex Kääpä
Author and Co-Author
Alex Kääpä,

Abstract
"Understanding the nature of the transition from Galactic to extragalactic cosmic rays (GCRs and EGCRs) has become a challenge in light of recent spectral and composition data. Galactic contributions appear to be disfavoured at energies beyond $10^{17} \\, {\\rm eV}$ where the composition becomes lighter, and extragalactic sources appear to inject mixed compositions, complicating the description of the EGCR contribution below ``ankle'' energies. As a result, the measured flux in the transition region cannot easily be accounted for. With the model-dependence of proposed extensions to both the Galactic and extragalactic contributions, a deeper understanding of CR propagation is in order, particularly within the Galactic magnetic field (GMF) as propagation herein shifts from diffusive to ballistic at these energies, which is expected to lead to a range of effects on CRs. \r\n\r\nUsing CRPropa3, we study these effects for rigidities between $10^{16-20} \\, {\\rm V}$. We identify various features at rigidities where the gyroradius equals typical length scales of the Galaxy, suggesting causes related to changes in the propagation regime. We further quantify modifications in the spectrum, composition and arrival direction of GCRs and EGCRs. We find that the GMF naturally induces a flux suppression of GCRs towards higher rigidities. This, in consequence, would lead to an increase in the mean mass of GCR primaries up to energies around the ``ankle'' in the cosmic ray spectrum. The distribution of GCR arrival directions is also shown to be correlated with the Galactic plane for rigidities above $10^{17}\\, {\\rm V}$. EGCRs experience no flux modification in the GMF if injected isotropically. Injection of pure dipoles, as well as single source scenarios indicate that the GMF isotropises injected anisotropies below $10^{18} \\, {\\rm V}$, but can still cause flux modifications depending on the direction of the anisotropy. Overall consequences to the transition of GCRs to EGCRs will be discussed."

Collaborations

Keywords and Comments
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Branch 1_Plenary

Subcategory Highlight

AMS Highlights

Time 12 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 01
Presenter Forum Table

Presenter
Javier Berdugo
Author and Co-Author
Javier Berdugo,

Abstract
'In nine years on the International Space Station, the Alpha Magnetic Spectrometer (AMS) has collected more than 170 billion cosmic rays measuring with unprecedented precision different components of the charged cosmic rays up to few TeVs. This includes fluxes of positrons, electrons, antiprotons, protons, and nuclei from helium to silicon and beyond. A summary of the latest results will be shown. Results on time variation of cosmic ray fluxes associated with solar activity on different time scales will be presented.'

Collaborations
AMS,

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Highlight

Highlights from direct dark matter detection

Time 14 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 03
Presenter Forum Table

Presenter
Marc Schumann
Author and Co-Author
Marc Schumann,

Abstract
'Direct detection experiments search for dark matter-induced signals in Earth-based detectors. I will present a short review on the current status and future of the field and will concentrate on selected results on the direct search for WIMPs, axions and beyond'

Collaborations

Keywords and Comments
", "

Branch 1_Plenary

Subcategory Highlight

Extragalactic cosmic ray sources

Time 21 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Highlight 09
Presenter Forum Table

Presenter
Michael Kachelriess
Author and Co-Author
Michael Kachelriess,

Abstract
'I review progress in ultrahigh-energy cosmic ray physics focusing on \r\nmodels developed for the interpretation of recent experimental results.\r\nEmphasis is put on models aiming to explain the transition from \r\nGalactic to extragalactic cosmic rays together with composition and \r\nanisotropy data. I discuss the additional constraints arising, if these \r\nsources contribute to the observed neutrino flux and, if time permits, \r\ncomment on the effect of extragalactic magnetic fields.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Highlight

CTA – the World's largest ground-based gamma-ray observatory

Time 21 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Highlight 09
Presenter Forum Table

Presenter
Roberta Zanin
Author and Co-Author
Roberta Zanin,

Abstract
'Very-high-energy (VHE) gamma-ray astroparticle physics is a relatively young field, and observations over the past decade have surprisingly revealed almost two hundred VHE emitters which appear to act as cosmic particle accelerators. These sources are an important component of the Universe, influencing the evolution of stars and galaxies. At the same time, they also act as a probe of physics in the most extreme environments known - such as in supernova explosions, and around or after the merging of black holes and neutron stars. However, the existing experiments have provided exciting glimpses, but often falling short of supplying the full answer. A deeper understanding of the TeV sky requires a significant improvement in sensitivity at TeV energies, a wider energy coverage from tens of GeV to hundreds of TeV and a much better angular and energy resolution with respect to the currently running facilities. The next generation gamma-ray observatory, the Cherenkov Telescope Array (CTA), is the answer to this need. In this talk I will present this upcoming observatory from its design to the construction, and its potential science exploitation. CTAO will allow the entire astronomical community to explore a new discovery space that will likely lead to paradigm-changing breakthroughs. In particular, CTA has an unprecedented sensitivity to short (sub-minute) timescale phenomena, placing it as a key instrument in the future of multi-messenger and multi-wavelength time domain astronomy. \r\nI will conclude the talk presenting the first scientific results obtained by the LST-1, the prototype of one CTA telescope type - the Large Sized Telescope, that is currently under commissioning.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Highlight

Space weather: Earth, neighboring planets and exoplanets

Time 15 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 04
Presenter Forum Table

Presenter
Norma Crosby
Author and Co-Author
Norma Crosby,

Abstract
"Modern society became vulnerable to a new type of extreme weather around the 19th century. It would later be coined space weather. This weather, observed as severe disturbances of the upper atmosphere and near-Earth space environment is driven by the Sun's magnetic activity. Not only does space weather affect Earth, but all planets in the Solar System are impacted by it. In essence, any planet in the Universe will have its own local space weather. The discovery of exoplanets has intensified interest in searching for habitable planets outside the Solar System and characterizing their local space weather. For this purpose, knowledge acquired about space weather at Earth and its neighboring planets is useful when studying space weather in other stellar systems. The talk will begin with an introduction to physical phenomena (e.g., flares, coronal mass ejections, energetic particles, galactic cosmic rays) that contribute to planetary space weather conditions. In the second part of the talk it will be discussed how extreme stellar activity could possibly influence the characteristics of exoplanets located in the 'Goldilocks Zone' in regard to their potential for habitability, as well as for life evolving on them. Specifically, examples of stellar superflares will be presented, posing the question: Can superflares also occur on our Sun and if yes, what would the consequences be if one did occur?"

Collaborations

Keywords and Comments
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Branch 1_Plenary

Subcategory Highlight

Fermi LAT and GBM collaboration results on GRB 200415A.

Time 12 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 01
Presenter Forum Table

Presenter
di Lalla Niccolo
Author and Co-Author
di Lalla Niccolo,

Abstract
'Magnetars are neutron stars with the strongest magnetic fields known in the Universe, with an intensity up to a thousand times higher than typical neutron stars. Rarely, magnetars can produce enormous eruptions, called Magnetar Giant Flares (MGF), consisting of short-duration bursts of hard X-rays and soft gamma rays – a bright and variable initial spike lasting a few tenths of a second and a significantly dimmer pulsating tail lasting a few hundred of seconds that can only be detected from MGFs within our close to our galaxy. On April 15, 2020, a short bright burst of MeV gamma rays triggered the Gamma-Ray Burst Monitor (GBM) aboard the Fermi spacecraft, called GRB 200415A and localized by the InterPlanetary Network (IPN) inside the disk of the nearby Sculptor galaxy. 19 seconds later, and for nearly 300 seconds, the Large Area Telescope (LAT) detected GeV photons in spatial coincidence with the signal at lower energies. In this talk we present the recently published results of the GBM and LAT analysis on GRB 200415A. Our detailed analysis shows that the low-energy emission has very peculiar properties typically observed in flares from nearby magnetars, while the GeV detection is consistent with the IPN localization and spatially associated with the Sculptor galaxy. Hence, we infer that gamma rays likely originated with the MGF in Sculptor, and not from a cosmological gamma-ray burst, and we suggest that the GeV signal is generated by an ultra-relativistic outflow that first radiates the prompt MeV-band photons. This discovery represents the first detection of the high-energy emission from a MGF and proves that extragalactic MGFs may indeed disguise as short GRBs and constitute a small fraction of current short GRB samples.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Highlight

Searching for Dark Matter from the Sun with IceCube

Time 19 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 07
Presenter Forum Table

Presenter
Jeffrey Lazar
Author and Co-Author
Jeffrey Lazar,

Abstract
"The existence of dark matter (DM) has been well-established by repeated experiments probing various length scales. Even though DM is expected to make up 85% of the current matter content of the Universe, its nature remains unknown. One broad class of corpuscular DM motivated by Standard Model (SM) extensions is weakly interacting massive particles (WIMPs). WIMPs can generically have a non-zero cross-section with SM nuclei, which allows them to scatter off nuclei in large celestial bodies such as the Sun, losing energy and becoming gravitationally bound in the process. After repeated scattering, WIMPs sink to the solar center, leading to an excess of WIMPs there. Subsequently, WIMPs can annihilate to stable SM particles, either directly or through a decay chain of unstable SM particles. Among stable SM particles, only neutrinos can escape the dense solar core. Thus, one may look for an excess of neutrinos from the Sun's direction as evidence of WIMPs. The IceCube Neutrino Observatory, which detects Cherenkov radiation of charged particles produced in neutrino interactions, is especially well-suited to such searches since it is sensitive to WIMPs with masses in the region preferred by supersymmetric extensions of the SM. In this contribution, I will present the results of and future prospects for IceCube's most recent solar WIMP search, which includes all neutrino flavors, covers the WIMP mass range from 10 GeV to 1 TeV, and has world-leading sensitivity over this entire range for most channels considered."

Collaborations
IceCube,

Keywords and Comments
", "

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Webpage icrc2021.desy.de

Branch 1_Plenary

Subcategory Highlight

Highlights from the Pierre Auger Observatory

Time 14 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Highlight 03
Presenter Forum Table

Presenter
Ralph Engel
Author and Co-Author
Ralph Engel,

Abstract
'tba'

Collaborations
Auger,

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Highlight

The High Energy cosmic-Radiation Detection (HERD) facility on board the Chinese Space Station: hunting for high-energy cosmic rays

Time 21 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Theater of Dreams
Presenter Forum Table

Presenter
Fabio Gargano
Author and Co-Author
Fabio Gargano,

Abstract
'tba'

Collaborations

Keywords and Comments
'', ''

Branch	1_Plenary
Subcategory	Highlight

Theater of Dreams CRI (GCOS)

Time	21 July 2021 | 16:00 - 17:30 | Berlin Time
Session	Plenary: Theater of Dreams
Presenter Forum Table	

Presenter
Jörg Hörandel
Author and Co-Author
Jörg Hörandel,

Abstract
'tbc'

Collaborations

Keywords and Comments
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Branch 1_Plenary

Subcategory Rapporteur

Rapporteur Talk: Cosmic Ray Indirect

Time 22 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Rapporteur 1
Presenter Forum Table

Presenter
Tareq Abu-Zayyad
Author and Co-Author
Tareq Abu-Zayyad,

Abstract
'At the final days of the conference, rapporteur speakers will summarise the main results of each scientific branch of the ICRC.'

Collaborations

Keywords and Comments
", "

Branch 1_Plenary

Subcategory Rapporteur

Rapporteur Talk: Cosmic Ray Direct

Time 22 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Rapporteur 1
Presenter Forum Table

Presenter
Philipp Mertsch
Author and Co-Author
Philipp Mertsch,

Abstract
'At the final days of the conference, rapporteur speakers will summarise the main results of each scientific branch of the ICRC.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Rapporteur

Rapporteur Talk: Gamma Ray Direct

Time 23 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Rapporteur 4
Presenter Forum Table

Presenter
Regina Caputo
Author and Co-Author
Regina Caputo,

Abstract
'At the final days of the conference, rapporteur speakers will summarise the main results of each scientific branch of the ICRC.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Rapporteur

Rapporteur Talk: Gamma Ray Indirect

Time 23 July 2021 | 16:00 - 17:30 | Berlin Time
Session Plenary: Rapporteur 4
Presenter Forum Table

Presenter
Alison Mitchell
Author and Co-Author
Alison Mitchell,

Abstract
'At the final days of the conference, rapporteur speakers will summarise the main results of each scientific branch of the ICRC.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Rapporteur

Rapporteur Talk: Dark Matter

Time 22 July 2021 | 16:00 - 18:00 | Berlin Time
Session Plenary: Rapporteur 2
Presenter Forum Table

Presenter
Marco Taoso
Author and Co-Author
Marco Taoso,

Abstract
'At the final days of the conference, rapporteur speakers will summarise the main results of each scientific branch of the ICRC.'

Collaborations

Keywords and Comments
'', ''

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Branch 1_Plenary

Subcategory Rapporteur

Rapporteur Talk: Neutrinos and Muons

Time 23 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Rapporteur 3
Presenter Forum Table

Presenter
Anna Friederike Nelles
Author and Co-Author
Anna Friederike Nelles,

Abstract
'At the final days of the conference, rapporteur speakers will summarise the main results of each scientific branch of the ICRC.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Rapporteur

Rapporteur Talk: Solar and Heliospheric

Time 22 July 2021 | 16:00 - 18:00 | Berlin Time
Session Plenary: Rapporteur 2
Presenter Forum Table

Presenter
Du Toit Strauss
Author and Co-Author
Du Toit Strauss,

Abstract
'At the final days of the conference, rapporteur speakers will summarise the main results of each scientific branch of the ICRC.'

Collaborations

Keywords and Comments
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Branch 1_Plenary

Subcategory Rapporteur

Rapporteur Talk: Multi Messenger

Time 23 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Rapporteur 3
Presenter Forum Table

Presenter
Irene Tamborra
Author and Co-Author
Irene Tamborra,

Abstract
'At the final days of the conference, rapporteur speakers will summarise the main results of each scientific branch of the ICRC.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Rapporteur

Rapporteur Talk: Outreach and Education

Time 22 July 2021 | 16:00 - 18:00 | Berlin Time
Session Plenary: Rapporteur 2
Presenter Forum Table

Presenter
Michael Burton
Author and Co-Author
Michael Burton,

Abstract
'At the final days of the conference, rapporteur speakers will summarise the main results of each scientific branch of the ICRC.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Review

Constraining Magnetic Fields at Galactic Scales

Time 13 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Review 01
Presenter Forum Table

Presenter
Tess Jaffe
Author and Co-Author
Tess Jaffe,

Abstract
'Magnetic fields are ubiquitous in the Universe, from compact objects to cosmic scales, and they play a central role in a variety of astrophysical processes. Surprisingly, even the Galactic magnetic field (GMF) in our own Milky Way remains poorly understood because of the challenges of observing it and the complexity of the phenomena we use to study it. Though we still have too many models that might fit the data, this is not to say that the field has not developed in the last few years. Radio observations have been used since the 1970’s to study the GMF and remain one of the most useful tracers. More recently, surveys of polarized dust have given us a new observable that is complementary to the more traditional radio tracers. A variety of other new tracers and related measurements are becoming available to improve current understanding. In this talk, I will summarize: the tracers available; the models that have been studied; what has been learned so far; what the caveats and outstanding issues are; and one opinion of where the most promising future avenues of exploration lie.'

Collaborations

Keywords and Comments
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Branch 1_Plenary

Subcategory Review

Probing particle acceleration through gamma-ray Solar flare observations

Time 14 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Review 02
Presenter Forum Table

Presenter
Melissa Pesce-Rollins
Author and Co-Author
Melissa Pesce-Rollins,

Abstract
'High-energy solar flares have shown to have at least two distinct phases: prompt-impulsive and delayed-gradual. Identifying the mechanism responsible for accelerating the electrons and ions and the site at which it occurs during these two phases is one of the outstanding questions in solar physics. Many advances have been made over the past decade thanks to new observational data and refined simulations that together help to shed light on this topic. For example, the detection by Fermi Large Area Telescope (LAT) of GeV emission from solar flares originating from behind the visible solar limb and >100 MeV emission lasting for more than 20 hours have suggested the need for a spatially extended source of acceleration during the delayed emission phase. In this talk I will review some of the major results from Fermi LAT observations of the 24th solar cycle and how this new observational channel combined with observations from across the electromagnetic spectrum can provide a unique opportunity to diagnose the mechanisms of high-energy emission and particle acceleration in solar flares.'

Collaborations

Keywords and Comments
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Branch 1_Plenary

Subcategory Review

Neutron Star Mergers as Multi-Messenger Sources

Time 19 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Review 04
Presenter Forum Table

Presenter
Brian Metzger
Author and Co-Author
Brian Metzger,

Abstract
'I will overview the multi-messenger signals of binary neutron star mergers, which for the first are now detectable via their gravitational wave emission. These signals include a thermal visual/infrared supernova-like transient ("kilonova") powered by the radioactive decay of heavy neutron-rich nuclei synthesized in the expanding merger ejecta; gamma-ray - and possibly high-energy neutrino - emission powered by outflows from the newly formed black hole remnant; and non-thermal emission across the electromagnetic spectra generated as the merger ejecta collides with the interstellar medium. Tentative hints have recently emerged for a new component of X-ray emission from LIGO/Virgo\'s first merger, GW170817, with potential implications for heavy nuclei cosmic ray acceleration in these events. Time permitting, I will highlight the potential diversity of multi-messenger signals expected from future mergers, particularly of the lowest mass binaries which may give birth to long-lived rapidly spinning magnetar remnants and "look" qualitatively different from GW170817.'

Collaborations

Keywords and Comments
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Branch 1_Plenary

Subcategory Review

Gamma-Ray Bursts detected at Very High Energies

Time 13 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Review 01
Presenter Forum Table

Presenter
Lara Nava
Author and Co-Author
Lara Nava,

Abstract
'Very high energy (VHE, >100 GeV) radiation from GRBs has eluded for several years all attempts of detection by Cherenkov telescopes, until the recent detection of strong VHE emission from the long GRB 190114C, located at redshift z=0.42.\r\nThe inclusion of TeV data in the modeling of afterglow multi-wavelength (from radio to X-rays) observations allows us to estimate physical properties that are usually unconstrained, such as the density of the external medium, the energy of the emitting particles, and the strength of the shock-amplified magnetic field. Since the first announcement of VHE detection from a GRB, three additional GRBs have been firmly detected by Cherenkov telescopes. In this talk I review the present status of observations and interpretation of VHE emission from GRBs. Prospects for future detections with the ASTRI-Mini Array and with CTA, revised in light of these recent observations, reveal that the VHE band is a very promising energy window for progressing our knowledge of GRB physics.'

Collaborations

Keywords and Comments
'', ''

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Branch 1_Plenary

Subcategory Review

The Muon Puzzle in air showers and its connection to the LHC

Time 15 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Review 03
Presenter Forum Table

Presenter
Hans Dembinski
Author and Co-Author
Hans Dembinski,

Abstract
"High-energy cosmic rays are observed indirectly by detecting the extensive air showers initiated in Earth's atmosphere. The interpretation of these observations relies on accurate models of air shower physics, which is a challenge and an opportunity to test QCD under extreme conditions. Air showers are hadronic cascades, which eventually decay into muons. The muon number is a key observable to infer the mass composition of cosmic rays. Air shower simulations with state-of-the-art QCD models underpredict the observed muon content; this is called the Muon Puzzle. The origin of this discrepancy has been traced to the composition of secondary particles in hadronic interactions. The muon discrepancy starts at the TeV scale, which suggests that this change in hadron composition is observable at the Large Hadron Collider. An effect that can potentially explain the puzzle has been observed at the LHC, but more experimental data in the forward region and with future oxygen beams at the LHC is needed to fully understand the impact. I will review what we currently know about the Muon Puzzle and which measurements at the LHC may point to a solution."

Collaborations

Keywords and Comments
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Branch 1_Plenary

Subcategory Review

Propagation of cosmic rays in Galactic turbulence: theory confronted with observations

Time 19 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Review 04
Presenter Forum Table

Presenter
Huirong Yan
Author and Co-Author
Huirong Yan,

Abstract
'Cosmic ray propagation is determined by the properties of interstellar turbulence. The multiphase nature of ISM and diversity of driving mechanisms give rise to spatial variation of turbulence properties. In the meantime, precision astroparticle experiments pose challenges to the conventional picture of homogeneous and isotropic transport of cosmic rays (CRs). We are beginning a new chapter of CR propagation research when studies of particle transport and interstellar turbulence can confront each other. I shall review our current understandings of the fundamental processes governing cosmic ray propagation, different regimes of particle transport, augmented with insight from multi-wavelength observations. Challenges and issues from bridging the current CR propagation paradigm and astroparticle measurements will be discussed.'

Collaborations

Keywords and Comments
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Branch 1_Plenary

Subcategory Review

Dark Matter: Knowns and Unknowns

Time 14 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Review 02
Presenter Forum Table

Presenter
Tracy Slatyer
Author and Co-Author
Tracy Slatyer,

Abstract
': I will give an overview of the landscape of possible scenarios for dark matter, including a discussion of current constraints and some future directions for the field. I will comment on the status of several claimed anomalies, their possible relationships to dark matter physics, and alternative explanations.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Review

Energetic particle observations close to the Sun by Solar Orbiter and Parker Solar Probe

Time 20 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Review 05
Presenter Forum Table

Presenter
Olga E. Malandraki
Author and Co-Author
Olga E. Malandraki | David McComas | J. Rodríguez-Pacheco | N. Schwadron | R. F. Wimmer-Schweingruber | G.C. Ho,

Abstract
'Solar Energetic Particles (SEPs) constitute an important contributor to the characterization of the space environment. They are emitted from the Sun in association with solar flares and Coronal Mass ejection (CME)-driven shock waves. SEP radiation storms may have durations from a period of hours to days or even weeks and have a large range of energy spectrum profiles. These events pose a threat to modern technology strongly relying on spacecraft, are a serious radiation hazard to humans in space, and are additionally of concern for avionics and commercial aviation in extreme circumstances. However, after decades of observations of SEPs from space-based observatories, relevant questions on particle injection, transport, and acceleration remain open. Understanding how particles are accelerated at the Sun to high energies (even relativistic) and how these particles propagate from their acceleration site to fill the heliosphere is one of the key questions that the Solar Orbiter (SoLO) ESA mission has set out to answer by means of the Energetic Particle Detector (EPD) measurements. Furthermore, the NASA's Parker Solar Probe (PSP) mission also addresses key questions regarding energetic particles, utilizing measurements by the Integrated Science Investigation of the Sun (ISOIS) instrument suite very close to the Sun, in a region that no spacecraft has been before. In this talk, a review of the new, exciting measurements of energetic particles in the near-Sun environment obtained by these two pioneering missions and the exciting, new results derived will be presented. How SoLO/EPD and PSP/ISOIS observations are advancing our current knowledge and understanding of the energetic particle environment close to the Sun (e.g. SEPs, cosmic rays, Corotating Interaction Region -associated suprathermal ions) will be reviewed.'

Collaborations

Keywords and Comments
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Branch 1_Plenary

Subcategory Review

Turbulence and its impact on particle acceleration/transport and the implications on gamma-ray observations

Time 20 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Review 05
Presenter Forum Table

Presenter
Siyao Xu
Author and Co-Author
Siyao Xu,

Abstract
'Gamma-ray observations of the Milky Way and star-forming galaxies provide a powerful tool for studying the acceleration and transport of energetic particles near a diverse variety of their sources and in the interstellar medium (ISM). Inefficient diffusion around cosmic ray (CR) acceleration sites suggested by pulsar TeV halos and in the vicinity of supernova remnants challenges the simplified scenario with homogeneous diffusion of CRs. The development of fundamental theories of magnetohydrodynamic (MHD) turbulence and the numerical tools for studying their interactions with CRs leads to a significant progress in our understanding on the acceleration and transport of CRs. Meanwhile, novel techniques and rich observational data bring us unprecedented informative maps of turbulent magnetic fields in the multi-phase and multi-scale ISM. In this talk, I will present a review on the recent findings in gamma-ray astronomy, theoretical and numerical developments on studying particle acceleration and transport, new techniques for mapping interstellar turbulent magnetic fields, and finally, their synergy toward a better understanding on the origin of CRs.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Review

Underwater Neutrino telescopes: status and future

Time 15 July 2021 | 14:00 - 15:30 | Berlin Time
Session Plenary: Review 03
Presenter Forum Table

Presenter
Paschal Coyle
Author and Co-Author
Paschal Coyle,

Abstract
'Large underwater neutrino telescopes not only allow us to scrutinize the sky for high energy cosmic neutrinos but to also study the fundamental properties of the neutrino themselves. Being located in the northern hemisphere they provide an excellent view of the Galactic Centre and the Galactic Plane. Furthermore, their clear waters with low light scattering offer the prospect of an unprecedented angular resolution for neutrino astronomy. \r\n\r\nIn this presentation recent results from the first pioneering telescopes BAIKAL and ANTARES will be summarised. The latest status and prospects of their successors GVD and KM3NeT, the next generation of underwater telescopes will be presented.'

Collaborations

Keywords and Comments
'', ''

Branch 1_Plenary

Subcategory Sustainability

Sustainability in Astroparticle Physics

Time
Session Plenary: Sustainability
Presenter Forum Table

Presenter
Stefan Funk
Author and Co-Author
Stefan Funk | Uli Katz | Markus Roth,

Abstract
'Moderator:\r\nStefan Funk (FAU)\r\nUlrich Katz (FAU)\r\nMarkus Roth (KIT)\r\n\r\nSpeaker:\r\nKnud Jahnke: General intro into the topic\r\nVolker Lindenstruth: Green Computing\r\nVictoria Grinberg: Conferences/Travel\r\nChristos Markou: Green Experiment'

Collaborations

Keywords and Comments
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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

An Helium calorimeter for Anti-Deuteron identification in cosmic rays

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 388

Presenter
Francesco Nozzoli
Author and Co-Author
Francesco Nozzoli | Roberto Iuppa | Ester Ricci | Paolo Zuccon,

Abstract
'Low energy anti-deuterons in cosmic rays are considered a golden channel for the search of Dark matter annihilations in the galaxy.\r\nAnti Deuteron Helium Detector (ADHD) project is aiming to study the signatures offered by an high pressure Helium target for the identification of anti-deuterons in cosmic rays.\r\nIn particular exotic atoms are produced by stopping anti-protons/anti-deuterons in the gas and the captured particle can orbit the Helium nucleus for microseconds before the annihilation. This meta-stability is a unique feature for the Helium target and the characteristic delayed annihilation is a distinctive signature to identify the antimatter nature of the stopping particle. \r\nA possible configuration for ADHD space/balloon detector consists of a pressurized helium calorimeter surrounded by scintillator layers for velocity measurement.\r\nAnti-deuterons are identified by combining the spectrometric measurement of the stopping particle (velocity/energy) with the delayed emission of outgoing charged pions caused by the annihilation.\r\nA prototype of the pressurized calorimeter, filled by 200 Bar Helium acting as a scintillator, has been characterized with cosmic muons and with 70-240 MeV proton beam in the INFN-TIFPA laboratory.\r\nSensitivity of the possible Anti-Deuteron-Helium-Detector for the measurement of low energy anti-deuterons and anti-protons in cosmic rays will be summarized and the results of the measured performance of the helium calorimeter prototype will be addressed.'

Collaborations
, ADHD

Keywords and Comments
'Antimatter; dark matter; antideuteron; antiproton; detector', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Empirical assessment of cosmic ray propagation in magnetised molecular cloud complexes

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 14 CRs and ISM | CRD
Presenter Forum Table

Presenter
Ellis Owen
Author and Co-Author
Ellis Owen, Alvina On | Kinwah Wu | Shih-Ping Lai

Abstract
'Molecular clouds are complex magnetised structures, with variations over a broad range of length scales. Ionisation in dense, shielded clumps and cores of molecular clouds is thought to be caused by charged cosmic rays (CRs). These CRs can also contribute to heating the gas deep within molecular clouds, and their effect can be substantial when CRs are abundant. CR propagation is predominantly diffusive within disordered magnetised media, and the complex magnetic structures in molecular clouds therefore regulate the spatial propagation and distribution of CRs within them, and hence the local ionisation and heating patterns. \r\n\r\nOptical and near-infrared (NIR) polarisation of starlight through molecular clouds can be used to trace magnetic fields. The diffusion coefficients of CRs through magnetised molecular cloud complexes can therefore be inferred from the observed fluctuations in these optical/NIR starlight polarisations. We present our calculations of the expected CR distribution and ionisation/heating patterns in the star-forming filaments of IC 5146, determined from optical/NIR observations. Our calculations show that the local conditions can lead to substantial variations in CR diffusion coefficients. This would affect the local CR heating power and the ionisation rate. These effects are more severe in galaxies that are rich in CRs. The molecular clouds within these galaxies could therefore evolve differently to those in galaxies where CRs are less abundant.'

Collaborations

Keywords and Comments
'Interstellar clouds; cosmic rays; galactic cosmic rays; interstellar magnetic fields; star formation', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

The Plastic Scintillator Detector of the HERD space mission

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 389

Presenter
Dimitrios Kyratzis
Author and Co-Author
Dimitrios Kyratzis | For the HERD Collaboration,

Abstract
'The High Energy cosmic Radiation Detector (HERD) is one of the prominent space-borne instruments to be installed on board the upcoming Chinese Space Station (CSS) in 2026 and is the result of a collaboration among chinese and european institutions. Primary scientific goals of HERD include: precise measurements of the cosmic ray (CR) energy spectra and mass composition at energies up to few PeV, electron/positron spectra up to tens of TeV, CR anisotropy, gamma ray astronomy and transient studies, along with indirect searches for Dark Matter particles. HERD is configured to accept incident particles from both its top and four lateral sides. Owing to its pioneering design, more than one order of magnitude increase in geometric acceptance is foreseen, with respect to previous and ongoing experiments.\r\nThe Plastic Scintillator Detector (PSD) constitutes an important sub-detector of HERD, particularly aimed towards photon tagging and precise charge measurements of incoming CR nuclei in a range of Z = 1 - 26. Main requirements concerning its design, include: high detection efficiency, broad dynamic range and good energy/charge resolution. In order to define the optimal layout, two configurations are currently under investigation: one based on long scintillator bars and the other on square tiles, with both layouts being readout by Silicon Photomultipliers (SiPMs). Ongoing activities and future plans regarding the HERD PSD will be presented in this work.'

Collaborations
other (fill field below), HERD

Keywords and Comments
'Space detectors; Cosmic Rays; Gamma-ray astronomy; Plastic scintillators; Silicon Photomultipliers;', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Data Acquisition Software for a Prototype of LET Spectrometer

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 390

Presenter
Wenrui Sun
Author and Co-Author
Wenrui Sun | Zhe Cao | Li Wang | Changqing Feng | Lei Zhao,

Abstract
'Silicon Micro-strip Detector (SMD) has been widely used in detecting charged particles. Using SMD as detector, and to measure the Linear Energy Transfer (LET) generated by the ionizing radiation in manned spacecraft, a prototype of LET spectrometer is designed. This paper presents the design of the data acquisition (DAQ) software for the LET spectrometer. To read out and preliminarily analyze the data, the DAQ software is consist of three modules, which are readout and control module, data real-time imaging module, and offline data analysis module. Multiple data tests are included in the DAQ software as a result of reliability requirement of the data. The DAQ software realizes the dual communication interface through the Ethernet interface of the back-end electronics, which are used to summarize the data generated from the three detectors of the prototype in the experiment, and the USB interface of the front-end electronics for debugging a single detector. Qt is used as the development tool for Windows platform, because of its excellent reliability and maintainability. Its cross-platform-ability is also important to operate in other platforms. Due to the small amount of data and high demand of efficiency, it is appropriate to choose C + + as the programming language. In the tests, the DAQ software shows good performance and fits the needs of application.'

Collaborations

Keywords and Comments
'LET spectrometer; data acquisition software; Qt', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Study of Backscattering Effects on the Particle Identification

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 391

Presenter
Eun-Suk Seo
Author and Co-Author
Jayoung Wu | Eun-Suk Seo, For the ISS-CREAM collaboration

Abstract
'One of the consequences of having a high-density calorimeter as part of an experiment is a large number of secondary shower particles generated in the calorimeter -- some of which scatter back up towards the charge measurement devices. This so-called "backscatter effect" can interfere severely with accurate charge measurement of the primary nucleus, especially at high energies, as the number of backscattered particles increases with the incident energy. In this analysis, we study the effect of backscattered particles on particle identification by simulating the ISS-CREAM instrument model detector response using the GEANT3 simulation package with the FLUKA hadronic model. Our study shows the importance of the fine segmentation of charge detectors above the calorimeter. It can minimize backscattered particle contamination in the same charge detector segment as the incident particle to avoid its charge misidentification. We will present simulation results regarding charge measurements, including the tracking resolution, backscattering effects, and charge determination efficiency.'

Collaborations
ISS-Cream,

Keywords and Comments
'Backscattering Effects; Particle Identification', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

The High Energy Particle Detector operational status during 3 years of flight on board the China Seismo-Electromagnetic Satellite

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 392

Presenter
Cinzia De Donato
Author and Co-Author
Cinzia De Donato, Giuseppe Masciantonio

Abstract
'The China Seismo-Electromagnetic Satellite is a multi-instrument space mission dedicated to the investigation of the topside ionosphere structure and dynamics (plasma parameters, electromagnetic fields and charge particles fluxes) and the possible correlation of its perturbations with the occurrence of high magnitude earthquakes. \r\nThe main contribution of the Italian collaboration to the mission is the High Energy Particle Detector (HEPD), designed and built for the detection of electrons and protons in the energy range 3-100 MeV and 30-200 MeV, respectively \\[[1]\\].\r\nThe satellite was launched on February 2, 2018 from the Jiuquan Satellite Launch Center (Inner Mongolia, China) and HEPD is fully operational since July 28, 2018. \r\nTo ensure correct operations and optimal performances during the expected life time of 5 years, the HEPD onboard software hosts the Control & Housekeeping system responsible for the detector management and monitoring.\r\nThe system handles instrument data acquisition and calibrations, HEPD configuration and monitoring and acts as the main interface of the detector with the satellite platform. The continuous monitoring of HEPD status allows to control the detector functionality, to check electronics stability, to identify anomalous behaviors and to perform recovery actions if necessary. Besides, the high configurability of the detector allows to modify HEPD configuration in order to preserve its detection efficiency that can deteriorate along with the detector age.\r\nIn this paper we describe the HEPD Control & Housekeeping system and HEPD operational status during its 3 years of flight.\r\n\r\nREFERENCES\r\n\\[[1]\\] Scientific goals and in-orbit performance of the High-Energy Particle Detector on board the CSES. Picozza P, et al., ApJS 2019;243(1):16. [http://dx.doi.org/10.3847/1538-4365/ab276c][1]\r\n\r\n\r\n [1]: http://dx.doi.org/10.3847/1538-4365/ab276c'

Collaborations
other (fill field below), CSES-Limadou

Keywords and Comments
'Low Earth orbit satellites; Space detectors; Earth Observing System', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

The High Energy Particle Detector (HEPD-02) for the second China Seismo-Electromagnetic

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 15 Future instrumentation | CRD-MM
Presenter Forum Table

Presenter
Cristian De Santis
Author and Co-Author
Cristian De Santis | Sergio Bruno Ricciarini,

Abstract
'The CSES (China Seismo-Electromagnetic Satellite) is a multi-instrumental scientific space program whose objectives are to investigate the near-Earth electromagnetic, plasma and particle environment and for studying the seismo associated disturbances in the ionosphere-magnetosphere transition zone, the anthropogenic electromagnetic noise as well as the natural non-seismic electromagnetic emissions, mainly due to tropospheric activity. In particular, the mission aims at confirming the existence of possible temporal correlations between the occurrence of earthquakes for medium and strong magnitude and the observation in space of electromagnetic perturbations, plasma variations and precipitation of bursts of high-energy charged particles from the inner Van Allen belt.\r\nThe first satellite (CSES-01) was launched on 2018, while a second one (CSES-02) is currently under development and its launch is expected by 2022. As in CSES-01, the suite of instruments on-board CSES-02 will comprise a particle detector (HEPD-02, High-energy Particle Detector) to measure the increase of the electron and proton fluxes due to short-time perturbations of the radiation belts induced by solar, terrestrial, or anthropic phenomena in the energy range 3-100 MeV for electrons and 30-200 MeV for protons.\r\nHEPD-02 comprises a tracker made of CMOS Monolithic Active Pixel Sensors (MAPS), a double layer of crossed plastic scintillators for trigger and a calorimeter, made of a tower of plastic scintillators and a matrix of inorganic crystals, surrounded by plastic scintillator veto planes. We present the main characteristics and performance of HEPD-02, highlighting the architectural choices made to meet the scientific objectives of the mission.'

Collaborations
, Limadou

Keywords and Comments
'Low earth orbit satellites; Space detectors', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

The HEPD-02 Data Processing and Control Unit for the CSES-02 mission

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 393

Presenter
Giuseppe Masciantonio
Author and Co-Author
Giuseppe Masciantonio, Cinzia De Donato | Alessandro Sotgiu

Abstract
'The China Seismo-Electromagnetic Satellite (CSES) is a multi-instrumental space mission devoted to the study of the ionosphere, with the main aim to investigate possible correlations between fluctuations of the ionosphere environment and the occurrence of an earthquake. The first satellite (CSES-01) was launched on 2018, while a second one (CSES-02) is currently under development and the launch is expected by 2022. As CSES-01, the second satellite includes a particle detector (HEPD-02, High-energy Particle Detector) to measure the increase of the electron and proton fluxes due to short-time perturbations of the radiation belts induced by solar, terrestrial, or anthropic phenomena \\[[1]\\]. The explored energy range is 3-100 MeV for electrons and 30-200 MeV for protons .\r\nThe HEPD-02 Electronic Subsystem (ELS) contains all the electronics that perform the control of the apparatus and the processing of the signals provided by the sensitive detectors. It consists of the following boards: Trigger, Tracker Data Acquisition (T-DAQ), and Data Processing and Control Unit (DPCU). The DPCU will carry out the functions of management and control of the HEPD-02 operations and the communication with the satellite computer. The DPCU board will implement HOT / COLD redundancy and rely on a Zynq XC7Z7045 Xilinx System on Chip (SoC). The boot and all the functional checks of the SoC will be carried out by a MICROSEMI ProASIC3E FPGA.\r\nWe present the main DPCU characteristics and functionalities, highlighting the electronic architectural choices to guarantee reliability and radiation tolerance during the entire mission life span.\r\n\r\nREFERENCES\r\n\\[[1]\\] The High Energy Particle Detector for the 2nd Chinese Seismo Electromagnetic Satellite, Masciantonio G., 2019 IEEE NSS/MIC, [DOI:10.1109/NSS/MIC42101.2019.9060030][1]\r\n\r\n\r\n [1]: https://doi.org/10.1109/NSS/MIC42101.2019.9060030'

Collaborations
other (fill field below), CSES-Limadou

Keywords and Comments
'Low earth orbit satellites; Space detectors; Earth Observing System.', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

CSES-Limadou data processing at ASI-SSDC

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 394

Presenter
Matteo Mergè
Author and Co-Author
Matteo Mergè,

Abstract
'The CSES space mission, an international collaboration between China and Italy, aims at monitoring the perturbations originated by electromagnetic emissions in the ionosphere, magnetosphere and in the Van Allen radiation belts, and at investigating possible correlations with seismic events. The Italian collaboration, named LIMADOU, contributed to the mission with the realization of the High Energy Particle Detector (HEPD), an instrument developed on the basis of a long experience in developing advanced space detectors for charged and neutral particles and gamma rays – on a wide range of energies – for applications in solar physics as well as in extra-galactic astrophysics\r\nand cosmology. The CSES Satellite was launched from the Jiuquan Satellite Launch Center on February 2, 2018 and the expected mission lifetime is of 5 years. Satellite data are transferred to the Institute of Crustal Dynamics (ICD) of the China Earthquake Administration (CEA) in Beijing, China. \r\nAfter the donwlink HEPD raw data are transferred to the Italian Ground Segment. In the IGS, HEPD raw data are processed from level0 to level2 after calibration and equalization and are then stored in a high-availability processing server and stored in a high-resilience storage. In this poster we present a schematic of the HEPD detector data structure and the processing pipeline that has been built at the Italian Space Agency – Space Science Data Center'

Collaborations
, Limadou

Keywords and Comments
", "

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Machine learning applications on event reconstruction and identification for ISS-CREAM

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 395

Presenter
Monong Yu
Author and Co-Author
Monong Yu, Chen Yu | Coutu Stephane | Link Jason | Mognet Isaac | Mitchell John | Nutter Scott | Sakai Kenichi

Abstract
'We explore applications of machine learning in particle astrophysics. A supervised machine learning algorithm is applied to the visual representations of the energy deposits in two orthogonal views of the calorimeter of ISS-CREAM. Convolutional Neural Networks (CNNs) backed by Tensorflow are used to calibrate the sampled energy of the calorimeter and reconstruct the total primary energy of cosmic rays (CR), as well as for CR identification. The CNN regression models are trained on detailed Monte Carlo simulated events reproducing the behavior of the ISS-CREAM instrument suite, and the results indicate that a calorimeter energy reconstruction resolution of as good as 20% is achieved. The energy sampled in the calorimeter is determined with a resolution as good as 10%. The CNN classification model can reach a CR identification accuracy of up to 93%. The results from machine learning methods are consistent with a simple scaling of the sampled energy. The increased accuracy of this CNN energy reconstruction comes from the additional information of the longitudinal and lateral energy deposit profiles. This machine learning approach is widely applicable to a range of particle physics and astrophysics problems.'

Collaborations

Keywords and Comments
'Machine learning; Energy reconstruction; Shower profile; Cosmic ray;', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

The High Energy cosmic Radiation Detector (HERD) Trigger System

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 396

Presenter
Miguel Angel Velasco
Author and Co-Author
Miguel Angel Velasco | for the HERD Collaboration,

Abstract
'The High Energy cosmic Radiation detector (HERD) facility has been proposed to be installed onboard the future China's Space Station (CSS).\r\n\r\nHERD will address major problems in fundamental physics and astrophysics with the precise measurement of charged cosmic-rays and gamma-rays from few GeV to PeV energies by means of a large acceptance detector based on an innovative concept.\r\n\r\nThe detector consists of a very thick (3 lambda, 55 X0) calorimeter made of nearly 7500 LYSO crystals arranged into an octagonal prism, surrounded by a scintillating fiber tracker, a plastic scintillator detector and a silicon charge detector to precisely identify and measure high energy particles. Additionally, a transition radiation detector provides accurate energy calibration.\r\n\r\nHERD is designed to accept incident particles from both its top and four lateral faces thus providing an effective geometrical factor one order of magnitude larger than that of current experiments.\r\n\r\nThe large geometrical acceptance of the system requires detailed studies to define an efficient trigger system, which is able to identify the event samples for science and calibration purposes and keep the trigger rate to the level required by the acquisition system.\r\n\r\nWe will present the studies performed with the use of up-to-date models based on the most recent data, detailed simulations of the detector response and a CSS model to define the HERD trigger strategy.'

Collaborations
other (fill field below), HERD

Keywords and Comments
'', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

The HEPD-02 trigger and PMT readout system for the CSES-02 mission

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 397

Presenter
Marco Mese
Author and Co-Author
Marco Mese | Antonio Anastasio | Donatella Campana | Vincenzo Masone | Giuseppe Osteria | Francesco Perfetto | Valentina Scotti | Antonio Vanzanella | For the CSES-Limadou Collaboration,

Abstract
'This contribution describes the Trigger board of the High-Energy Particle Detector, which will be placed onboard the second China Seismo-Electromagnetic Satellite for CSES-Limadou mission.\r\nThis mission will monitor variations in ionospheric parameters that are supposed to be related to earthquakes.\r\nThe first satellite is already in orbit and the second one will be launched in 2023.\r\nThe HEPD detector will be composed by a tracker made of CMOS sensors (ALPIDE sensors), followed by two segmented planes of plastic scintillators used for trigger signals generation.\r\nThe actual calorimeter will be composed by twelve planes of plastic scintillator and two segmented planes of an inorganic scintillator called LYSO. The calorimeter is surrounded by five scintillator planes used as a veto system.\r\nAll the scintillators are coupled with PMTs, whose signals are acquired and digitized by the Trigger board, that also implements the trigger system for the whole apparatus.\r\nThe ongoing work on the Trigger board consists in the design of both the hardware and the firmware used for the communication with the other boards of the detector, power managing, and the interfacing with the ASIC used for PMTs' readout. \r\nEventually the Trigger board will be tested to verify its functionalities and its compliance with the HEPD design specifications. Next developments are the integration of the Trigger board with the other systems on the detector and the environmental testing of the whole system.'

Collaborations
other (fill field below), CSES-Limadou

Keywords and Comments
'electronics; High-Energy Particle Detector; satellite; earthquakes; calorimeter; trigger system; CSES; Limadou; Low earth orbit satellites; Space detectors', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Deep learning based event reconstruction for Limadou HEPD

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 398

Presenter
Francesco Maria Follega
Author and Co-Author
Francesco Maria Follega | Roberto Iuppa | Marco Cristoforetti | For the CSES-Limadou collaboration,

Abstract
'Deep learning algorithms have gained importance in astroparticle physics in the last years. They have been shown to outperform traditional strategies in particle identification, tracking and energy reconstruction.\r\nThe attractive feature of these techniques is their ability to model large dimensionality inputs and catch non-trivial correlations among the variables, which could be hidden or not easy to model. This contribution focuses on the application of deep neural networks to the event reconstruction of the Limadou High-Energy Particle Detector on board of the China Seismo-Electromagnetic Satellite. We describe the model adopted for the neural network and report on the performance measured on simulated and real data.'

Collaborations
other (fill field below), CSES-Limadou

Keywords and Comments
'detector simulation; charged particles; cosmic ray; event reconstruction; deep learning', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

The analysis strategy for the measurement of the electron flux with CALET on the International Space Station

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 399

Presenter
Eugenio Berti
Author and Co-Author
Eugenio Berti | Lorenzo Pacini | Yosui Akaike | for the CALET Collaboration,

Abstract
'The CALorimetric Electron Telescope (CALET), operating aboard the International Space Station since October 2015, is an experiment dedicated to high-energy astroparticle physics. The primary scientific goal of the experiment is the measurement of the electron+positron flux up to the multi-TeV region. In this poster, we will present the analysis strategy employed for this measurement. At first, we will describe the careful selection of all variables used in the analysis in order that they are well reproduced by simulations. Then, we will discuss the analysis itself, which is divided in two main steps. The first step consists of a set of selections to obtain a sample of well reconstructed candidates, removing particles outside the detector acceptance and particles with a charge Z>1, while keeping a high selection efficiency for electrons. The second step consists of a final rejection to remove the residual proton background: this is the most crucial point of the analysis and is performed using different methodologies. We will demonstrate that, at low energies, it is enough to use a simple single cut that makes use of the reconstructed longitudinal and lateral profile, whereas, at high energies, it is necessary to use a more powerful cut that combines all detector information by the use of a multivariate analysis technique. Finally, we will show that this rejection algorithm leads to very stable performances at all energies, strongly reducing the impact of the associated uncertainty, which is the main source of systematic uncertainty in the high energy region.'

Collaborations
CALET,

Keywords and Comments
'Electron+Positron; Electron/Proton Discrimination; Analysis methods; Detector Performance', 'On behalf of the CALET Collaboration'

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Design and expected performances of the large acceptance calorimeter for the HERD space mission.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 400

Presenter
Lorenzo Pacini
Author and Co-Author
on behalf of the HERD collaboration | Lorenzo Pacini, Ran Li | Jia-rui Gao | Oleksandr Starodubtsev | Da-lian Shi | Oscar Adriani | Eugenio Berti | Li Zhang | Valerio Vagelli | Zheng Quan | Sergio Bottai | Nicola Mori | Jin-kun Zheng | Lin-wei Lyu | Xing-zhu Cui | Wei-wei Cao | Ming Xu | Yang Yang | Zhi-chen

Abstract
'The High Energy cosmic-Radiation Detection (HERD) is a future space experiment which will be installed on the China's space station around 2025. The main goal of the experiment is the measurement of cosmic rays up to energies which are not explored by the instruments currently operating in space, in particular proton with energies up to PeV, nuclei up to hundreds of TeV per nucleon and electrons up to tens of TeV. The instrument will consist of silicon charge detectors, anti-coincidence scintillators, scintillating fiber trackers, a transition radiation detector and a deep calorimeter.\r\nThe latter is a homogeneous 3D segmented calorimeter made by about 7500 LYSO cubic crystals: thanks to this innovative design, it will achieve large acceptance, good energy resolution and excellent electron/proton discrimination. In order to increase both energy calibration capabilities and redundancy of the instrument, the LYSO scintillation light will be read-out by two independent systems: one is made by wave-length shifting fibers coupled with imaged intensified IsCMOS, and the other one consists of photodiodes with different active areas connected to a custom front-end electronics. Both read-out systems are designed to have a large dynamic range and a low power consumption. The design of the calorimeter is validated by several Monte Carlo simulations and beam test results obtained by detector prototypes. In this presentation we describe the anticipated performances of the calorimeter and the current status of the double read-out system, and we discuss recent developments of both the HERD prototype and the flight model design.'

Collaborations
other (fill field below), HERD

Keywords and Comments
'calorimeter; comsic ray', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

FIT: the scintillating fiber tracker of the HERD space mission

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 401

Presenter
Chiara Perrina
Author and Co-Author
Chiara Perrina | For the HERD Collaboration,

Abstract
'The High Energy cosmic-Radiation Detection (HERD) facility is a space payload proposed to be installed onboard the China's Space Station (CSS). The aim of HERD is the direct detection of cosmic rays towards the “knee” of the spectrum (~ 1 PeV) and the monitoring of the gamma ray sky up to 1 TeV. The HERD core is a calorimeter capable of accepting particles incident on its top and four lateral sides, each equipped with a sector of the scintillating fiber tracker: FIT. The top sector hosts 5 tracking planes while a side sector hosts 9 tracking planes. Each tracking plane is made of 16 modules. The module, composed of a fiber mat and 3 arrays of SiPMs, is the elementary brick of FIT. Several FIT modules have been built and tested with particle beams at CERN. A FIT prototype, made of two partially instrumented tracking planes, has been assembled and sent through vibrational and thermal-vacuum space qualification tests. The results of all the tests as well as the detailed design of FIT will be presented in this contribution.'

Collaborations
, HERD

Keywords and Comments
'tracker; scintillating fiber; SiPM; cosmic ray; gamma ray', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Development of a Carbon-fiber reinforced polymer-based mechanics for embedding ALPIDE pixel sensors in the High-Energy Particle Detector space module onboard the CSES-02 satellite.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 402

Presenter
Silvia Coli
Author and Co-Author
Silvia Coli | Massimo Angeletti | Corrado Gargiulo | Roberto Iuppa | Enrico Serra,

Abstract
'The mission CSES (China Seismo-Electromagnetic Satellite) will put into orbit satellites to study perturbations in the ionosphere, possibly correlated with the occurrence of seismic events. CSES-02, the second satellite of the constellation, will be supplied with a High-Energy Particle Detector (HEPD), composed by a tracker, a trigger system and a calorimeter, designed for the detection of electrons (protons) in the 3-150 (30-250) MeV energy range. The tracker is based on the innovative monolithic pixel sensors ALPIDE, developed for the ALICE experiment, at CERN. The adaptation of the ALPIDE technology to the use in space environments, demanded for ad-hoc solutions for the mechanics, as supporting structures have to withstand structural and vibrational stresses in a wide energy range, maintaining their capability to dissipate the heat generated by ALPIDE operations. This work presents the HEPD-02 tracker, consisting of 150 pixel sensors, supported by Carbon Fiber reinforced Plastic (CFRPs) and enclosed in an Aluminum frame, focussing on the little impact that devised solutions have on the physics performance. We report results from an intense campaign of qualification tests, conducted according to the space register and constituting an important premise for using monolithic active pixel sensors in future space cosmic ray experiments.'

Collaborations
other (fill field below), CSES-Limadou

Keywords and Comments
", "

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Ultra-Heavy Cosmic Ray Analysis with CALET on the International Space Station: Established and Developing Procedures

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 403

Presenter
Anthony Ficklin
Author and Co-Author
Anthony Ficklin | Brian Rauch | Wolfgang Zober | Nicholas Cannady | for the CALET Collaboration,

Abstract
'The CALorimetric Electron Telescope (CALET) has collected over 60 months of uninterrupted data on the flux and spectrum of the Ultra-Heavy (UH) cosmic rays from Z=30 to 40. Using the latest data provided from CALET's UH trigger, we present a newly developed UH analysis complementary to the ongoing analysis presented at this conference by Zober et al. This work introduces a new Ultra-Heavy Analysis (UHA) dataset produced from CALET production data allowing for more streamlined analysis. We detail temporal and spatial correction algorithms using both the 26Fe and 14Si peaks to improve charge resolution in the Z > 26 region. Additionally, this work presents a new method for removing the contributions from low-Z nuclei using the McIlwain L-shell parameter in place of the previously used vertical rigidity cutoff. We show that parameterization of the data with L-shell, calculated from the IGRF13 and T05 (Tsyganenko 05) geomagnetic field models, leads to fewer events being removed from the dataset, while maintaining improved charge resolution for Z > 26. Furthermore, we introduce Tarle function peak fitting to perform charge corrections needed as a result of any quenching effects. We show the most recent CALET UH results showing the effect of these improvements in the analysis.'

Collaborations
CALET,

Keywords and Comments
'', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

The innovative particle tracker for the HEPD space experiment onboard the CSES-02

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 404

Presenter
Roberto Iuppa
Author and Co-Author
Roberto Iuppa | Sergio Bruno Ricciarini | Silvia Coli | Stefania Beole | Lorenzo De Cilladi | Giuseppe Gebbia | Ester Ricci | Paolo Zuccon,

Abstract
'China Seismo-Electromagnetic Satellites are the most advanced initiative for the study of the ionosphere-lithosphere coupling from space. They are sensitive to any type of short- to long-lasting perturbations in the ionosphere, thanks to the variety of instruments that they host on board. Among them, the High-Energy Particle Detector is devoted to the observation of electrons and protons with energy thresholds of 3 MeV and 30 MeV respectively. The Limadou collaboration has designed an improved version of the HEPD for the second satellite of the CSES constellation, whose launch is scheduled for mid-2022. The main upgrade pertains to the tracker, which will be made of Monolithic Active Pixel Sensors, never used so far in space. With respect to the standard hybrid silicon microstrip technology, MAPS are more precise, more robust, easier to control and readout, cheaper and less invasive. On the other hand, they are still relatively small-sized and power-demanding. \r\n\r\nWe report on the process of spatialisation carried out by the HEPD-02 tracker team, which has adapted the operation mode of the ALPIDE sensor to realize a modular and compact particle detector, made of 5 turrets, each one containing 3 stacked sensitive planes. All of 150 ALPIDE sensors are controlled and readout with a Hybrid Integrated Circuit and supported by Carbon Fiber Reinforced Plastics staves, housed in an aluminium case. We describe in detail the HEPD-02 tracker project, demonstrating the advantages of using MAPS in space and manifesting the pioneering nature of the project for next-future larger size space missions.'

Collaborations
other (fill field below), CSES-Limadou

Keywords and Comments
'Monolithic Active Pixel Sensors; Particle tracking; Low background; Cosmic-ray detector', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Enabling low-power MAPS-based space trackers: a sparsified readout based on smart clock gating for the High Energy Particle Detector-02

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 405

Presenter
Sergio Bruno Ricciarini
Author and Co-Author
Sergio Bruno Ricciarini | Stefania Beole | Lorenzo De Cilladi | Giuseppe Gebbia | Roberto Iuppa | Ester Ricci | Paolo Zuccon,

Abstract
'The adoption of pixel sensors for space-based tracking detectors requires low power consumption and enhanced heat dissipation to cope with the satellite power and cooling constraints. The High Energy Particle Detector (HEPD) tracker onboard the CSES-02 will be the first application of monolithic active pixel sensors (MAPS) to a satellite-based experiment. This result is achieved with a parallel sparsified readout architecture implemented on a single low-power FPGA chip, which manages the 150 ALPIDE chips of the three-plane tracker. The power consumption is reduced by reading out the ALPIDE chips via the control line instead of the high speed data link, and by distributing the clock only to the portions of the detector crossed by a particle. The readout concept presented in this contribution allows to deal with both the required performance and the power constraints, and is scalable to larger and more complex detectors.'

Collaborations
other (fill field below), CSES-Limadou

Keywords and Comments
'', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Expected performance of the High-Energy Particle Detector onboard the second China Seismo-electromagnetic Satellite

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 406

Presenter
Zouleikha Sahnoun
Author and Co-Author
Zouleikha Sahnoun | Francesco Maria Follega | Roberto Iuppa | Alberto Oliva | Michele Pozzato | Ester Ricci,

Abstract
'The High Energy Particle Detector (HEPD) is one of the scientific payloads of the China Seismo-Electromagnetic Satellite (CSES). The first satellite of the constellation was launched in February 2018 and has been operational in nominal conditions since then. With the launch of the CSES-02 scheduled for mid 2022, the realisation of the HEPD-02 detector is ongoing.\r\nThe Limadou collaboration, in charge of the payload, updated the HEPD design to improve its performance and correct minor issues observed in HEPD-01.\r\nA Monte Carlo simulation has been developed using the GEANT4 tool, in order to study the response of the new detector to protons, electrons and light nuclei and validate the new design. The comparison between simulation results and data collected during tests will also allow to calibrate the detector response and to train a specifically designed neural network for event reconstruction. We report preliminary results from the simulation and show that the updated HEPD meets the scientific requirements of the CSES-02 mission.'

Collaborations
other (fill field below), CSES-Limadou

Keywords and Comments
", "

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Charge measurement of cosmic rays by Plastic Scintillantor Detector of DAMPE

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 407

Presenter
Pengxiong Ma
Author and Co-Author
Pengxiong Ma, Margherita Di Santo | Zhihui Xu | Yongjie Zhang | For the DAMPE Collaboration

Abstract
'Plastic Scintillantor Detector (PSD) is part of DArk Matter Particle Explorer (DAMPE), which plays a crucial role of charge measurement for charged cosmic rays and acts as a veto for gamma rays. In this work, we give some updated correction methods to enhance the quality of charge measurement, especially for heavy nuclei. DAMPE has collected nearly 10 billions events by end of 2020, it has substantial potential to measure the spectra of cosmic rays nuclei up to hundreds of TeV energies, which could be benefited from these corrections for charge measurement.'

Collaborations
DAMPE,

Keywords and Comments
'"Plastic Scintillantor; Cosmic rays; Charge measurement "', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

On-Orbit Energy Calibration of the Calorimeter on the ISS-CREAM Instrument Using the Boronated Scintillator Detector

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 408

Presenter
Yu Chen
Author and Co-Author
Yu Chen, Jacob Smith | Monong Yu | Jason Link | Scott Nutter | Tyler Anderson | Tyler LaBree | John W. Mitchell | S.A. Isaac Mognet | Kenichi Sakai | Stephane Coutu

Abstract
'The Cosmic Ray Energetics And Mass instrument on the International Space Station (ISS-CREAM) aims to measure the energy spectra of cosmic ray (CR) nuclei from Z=1 to Z=26 with energies from 10^{12} eV to 10^{15} eV. The calorimeter (CAL) was designed to measure the energy of the CR particles. The ISS-CREAM on-orbit data provide evidence that the CAL may have either suffered from an efficiency problem or its energy scale may be in need of calibration. As a result, a careful scrutiny of the absolute energy calibration of the CAL is needed. We propose an approach to calibrate the energy scale using the on-orbit data of the boronated scintillator detector, which is independent of CAL data and reduces potential bias. In this talk we will discuss the issues revealed by the on-orbit data, demonstrate how this can be corrected using the boronated scintillator detector and present preliminary results.'

Collaborations

Keywords and Comments
'energy calibration', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Application of Desensitized Nuclear Emulsion films for Chemical Composition Study of Cosmic-ray Nuclei in GRAINE 2018 balloon-borne experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 409

Presenter
Atsushi Iyono
Author and Co-Author
Atsushi Iyono | Saya Yamamoto | Shigeki Aoki | Hiroki Rokujo | Satoru Takahashi,

Abstract
'We have developed the desensitized nuclear emulsion films suitable for the detection of heavy cosmic ray nuclei in the high speed image processing systems (HTS) which was utilized at Nagoya University. And we have carried out our balloon flight of nuclear emulsion telescope for high resolution gamma-ray imaging of Vela Pulsar in April, 2018. We have deployed the emulsion chamber which consisted of several sensitivity type of desensitized nuclear emulsion films in this balloon flight.\r\nWe are going to report the results of this pilot studies of the application of desensitized films for the detection of cosmic ray nuclei, and the potential of sensitivity control of nuclear emulsion films suitable for image analysis.'

Collaborations
other (fill field below), GRAINE collaboration

Keywords and Comments
'cosmic ray nuclei; desensitized nuclear emulsion film', 'on behalf of the GRAINE collaboration'

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Study of Desensitized Nuclear Emulsion Films with HIMAC heavy ion beams

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 410

Presenter
Moegi Okuyama
Author and Co-Author
Moegi Okuyama | Atsushi Iyono | Saya Yamamoto | Koshiro Izumi | Shigeki Aoki | Satoshi Kodaira,

Abstract
'By adding suitable amount of Rh compound (Na$_3$RhCl$_6$·5H$_2$O) during the production of nuclear emulsion gel, it enabled to reduce the sensitivity of the nuclear emulsion films and realized the selection of heavy nuclei by using image processing system suitable for minimum ionized particles. We have carried out the beam exposure of desensitized nuclear emulsion films in October, 2019 at Heavy Ion Medical Accelerator in Chiba(HIMAC). When charged particles passed through the nuclear emulsion films, the track were measured as a series of silver grains of which size is typically less than one micrometer, and we traditionally determine their charge amount by measuring ionization loss signals such as grain density, delta-ray count. In this study, we measured the energy losses of heavy ion beams in desensitized emulsion films exposed horizontally to emulsion layer, and we have estimated the desensitization effect for heavy ion deltections.'

Collaborations
other (fill field below),

Keywords and Comments
'Desensitized nuclear emulsion films; Comic ray nuclei', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Machine learning methods for helium flux analysis with DAMPE experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 411

Presenter
Mikhail Stolpovskiy
Author and Co-Author
Mikhail Stolpovskiy | David Droz | Arshia Ruina | Tykhonov Andrii | Xin Wu,

Abstract
'DAMPE is a space-borne experiment for the measurement of the cosmic- ray fluxes at energies up to around 100 TeV per nucleon. At energies above several tens of TeV, the electronics of DAMPE calorimeter would saturate, leaving certain bars with no energy recorded. It is also observed that at high energies the tracker and the scintillator detector that serve for the charge identification become heavily populated with back-splash tracks. Both effects interfere in precise measurements of the helium flux at highest energies. In the present contribution we discuss the application of machine learning techniques for the treatment of DAMPE data, to compensate the calorimeter energy lost by saturation and to identify helium events.'

Collaborations
DAMPE,

Keywords and Comments
", "

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Monte-Carlo simulation of the NUCLEON-HERO orbital detector.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 412

Presenter
ILYAS SATYSHEV
Author and Co-Author
ILYAS SATYSHEV | Leonid Tkachev | Anatoliy Pan,

Abstract
'A project of the OLVE-HERO space detector is proposed for CR measurement in the range 1012-1016 eV and will include a large ionization 3D calorimeter with a high granularity and geometric factor of ~16 m2·sr. The 3D structure of the calorimeter will allow registering CR particles coming from different directions. As the main NUCLEON-HERO detector is expected an image calorimeter of a boron loading of plastic scintillator with tungsten absorber. Such a calorimeter allows to measure an additional neutron signal which will improve the energy resolution of the detector. The more important, the rejection power between electromagnetic and nuclear CR components will be increased by factor 30-50 in the whole energy range. The boron loading scintillator detector prototype was designed and tested at the H8 beam test area at CERN SPS. Results of the Monte-Carlo simulation of the NUCLEON-HERO detector will be presented in the report.'

Collaborations

Keywords and Comments
", "

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

The GAPS Instrument: A Large Area Time of Flight and High Resolution Exotic Atom Spectrometer for Cosmic Antinuclei

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 413

Presenter
Sean Quinn
Author and Co-Author
Sean Quinn, For the GAPS Collaboration

Abstract
'Low-energy cosmic ray antideuterons (< 0.25 GeV/n) are a compelling, mostly uncharted channel of many viable dark matter models, and they benefit from a highly sup-pressed astrophysical background. The General Antiparticle Spectrometer (GAPS) is a first-of-its-kind Antarctic balloon-borne experiment specialized for the detection of low energy antiprotons, antideuterons, and antihelium with a targeted launch in 2022.\r\n\r\nThe results of our novel technology development and a summary of our current construction status are the focus of this contribution. GAPS exploits an antiparticle identification technique based on exotic atom formation and decay, allowing more active target material for a larger overall acceptance since no magnet is required. The GAPS instrument consists of a large-area ($\\sim 50$ m^2) scintillator time-of-flight, ten planes of custom silicon detectors with dedicated ASIC readout, and a novel oscillating heat pipe cooling approach.\r\n\r\nThis contribution will briefly introduce the exotic atom detection technique and expected flux sensitivities. Following this, the instrument design will be discussed, and a detailed description of experimental hardware and expected performance will be presented, followed by a summary of the progress on construction and testing while also highlighting developments of a scaled, integrated prototype.'

Collaborations
GAPS,

Keywords and Comments
'tof;sipm;tracker;antiproton;antideuteron;antihelium;balloon;exotic atom;daq;', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

ISS-CREAM detector performance and tracking algorithms

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 414

Presenter
Kenichi Sakai
Author and Co-Author
Kenichi Sakai | for the ISS-CREAM Data Analysis Collaboration,

Abstract
'The goal of the ISS-CREAM experiment is to measure spectra of cosmic-ray particles up to 1000 TeV from protons to iron nuclei. The detector was designed to complement other current space-based cosmic-ray missions, and was installed on the ISS on August 22, 2017. During 539 days of on-orbit operations, ISS-CREAM recorded over 58 million events. The instrument consists of a 4-layer silicon charge detector, a tungsten/scintillating-fiber sampling calorimeter for energy measurement, top and bottom scintillating detectors to create a trigger, and a boronated scintillator detector for additional shower sampling. A variety of subsystem issues developed during on-orbit operations, requiring careful data filtering, the development of extensive calibrations, and multiple tracking algorithms. We report on the performance of the ISS-CREAM instrument and present details of the analysis.'

Collaborations

Keywords and Comments
'Cosmic ray; ISS; ISS-CREAM', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

On-orbit performance of the DAMPE BGO calorimeter

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 415

Presenter
Yifeng Wei
Author and Co-Author
Yifeng Wei | F.C.T. Barbato | E. Casilli | F. de Palma | G. Marsella | on behalf of the DAMPE Collbaration,

Abstract
'The DArk Matter Particle Explorer (DAMPE) is a Chinese cosmic-ray direct detection experiment. It has been operating smoothly on-orbit since its successful launch at the end of 2015. Currently, its sub-detectors and the satellite are in good working order. The DAMPE payload employs a BGO Calorimeter for energy measurements, trigger and e/p identification. The calorimeter is constructed of 308 BGO crystals, and PMTs are coupled to the crystals with optical filters to readout scintillation light. In this work, we will present the status and performance of the calorimeter, including orbit calibration, energy measurement, especially in TeV range, detector endurance, and long term performance in a duration of 5 years.'

Collaborations
DAMPE,

Keywords and Comments
'DAMPE; calorimeter; energy measurement; long term performance', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Simulation of the DAMPE detector

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 416

Presenter
Wei Jiang
Author and Co-Author
Wei Jiang | Zhan-Fang Chen | David Droz | Yifeng Wei | Yongjie Zhang | on behalf of DAMPE Collbaration,

Abstract
'Extensive Monte Carlo (MC) simulations are essential in understanding the detector’s response for high-energy particle detection experiments. We present the infrastructure and status of MC simulations of the DArk Matter Particle Explorer (DAMPE), a satellite project for the direct detection of high-energy cosmic rays and gamma rays. The DAMPE simulation tool employs two widely used softwares, GEANT4 and FLUKA, which implement various physics lists to simulate the interactions of particles in the detector. The framework of the simulation tool, the production farms, the data-MC comparison, and the performance of MC simulations on the analysis are summarized.'

Collaborations
DAMPE,

Keywords and Comments
'', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Charge Loss Correction in the Silicon-Tungsten Tracker-Converter for Proton-Helium Charge Identification in the DAMPE Detector

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 417

Presenter
Arshia Ruina
Author and Co-Author
Arshia Ruina | Mikhail Stolpovskiy | Maksym Deliyergiyev | Yuxing Cui,

Abstract
'The DArk Matter Particle Explorer (DAMPE) is a satellite-borne experiment, in operation since 2015, aimed at studying high-energy gamma rays and cosmic nuclei fluxes. Of the various sub-detectors in the DAMPE payload, the Silicon-Tungsten tracKer-converter (STK) plays a significant role in the charge measurement of incoming ions. Depending on the angle of inclination of the impinging particle and its position of impact on these strips, the collected charge can spread between the strips which results in a small fraction of signal loss. The $\\eta$ variable is used to identify this spread of charge across the strips and correct for the associated charge loss. This brings us closer to accurate determination of particle charge which is crucial for ensuring a good discrimination between particles. The $\\eta$-correction is, therefore, expected to play an important role in the determination of heavy ions by the DAMPE detector. It has helped reduce the proton background for the helium identification in STK by a factor of 1.5 for MIP tracks.'

Collaborations
DAMPE,

Keywords and Comments
", "

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Performance of the DAMPE silicon-tungsten tracker during the first 5 years of in-orbit operation

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 418

Presenter
Chiara Perrina
Author and Co-Author
Chiara Perrina | for the DAMPE Collaboration, Philipp Azzarello | Enrico Catanzani | Andrii Tykhonov | Xin Wu

Abstract
'Since its launch, in December 2015, the DAMPE (DArk Matter Particle Explorer) satellite is taking data smoothly. The Silicon-Tungsten Tracker (STK) of DAMPE consists of six tracking planes (6x, 6y) of single-sided silicon strip detectors mounted on seven support trays. Tungsten plates (1 mm thick) are integrated in the 2nd, 3rd and 4th tray from the top to serve as photon converters. The STK is able to precisely reconstruct the track of charged particles and converted photons, and to measure the charge of the incoming cosmic rays thus improving the particle identification. Commissioned rapidly after the launch, the STK is running extremely well since then. The STK in-orbit calibration and performance during its first 5 years of operation, including the noise behavior and the thermal and mechanical stability, will be presented in this contribution.'

Collaborations
DAMPE,

Keywords and Comments
'tracker; silicon strip detector; satellite; dark matter', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Harmonic Interference of Earth's Orbital Velocity and the Sidereal Cosmic Ray Anisotropy

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 419

Presenter
Juan Carlos Díaz Vélez
Author and Co-Author
Juan Carlos Díaz Vélez | Rasha Abbasi | Paolo Desiati | Frank McNally, Hannah Woodward

Abstract
"When cosmic-ray arrival directions are observed in celestial coordinates, they appear to have a small anisotropy whose origin is still largely unknown. In addition to this celestial anisotropy, the Earth's revolution around the Sun produces a faint Compton-Getting dipole anisotropy with an excess oriented towards the direction of motion in solar coordinates. The relative rotation of the celestial and solar reference frames over a calendar year causes interference between the two sources of anisotropy. It is possible to characterize the resulting yearly modulations by studying the side-bands to the diurnal and sidereal frequencies in anti- and extended-sidereal time frames. This work provides a numerical simulation of the interference between anisotropies in sidereal and solar reference frames to predict the anti-sidereal and extended-sidereal frames' distributions."

Collaborations

Keywords and Comments
'Cosmic Ray Anisotropy; Monte Carlo; Integration; Systematics', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

The TIGERISS instrument

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 15 Future instrumentation | CRD-MM
Presenter Forum Table

Presenter
John Mitchell
Author and Co-Author
John Mitchell, john Krizmanic | Brian Rauch

Abstract
'TIGERISS (Trans-Iron Galactic Element Recorder for the International Space Station) is a natural evolution to space of the balloon-borne TIGER and SuperTIGER instruments discussed elsewhere at this conference. TIGERISS will be proposed to the next NASA Pioneers opportunity, anticipated in September 2021, as an ISS-attached mission to extend measurements of the relative abundances of galactic cosmic-ray nuclei to the Pt-Pb region with individual element resolution and excellent statistical precision. TIGERISS is designed to accurately determine the atomic number of incident nuclei to beyond the end of the periodic table and to begin measurements at a low-Z trigger threshold, planned for between He and C in order to measure the velocity distributions of the more common species using its Cherenkov detectors. TIGERISS measures the atomic number of incident nuclei by both the differential ionization energy loss (dE/dX) vs. Cherenkov (velocity) technique and the Cherenkov vs. Cherenkov technique using acrylic and silica-aerogel Cherenkov detectors as in TIGER and SuperTIGER. However, it utilizes silicon strip detectors for dE/dX and trajectory measurements, replacing the plastic scintillators and scintillating fiber hodoscopes of TIGER and SuperTIGER. The scientific goals and anticipated results of TIGERISS are discussed in an accompanying paper at this conference. Here we give the details of the TIGERISS measurement technique and its technical implementation.'

Collaborations
other (fill field below), TIGERISS

Keywords and Comments
'ultra-heavy cosmic-ray nuclei; particle detectors; space station', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

The Trans-Iron Galactic Element Recorder for the International Space Station (TIGERISS)

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 420

Presenter
Brian Rauch
Author and Co-Author
Nathan Walsh | Brian Rauch, Makoto Sasaki | Marcus Alfred | J. Vanderlei Martins | Tyler Anderson | Stephane Coutu | Terri Brandt | Michaela Amoo | James Buckley | Don Engel | Kenichi Sakai | A.W. Labrador | Wolfgang Zober | Jason Link | Nicholas Cannady | Georgia A. de Nolfo | S

Abstract
'TIGERISS is an Ultra-Heavy Galactic Cosmic Ray (UHGCR) detector to be proposed to the NASA Astrophysics Pioneers program capable of measuring the abundance relative to $_{26}$Fe of every element from $_{5}$B to $_{82}$Pb. It is evolved from the LDB TIGER and SuperTIGER balloon instruments and the Heavy-Nuclei Explorer SMEX, and compared to its predecessors, TIGERISS will have a greatly improved capability to definitively identify UHGCR nuclei. This has been demonstrated in component accelerator tests at CERN, including silicon strip detectors in place of scintillators. The geometry factor for TIGERISS is estimated to be from 1.1 to 1.7 m^{2} sr depending on the ISS attachment point, compared to 0.6 m^{2} sr for TIGER. Within one-year TIGERISS would observe $\\sim$27 $_{56}$Ba nuclei, a 20$\\%$ statistically significant result comparable to the current SuperTIGER data set. Not requiring corrections for atmospheric interactions and scintillator saturation effects the TIGERISS results would be cleaner, and they would also make preliminary measurements to higher charges that will test models for cosmic-ray origins and acceleration. TIGERISS will measure UHGCR nuclei resulting from neutron-capture nucleosynthesis in heavy stars, supernovae, and binary neutron-star mergers and will probe the relative contribution of r-process elements to the cosmic rays.-process elements to the cosmic rays.'

Collaborations
other (fill field below), TIGERISS

Keywords and Comments
'ultra-heavy cosmic-ray nuclei; particle detectors; space station', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Determination of Expected TIGERISS Observations

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 421

Presenter
Brian Rauch
Author and Co-Author
Nathan Walsh | Wolfgang Zober | Brian Rauch,

Abstract
'We present the method used to estimate the cosmic-ray observations expected for that the Trans-Iron Galactic Element Recorder for the International Space Station (TIGERISS), which is designed to measure the abundances of the rare Ultra-Heavy Galactic Cosmic Rays (UHCR) $_{30}$Zn and heavier. TIGERISS uses planes of crossed silicon strip detectors at the top and bottom for charge and trajectory determination and acrylic and aerogel Cherenkov detectors for velocity and charge determination. Instruments are modeled in configurations for the Japanese Experiment Module (JEM) "Kibo" Exposed Facility ($\sim$1.66 m^{2} sr), as an European Space Agency Columbus Laboratory external payload ($\sim$1.16 m^{2} sr), and as an ExPRESS Logistics Carrier (ELC) experiment ($\sim$1.10 m^{2} sr). Differential geometry factors determined for detector orientations within the geomagnetic field over the ISS 51.6° inclination orbit are used to determine geomagnetic screening. Energy spectra are integrated using the higher of the energies needed to trigger the instrument or penetrate the geomagnetic field for time-weighted bins of geomagnetic latitude, instrument orientation, and incidence angle. Finally, abundances are reduced by the fraction of events calculated to fragment in the instrument.'

Collaborations
other (fill field below), TIGERISS

Keywords and Comments
'ultra-heavy cosmic-ray nuclei; particle detectors; space station', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

SuperTIGER Ultra-Heavy Galactic Cosmic Ray Atmospheric Propagation Corrections and Uncertainty Analysis

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 422

Presenter
Brian Rauch
Author and Co-Author
Brian Rauch | Nathan Walsh,

Abstract
'The SuperTIGER (Super Trans-Iron Galactic Element Recorder) balloon-borne ultra-heavy galactic cosmic-ray (UHGCR) detector has flown twice in the stratosphere over Antarctica at altitudes up to $\\sim$130,000 ft. Corrections for propagating through the last $\\sim$0.5$\\%$ of the atmosphere are based on those developed for the preceding TIGER instrument. Changes due to nuclear interactions are determined by finding top of the atmosphere (TOA) elemental abundances that yield those measured in the instrument after solving networks of equations for all elements with partial and total charge changing cross sections stepping through fine slabs of material. Varying rates of energy loss in the atmosphere for different elements yield different TOA minimum energies for the acrylic Cherenkov detector threshold (~350 MeV/nuc). TOA abundances corrected for nuclear interactions for each element are scaled with the fraction of the integral energy spectrum for its TOA minimum energy, using the iron spectrum for the UHGCR. Statistical uncertainties are derived at the TOA by shifting the abundance of each element individually up and down by the measured uncertainty in the instrument and calculating the TOA abundance of that element. Systematic uncertainties previously were estimated by simultaneously shifting the partial and then the total cross sections for all elements up and down by their uncertainties and finding TOA abundances compared to the nominal values. Here we present a Monte Carlo study of the systematic impact of simultaneously randomly varying atmospheric propagation parameters over many trials to find the normal range of variation in the resulting TOA element abundances. Total and partial charge changing cross sections for each element are individually varied in each sampling.'

Collaborations
other (fill field below), SuperTIGER

Keywords and Comments
'ultra-heavy cosmic-ray nuclei; atmosphere corrections; stratospheric balloon', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Calibration of Aerogel Tiles for the RICH of the HELIX Experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 423

Presenter
stephan o'brien
Author and Co-Author
stephan o'brien,

Abstract
'HELIX (High Energy Light Isotope eXperiment) is a balloon-borne instrument designed to measure the chemical and isotopic abundances of light cosmic-ray nuclei. In particular, HELIX is optimized to measure 10Be and 9Be in the range 0.2 GeV/n to beyond 3 GeV/n. To achieve this, HELIX utilizes a 1 Tesla superconducting magnet with a high-resolution gas drift tracking system, time-of-flight detector, and a ring-imaging Cherenkov (RICH) detector. The RICH detector consists of aerogel tile radiators (refractive index ~1.15) with a silicon photomultiplier detector plane. To adequately discriminate between 10Be and 9Be isotopes, the refractive index of the aerogel tiles must be known to a precision of 0.1%. In this contribution, detailed mapping of the refractive index across the aerogel tiles is presented and the methodology used to obtain these measurements is discussed.'

Collaborations
other (fill field below), HELIX

Keywords and Comments
'cosmic ray; RICH; aerogel; Calibration; balloon', 'For the HELIX collaboration'

ICRC 2021

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Cosmic-ray isotope measurements with HELIX

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 15 Future instrumentation | CRD-MM
Presenter Forum Table

Presenter
Nahee Park
Author and Co-Author
Nahee Park | for the HELIX Collaboration,

Abstract
'Recent discoveries of new features in Galactic cosmic-ray fluxes emphasize the importance of understanding the propagation of cosmic rays. HELIX (High Energy Light Isotope eXperiment) is designed to improve the measurements of light cosmic-ray isotopes, including the propagation clock isotope $^{10}\\mathrm{Be}$ and stable secondary isotope $^{9}\\mathrm{Be}$, which will be essential to study the propagation of the cosmic rays. The magnetic spectrometer of HELIX consists of a 1 Tesla superconducting magnet containing a high-resolution gas drift chamber as a tracking detector and two velocity measuring detectors: a time-of-flight detector and a ring-imaging Cherenkov detector. While the HELIX instrument can measure the fluxes of the light isotopes from protons (Z=1) up to neon (Z=10), it is optimized to study the flux of beryllium isotopes from 0.2 GeV/n to beyond 3 GeV/n with a sufficient mass resolution to discriminate between $^{10}\\mathrm{Be}$ and $^{9}\\mathrm{Be}$. In this talk, I will review the scientific goals and the design of the instrument and report its current status and project plans.'

Collaborations
other (fill field below), HELIX Collaboration

Keywords and Comments
'cosmic-ray; cosmic-ray isotopes; balloon experiment; cosmic-ray propagation; magnetic spectrometer', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Methods & Instrumentation

Modeling the SuperTIGER Instrument and Response with Geant4

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 424

Presenter
A.W. Labrador
Author and Co-Author
A.W. Labrador, W.R. Binns | R.G. Bose | T.J. Brandt | P.F. Dowkontt | T. Hams | M.H. Israel | J.T. Link | R.A. Mewaldt | J.W. Mitchell | R.P. Murphy | B.F. Rauch | K. Sakai | M. Sasaki | C. Sosa | E.C. Stone | C.J. Waddington | N.E. Walsh | J.E. Ward | M.E. Wiedenbeck |

Abstract
'SuperTIGER (Trans-Iron Galactic Element Recorder) is a large-area balloon-borne instrument built to measure the galactic cosmic-ray (GCR) abundances of elements from Z=10 (Ne) through Z=56 (Ba) at energies 0.8-10 GeV/nuc. SuperTIGER flew over Antarctica for a record-breaking 55 days, from December 8, 2012 to February 1, 2013. The instrument identifies particles using a combination of scintillating optical fiber hodoscopes for determining particle trajectories, three scintillators for charge identification, and an acrylic Cherenkov detector and an aerogel Cherenkov detector for charge and velocity determination. We have developed a Geant4 simulation to study the interactions of particles through the atmosphere and through the instrument and supplemented it with additional code to simulate the Cherenkov signals. The Geant4 model simulates interaction energy losses as well as interaction losses and production of secondary particles. The Cherenkov simulation code includes background from knock-on electrons, as well as background scintillation and Cherenkov light from the light reflectors and mounting material within the detectors. In this presentation, we will demonstrate the application of corrections due to energy losses and interaction losses from the top of the atmosphere through the instrument derived from the simulation, and we will demonstrate the establishment of the energy scales from the Cherenov simulation. These results are a critical contribution to the SuperTIGER energy spectra calculation for Z=10-30.'

Collaborations
other (fill field below), SuperTIGER

Keywords and Comments
'Instrument Simulation; Galactic Cosmic Rays', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Energy spectra of carbon and oxygen cosmic rays with CALET on the International Space Station

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
paolo maestro
Author and Co-Author
paolo maestro | For the CALET collaboration,

Abstract
'We present the measurements of the energy spectra of carbon and oxygen nuclei in cosmic rays based on 4 years of observation with the Calorimetric Electron Telescope (CALET) on the International Space Station. The energy spectra are measured from 10 GeV/n to 2.2 TeV/n with an all calorimetric instrument with a total thickness corresponding to 1.3 nuclear interaction length and equipped with charge detectors capable of single element resolution. Data analysis, including the detailed assessment of systematic uncertainties, and results are reported. The observed carbon and oxygen fluxes show a spectral hardening around 200 GeV/n established with a significance > 3σ. They have the same energy dependence and a constant C/O flux ratio above 25 GeV/n. These measurements will contribute to a better understanding of the origin of the spectral hardening.'

Collaborations
CALET,

Keywords and Comments
", "

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Analysis Result of the High-Energy Cosmic-Ray Proton Spectrum from the ISS-CREAM Experiment

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Gwangho Choi
Author and Co-Author
Gwangho Choi,

Abstract
'The Cosmic Ray Energetics And Mass for the International Space Station (ISS-CREAM) experiment successfully recorded the data for about 539 days from August 2017 to February 2019. In this talk, we report the measurement of the cosmic-ray proton energy spectrum from the ISS-CREAM experiment in the energy range of 2.5 TeV−650 TeV. For the analysis, we used the silicon charge detector (SCD) placed at the top of the ISS-CREAM payload to identify the incoming cosmic-ray charge. The SCD is finely segmented to minimize charge misidentification due to backscatter effects. The four-layer SCD consists of 10,752 silicon pixels, each of which is 1.37 x 1.57 x 0.05 cm3 in size. The calorimeter (CAL) consists of 20 layers of tungsten/scintillating fibers preceded by carbon targets. It provided cosmic-ray tracking, energy determination, and the high-energy trigger. The Top and Bottom Counting detectors (T/BCD) are above and below the CAL, respectively, and provided the low energy trigger. Each T/BCD is composed of an array of 20 x 20 photodiodes on plastic scintillators. The measured proton spectral index of 2.67 ± 0.01 between 2.5 and 12.5 TeV is consistent with prior CREAM measurements. The spectrum softens above ~ 10 TeV consistent with the bump-like structure as reported by CREAM I+III, DAMPE, and NUCLEON, but ISS-CREAM extends measurements to higher energies than those prior measurements.'

Collaborations
ISS-Cream,

Keywords and Comments
'High-energy cosmic ray; ISS-CREAM; Proton spectrum; Direct measurement', 'For the ISS-CREAM collaboration'

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Results from the Cosmic Ray Energetics And Mass for the International Space Station (ISS-CREAM) experiment

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Eun-Suk Seo
Author and Co-Author
Eun-Suk Seo,

Abstract
'The Cosmic Ray Energetics And Mass for the International Space Station (ISS-CREAM) experiment took high energy cosmic ray data for 539 days after its successful installation\r\non the ISS in August 2017. The ISS-CREAM instrument is configured with complementary\r\nparticle detectors capable of measuring elemental spectra for Z = 1 - 26 nuclei in the energy\r\nrange 10¹² – 10¹⁵ eV; as well as electrons at multi-TeV energies. The goal is to understand cosmic ray origin, acceleration and propagation by extending direct measurements of cosmic rays to energies that overlap the energy region of air showers measurements. The four layers of finely segmented Silicon Charge Detectors provide precise charge measurements. They have been designed to minimize hits of accompanying backscattered particles in the same segment as the incident cosmic ray particle to avoid the charge misidentification. The sampling tungsten/scintillating-fiber calorimeter identical to the calorimeter for prior CREAM balloon flights provides energy measurements. In addition, scintillator-based Top and Bottom Counting Detectors distinguish electrons from nuclei. Our analysis indicates that the data extend well above 100 TeV. Recent results from the ongoing analysis will be presented.'

Collaborations
ISS-Cream,

Keywords and Comments
'multi-TeV elemental spectra; acceleration limit; spectral features; calorimeter; silicon charge detector; ISS', 'for the ISS-CREAM Collaboration'

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Properties of Cosmic Helium Isotopes Measured by the Alpha Magnetic Spectrometer

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Francesca Giovacchini
Author and Co-Author
Francesca Giovacchini | for the AMS02 Collabroration,

Abstract
'Precision measurements by the Alpha Magnetic Spectrometer (AMS) on the International Space Station of 3He and 4He fluxes are presented. The measurements are based on 100 million 4He nuclei in the rigidity range from 2.1 to 21 GV and 18 million 3He from 1.9 to 15 GV collected from May 2011 to November 2017. We observed that the 3He and 4He fluxes exhibit nearly identical variations with time. The relative magnitude of the variations decreases with increasing rigidity. The rigidity dependence of the 3He/4He flux ratio is measured for the first time. Below 4 GV, the 3He/4He flux ratio was found to have a significant long-term time dependence. Above 4 GV, the He/4He flux ratio was found to be time independent, and its rigidity dependence is well described by a single power law ∝RΔ with Δ=−0.294±0.004. Unexpectedly, this value is in agreement with the B/O and B/C spectral indices at high energies.'

Collaborations
AMS,

Keywords and Comments
'Cosmic Rays; Helium Isotopes; Galactic Cosmic rays Propagation', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Cosmic-ray Heavy Nuclei Spectra Using the ISS-CREAM Instrument

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Sinchul Kang
Author and Co-Author
Sinchul Kang,

Abstract
'Cosmic Ray Energetic And Mass for the International Space Station (ISS-CREAM) was designed to study high-energy cosmic-rays on the ISS. The ISS-CREAM instrument can measure high energy cosmic rays up to PeV energies and recorded data from August 22nd, 2017 to February 12th, 2019. In this analysis, the silicon charge detector (SCD), calorimeter (CAL) and top and bottom counting detectors (TCD/BCD) are used. The SCD is composed of 4 layers and provides the measurement of cosmic-ray charges with resolution of ~0.2 e. The CAL is composed of 20 interleaved tungsten plates and scintillators. It measures the energies of the incident cosmic-ray particles and provides a high energy trigger. The TCD/BCD consist of photodiode arrays and plastic scintillators and provide a low energy trigger. In this analysis, the SCD top two layers are used for charge determination. The measured energy distribution from CAL is deconvolved into an incident energy distribution. Monte-Carlo simulation data is used to calculate efficiency. We will present preliminary results of cosmic-ray heavy nuclei spectra from the ISS-CREAM instrument.'

Collaborations
ISS-Cream,

Keywords and Comments
'''ISS-CREAM; Heavy Nuclei''', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Extended measurement of the proton spectrum with CALET on the International Space Station

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Kazuyoshi Kobayashi
Author and Co-Author
Kazuyoshi Kobayashi | for the CALET Collaboration,

Abstract
'Calorimetric Electron Telescope (CALET) is aiming to measure the main components of high energy cosmic rays up to ~1 PeV in order to understand the cosmic ray acceleration and propagation. The detector consisting of a charge detector, an imaging calorimeter, and a total absorption calorimeter, is located on the International Space Station. The thickness of the calorimeter corresponds to 30 radiation length and to ~1.3 proton interaction length. Data taking has started in October 2015 and continues stably without any serious troubles. We have taken data for more than 5 years so far. We present the latest result of proton spectrum analysis in the energy region from 50 GeV to several tenths of TeV. A fiducial geometrical factor of ~416 cm2 sr is used. The energy resolution of proton is 30-40%. The remaining background is less than 10% in 50 GeV<E<10 TeV region. Compared to our previous result published in Physical Review Letters in 2019, statistics has been increased by more than two years. Spectral hardening in E=1-10 TeV region is then confirmed with higher statistics. We will newly discuss spectral softening above 10 TeV as well as the proton to helium spectrum ratio.'

Collaborations
CALET,

Keywords and Comments
'proton; helium; CALET', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Neural Networks aproach to event reconstruction for the GAPS experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 425

Presenter
Nadir Marcelli
Author and Co-Author
Nadir Marcelli,

Abstract
'The General Antiparticle Spectrometer (GAPS) is a balloon-borne detector, whose first flight is scheduled in the austral summer 2022,and is designed to measure low energy (<0.25 GeV/n) cosmic antinuclei. A particular focus is on antideuterons, which are predicted to have an ultra-low astrophysical background as compared to signals from dark matter annihilation or decay in the Galactic halo. GAPS uses a novel technique for particle identification based on the formation and decay of exotic atoms. To achieve sufficient rejection power for particle identification, an accurate determination of several fundamental quantities is needed. The precise reconstruction of the energy deposition pattern on the primary track is a particularly intricate problem and we exhibit a strategy devised to solve this using modern machine learning techniques. In the future, this approach can be used for particle identification. Here, we present preliminary results of these efforts obtained from simulated data.'

Collaborations
GAPS,

Keywords and Comments
'', 'On behalf of the GAPS collaboration'

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Investigating the Vela SNR's Emission of Electron Cosmic Rays with CALET at the International Space Station

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Holger Motz
Author and Co-Author
Holger Motz | for the CALET Collaboration,

Abstract
'The ISS-based Calorimetric Electron Telescope (CALET) is directly measuring the energy spectrum of electron+positron cosmic rays up to 20 TeV. Cosmic-ray electrons of TeV region energy are limited by energy loss to a propagation range of about 1 kpc, therefore the expected sources are a few nearby supernova remnants (SNR), with the Vela SNR dominating the spectrum [Kobayashi et al. 2004]. \r\nThe latest spectrum measured by CALET in combination with the positron-only flux published by AMS-02 [Aguilar et al. 2019] is fitted with a comprehensive model including nearby pulsars as the source of the positron excess. This model is extended to the TeV region by addition of the flux from the Vela SNR as calculated with DRAGON, with the integrated energy emitted in electron cosmic rays by the SNR as a variable scale factor. Exploring various scenarios for the time and energy dependence of the cosmic-ray release from Vela, under varied propagation conditions, best-fitting interpretations of the spectrum and upper limits on the emission of cosmic-ray electrons by Vela have been derived.'

Collaborations
CALET,

Keywords and Comments
'Vela SNR ; Cosmic Ray Acceleration ; Cosmic Ray Propagation', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Measurement of the energy spectrum of cosmic-ray helium with CALET on the International Space Station

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Paolo Brogi
Author and Co-Author
Paolo Brogi | for the CALET collaboration,

Abstract
'The CALorimetric Electron Telescope (CALET) is a space instrument designed to carry out precision measurements of high energy cosmic-rays. \r\nIt was installed onboard the International Space Station in August 2015 and since mid-October 2015 it is collecting data with excellent performance and no significant interruptions.\r\nThe instrument consists of two layers of segmented plastic scintillators to identify the charge of individual elements from proton to iron, followed by a thick (30 X_{0} and ~1.3 $\\lambda_{I}$) calorimeter. It comprises a finely segmented imaging calorimeter (3 X_{0}), providing accurate particle tracking and complementary charge measurement, and a total absorption (27 X_{0}) homogeneous calorimeter.\r\nIn addition to its primary science goal of identifying nearby sources of high-energy electrons and possible signatures of dark matter in the electron spectrum, \r\nCALET is carrying out measurements of the energy spectra, relative abundances and secondary-to-primary ratios of individual elements from proton to iron and above,\r\nin order to shed light on the mechanism of acceleration and propagation of cosmic rays in the Galaxy. \r\nPreliminary measurements of the energy spectrum of cosmic-ray helium, based on the first five years of collected data, will be presented and details of the analysis are given. The observations performed by CALET in the energy interval from a few GeV/n to the multi-TeV region show that the helium differential spectrum does not follow a simple power-law.'

Collaborations
CALET,

Keywords and Comments
'', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Measurement of Nuclear Fragmentation Cross Sections with NA61/SHINE for a better understanding of the Propagation of Cosmic-Ray Nuclei in the Galaxy

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Neeraj Amin
Author and Co-Author
Neeraj Amin,

Abstract
"The NA61/SHINE facility is a multi-purpose experiment located at the H2 beam line of the CERN SPS North Area, with the aim of studying the properties of hadron production in nuclear collisions with fixed targets. Important goals are to measure hadron-nucleus interactions to improve cosmic-ray shower modeling and also to study light, secondary cosmic-ray nuclei production (Li, Be \\& B) in the Galaxy. An analysis of the data taken during a pilot run in 2018 will be presented in this contribution. These data were taken with ^{12}C projectiles at a beam momentum of 13.5 *A* GeV/c and two fixed targets, viz.polyethylene (C$_{2}$H$_{4}$) and graphite. The specific focus here is the measurement of total boron (^{10}B & ^{11}B) production cross section in C+p interactions at 13.5 *A* GeV/c. The cosmic-ray nucleus ^{11}C is termed a 'Ghost nucleus' on account of its short lifetime compared to the usual cosmic-ray diffusion time in the Galaxy and it ultimately decays to Boron as, ^{11}C$\\rightarrow ^{11}$B + $\\beta^+$. Therefore, precise knowledge of the production cross section of ^{11}C is very relevant for the understanding of boron production in the Galaxy.\r\n\r\nA new measurement of the fragmentation cross section of C+p $\\rightarrow^{11}$C will be presented, which, together with our previously reported B-production cross section, provides a new constraint on boron production in the Galaxy in the high-energy range relevant for modern space based cosmic-ray experiments like AMS-02.\r\n\r\nMoreover, the impact of our measurement on the interpretation of the B/C ratio and an outlook for future fragmentation measurements with NA61/SHINE will be briefly discussed."

Collaborations
other (fill field below), NA61/SHINE

Keywords and Comments
'fragmentation; cross-section; fixed target; B/C ratio; boron-to-carbon ratio; 10B; 11B; 11C; propagation; diffusion', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Analysis Results from the Cosmic Ray Energetics And Mass Instrument for the International Space Station (ISS-CREAM)

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Scott Nutter
Author and Co-Author
Scott Nutter | Tyler Anderson | Yu Chen | Stephane Coutu | Tyler LaBree | Jason Link | John W. Mitchell | S.A. Isaac Mognet | Kenichi Sakai | Jacob Smith | Monong Yu,

Abstract
'We present the results of an analysis of on-orbit data from the Cosmic Ray Energetics And Mass instrument for the International Space Station. The design objective is to measure the elemental spectra of cosmic rays from Z=1 to Z=26 over the energy range of $10^{12} - 10^{15}$ eV. The instrument was installed on the ISS on August 22, 2017 with operations terminated on February 12, 2019, resulting in approximately 1.5 years of operation. We compare detailed GEANT4 simulations to instrument data, demonstrate how we determine the appropriate energy scale for the instrument, and show some preliminary results.'

Collaborations

Keywords and Comments
'elemental spectra;', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Properties of Heavy Secondary Fluorine Cosmic Rays Results from the Alpha Magnetic Spectrometer

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Qi Yan
Author and Co-Author
Qi Yan, Vitaly Choutko

Abstract
'Precise knowledge of the charge and rigidity dependence of the secondary cosmic ray fluxes and the secondary-to-primary flux ratios is essential in the understanding of cosmic ray propagation. We report the properties of heavy secondary cosmic ray fluorine F in the rigidity R range 2.15 GV to 2.9 TV based on 0.29 million events collected by the Alpha Magnetic Spectrometer experiment on the International Space Station. The fluorine spectrum deviates from a single power law above 200 GV. The heavier secondary-to-primary F/Si flux ratio rigidity dependence is distinctly different from the lighter B/O (or B/C) rigidity dependence. In particular, above 10 GV, the (F/Si)/(B/O) ratio ratio can be described by a power law Rδ with δ = 0.052±0.007. This shows that the propagation properties of heavy cosmic rays, from F to Si, are different from those of light cosmic rays,from He to O, and that the secondary cosmic rays have two classes.'

Collaborations
AMS,

Keywords and Comments
'AMS; Fluorine; heavy nuclei; secondary cosmic ray; cosmic ray propagation; latest new AMS result', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Precise Measurement of the Cosmic-Ray Electron and Positron Spectrum with CALET on the International Space Station

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Shoji Torii
Author and Co-Author
Shoji Torii | Yosui Akaike | for the CALET Collaboration,

Abstract
'Primary objectives of the CALET (CALorimetric Electron Telescope) mission are to search for possible nearby cosmic-ray sources and dark matter signatures with the precise measurement of the electron and positron (all-electron) spectrum. The instrument, consisting of a charge detector, an imaging calorimeter and a total absorption calorimeter, is optimized to measure the all-electron spectrum well into the TeV region with a thick calorimeter of 30 radiation length with fine shower-imaging capability. Due to the excellent energy resolution (a few % above 10 GeV) and the outstanding e/p separation (~105), CALET achieves optimal performance for a detailed search for structures in the energy spectrum.\r\nCALET has been accumulating scientific data for more than five years without any major interruption, and the statistics of observed electron events has increased more than double since the latest publication in 2018. In this paper we will present precise measurements of the all-electron spectrum up to several TeV, as obtained with the high statistics data, and we will briefly discuss about its interpretation.'

Collaborations
CALET,

Keywords and Comments
'Cosmic ray electron; Electron spectrum; Particle acceleration; Nearby source; Dark matter;', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Properties of Cosmic Sodium : Results from the Alpha Magnetic Spectrometer

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
cheng zhang
Author and Co-Author
cheng zhang, Zhen Liu | For the AMS collaboration

Abstract
'We report the properties of sodium (Na) cosmic rays in the rigidity range 2.15 GV to 3.0 TV with 0.46 million nuclei collected by the Alpha Magnetic Spectrometer experiment on the International Space Station. We observed that above 6 GV the Na flux is well described by the weighted sum of the silicon flux (primary cosmic rays) and the fluorine flux (secondary cosmic rays).\r\n The fraction of primary component increases with rigidity and becomes dominant at highest rigidities. Na/Si abundance ratio at the source is determined independent of cosmic ray propagation models.'

Collaborations
AMS,

Keywords and Comments
'Cosmic rays & astroparticles; Cosmic ray composition & spectra; Cosmic ray acceleration; Cosmic ray propagation; Cosmic ray sources', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Properties of Neon, Magnesium, and Silicon Primary Cosmic Rays Results from the Alpha Magnetic Spectrometer

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Alberto Oliva
Author and Co-Author
Alberto Oliva,

Abstract
'We report the observation of new properties of primary cosmic rays, neon (Ne), magnesium (Mg), and silicon (Si), measured in the rigidity range 2.15 GV to 3.0 TV with 1.8 million Ne, 2.2 million Mg, and 1.6 million Si nuclei collected by the Alpha Magnetic Spectrometer experiment on the International Space Station. The Ne and Mg spectra have identical rigidity dependence above 3.65 GV. The three spectra have identical rigidity dependence above 86.5 GV, deviate from a single power-law above 200 GV, and harden in an identical way. Unexpectedly, above 86.5 GV the rigidity dependence of primary cosmic rays Ne, Mg, and Si spectra is different from the rigidity dependence of primary cosmic rays He, C, and O. This shows that the Ne, Mg, and Si and He, C, and O are two different classes of primary cosmic rays.'

Collaborations
AMS,

Keywords and Comments
'AMS-02', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Anisotropy of Protons and Light Primary Nuclei in Cosmic Rays Measured with the Alpha Magnetic Spectrometer on the ISS

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Miguel Angel Velasco
Author and Co-Author
Miguel Angel Velasco | Jorge Casaus | for the AMS Collaboration,

Abstract
'Analysis of anisotropy of the arrival directions of galactic protons, helium, carbon and oxygen has been performed with the Alpha Magnetic Spectrometer on the International Space Station. These results allow to investigate the origin of the spectral hardening observed by AMS in these cosmic ray species. The AMS results on the dipole anisotropy are presented along with the discussion of the implications of these measurements.'

Collaborations
AMS,

Keywords and Comments
", "

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Measurement of the iron spectrum with CALET on the International Space Station

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Francesco STOLZI
Author and Co-Author
Francesco STOLZI | Caterina CHECCHIA | Yosui Akaike | for the CALET Collaboration,

Abstract
'The Calorimetric Electron Telescope (CALET), in operation on the International Space Station since 2015, has collected a large sample of cosmic-ray charged particles and gamma-rays over a wide energy interval. The instrument consists of two layers of segmented plastic scintillators to identify the charge of individual elements from proton to iron (and above), a thin imaging tungsten scintillating fiber calorimeter providing accurate particle tracking, and a lead-tungstate homogeneous calorimeter to measure energy. One of the scientific objectives of CALET is the direct measurement of the energy spectra of cosmic nuclei conveying important information on their acceleration and propagation in the Galaxy. Based on the first five years of CALET observation, CALET has measured the iron spectrum in the range of kinetic energy per nucleon from 10 GeV/n to 2.0 TeV/n. We present the CALET iron results, describe the analysis of the data and the detailed assessment of systematic uncertainties, and compare the CALET results with the findings of previous experiments.'

Collaborations
CALET,

Keywords and Comments
", "

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Properties of Cosmic Aluminum Nuclei: Results from the Alpha Magnetic Spectrometer

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Zhen Liu
Author and Co-Author
Zhen Liu | cheng zhang | Mercedes Paniccia,

Abstract
'We report the properties of aluminum (Al) cosmic rays in the rigidity range 2.15 GV to 3.0 TV with 0.51 million nuclei collected by the Alpha Magnetic Spectrometer experiment on the International Space Station. We observed that above 6 GV the Al flux is well described by the weighted sum of the silicon flux (primary cosmic rays) and the fluorine flux (secondary cosmic rays). The fraction of primary component increases with rigidity and becomes dominant at highest rigidities. Al/Si abundance ratio at the source is determined independent of cosmic ray propagation models.'

Collaborations
AMS,

Keywords and Comments
", "

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Towards Understanding the Origin of Cosmic-Ray Electrons

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Dimitrii Krasnopevtsev
Author and Co-Author
Dimitrii Krasnopevtsev | For the AMS02 Collaboration,

Abstract
'Precision results on cosmic-ray electrons are presented in the energy range from 0.5 GeV to 1.4 TeV based on 28.1 million electrons collected by the Alpha Magnetic Spectrometer on the International Space Station. In the entire energy range the electron and positron spectra have distinctly different magnitudes and energy dependences. The electron flux exhibits a significant excess starting from 41.2 GeV compared to the lower energy trends, but the nature of this excess is different from the positron flux excess above 25.2 GeV. Contrary to the positron flux, which has an exponential energy cutoff of 810 GeV, at the 5σ level the electron flux does not have an energy cutoff below 1.9 TeV. In the entire energy range the electron flux is well described by the sum of two power law components. The different behavior of the cosmic-ray electrons and positrons measured by AMS is clear evidence that most high energy electrons originate from different sources than high energy positrons.'

Collaborations
AMS,

Keywords and Comments
", "

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Measurement of the cosmic-ray secondary-to-primary ratios with CALET on the International Space Station

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Yosui Akaike
Author and Co-Author
Yosui Akaike | paolo maestro | For the CALET Collaboration,

Abstract
'CALorimetric Electron Telescope, CALET, has been measuring high-energy cosmic rays on the International Space Station since October 2015. One of the scientific objectives of the CALET mission is the precise measurements of the energy spectra of individual cosmic-ray nuclei and the energy dependence of secondary-to-primary abundance ratio to reveal the detail of the cosmic-ray acceleration and propagation in the Galaxy. The instrument, consisting of two layers of segmented plastic scintillators, a 3 radiation length thick tungsten-scintillating fiber imaging calorimeter, and a 27 radiation length thick PWO calorimeter, has capabilities to identify individual nuclei elements up through Iron with excellent charge resolution and cover the wide energy range from 10 GeV to a PeV scale. Long-term observation with CALET for over five years of operation allows to investigate the TeV region of the secondary components. In this contribution, the details about the analysis of secondary-to-primary cosmic-ray ratios such as B/C and their preliminary results will be presented.'

Collaborations
CALET,

Keywords and Comments
'secondary to primary ratio; propagation in Galaxy;', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Precision Measurement of Cosmic Ray Deuterons with the Alpha Magnetic Spectrometer

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Eduardo Ferronato Bueno
Author and Co-Author
Eduardo Ferronato Bueno, Fernando Barão | Javier Berdugo | Carlos Delgado | Francesco Dimiccoli | Diego Gomez Coral | Manuela Vecchi | Paolo Zuccon | Philip von Doetinchem | For the AMS02 Collaboration

Abstract
'The Alpha Magnetic Spectrometer (AMS-02) has been operating aboard the International Space Station (ISS) since May 2011. Deuterons represent about 1% of the single-charged cosmic-ray nuclei. They are mainly produced by fragmentation reactions of primary cosmic 4He nuclei on the interstellar medium and represent a very sensitive tool to verify and constrain CR propagation models in the galaxy. Given the smaller cross-section for 4He->D with respect to C->B, the deuteron flux provides additional information about the propagation of cosmic rays compared to the cosmic B/C ratio. Precise particle rigidity and velocity measurements and a large acceptance enable separating deuterons from abundant protons in the rigidity range from 1.92 to 21.1 GV. Precision measurements of the deuteron flux obtained with a high-statistics data sample collected by the AMS-02 during its 8.5 years of operation on the International Space Station will be presented.'

Collaborations
AMS,

Keywords and Comments
'deuteron; cosmic-ray; AMS-02; secondary', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Cosmic Ray Helium spectrum measured by the DAMPE experiment

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Margherita Di Santo
Author and Co-Author
Margherita Di Santo, Antonio Surdo | Pengxiong Ma | Chuan Yue | Yapeng Zhang | For the DAMPE Collaboration

Abstract
'DAMPE (DArk Matter Particle Explorer) is a Space mission project promoted by the Chinese Academy of Sciences (CAS), in collaboration with Universities and Institutes from China, Italy and Switzerland. The satellite hosting the DAMPE detector has been successfully launched on December 17th, 2015, and is currently collecting data in a stable way. The main goals of the mission are: indirect search of Dark Matter, looking for signatures in the electron and photon spectra with energies up to 10 TeV; high energy gamma-ray astronomy; analysis of the flux and composition of primary Cosmic Rays (CR) in the energy range from few tens of GeV up to hundreds of TeV. In this work we present the latest result on the CR Helium spectrum measured by DAMPE and discuss the observed features in the light of the current models about the origin, acceleration and propagation of galactic Cosmic Rays. The outcome is validated through independent analyses performed inside the DAMPE Collaboration, which give consistent results within the overall uncertainties.'

Collaborations
DAMPE,

Keywords and Comments
'Cosmic Rays; CR Direct detection; CR Helium flux; Space experiments', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Direct Measurement of the Cosmic-Ray Iron Spectrum with the Dark Matter Particle Explorer

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
ZhiHui Xu
Author and Co-Author
ZhiHui Xu, Francesca Alemanno | Pengxiong Ma | Leandro Silveri | Qiang Yuan | For the DAMPE Collaboration

Abstract
'Dark Matter Particle Explorer（DAMPE) is a calorimetric-type, satellite-borne detector for observations of high energy electrons, gamma-rays, and cosmic-ray nuclei. Using five years data recorded with DAMPE from January 1, 2016 to December 31, 2020, we measure the spectrum of iron nuclei in a wide energy range. Detailed studies of the fragmentation of iron in the detector have been performed using Monte Carlo simulations. The DAMPE result shows good consistency with previous measurements by other experiments below hundreds of GeV/n, and improves the precision at higher energies.'

Collaborations
DAMPE,

Keywords and Comments
'Cosmic Rays; CR Direct detection; CR Iron Flux; Space experiments', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Antiproton Flux and Properties of Elementary Particle Fluxes in Primary Cosmic Rays Measured with the Alpha Magnetic Spectrometer on the ISS

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Hsin-Yi Chou
Author and Co-Author
Hsin-Yi Chou | Zuhao Li | Zhi-Cheng Tang | Zhili Weng | Andrei Kounine,

Abstract
'The fluxes and flux ratios of charged elementary particles in cosmic rays are presented in the absolute rigidity range from 1 up to 2000 GV. In the absolute rigidity range ~60 to ~500 GV, the antiproton, proton, and positron fluxes are found to have nearly identical rigidity dependence and the electron flux exhibits different rigidity dependence. Below 60 GV, the antiproton-to-proton, antiproton-to-positron, and proton-to-positron flux ratios each reaches a maximum. Particular emphasis is made on new observations of the properties of elementary particles in the rigidity range above 500 GV.'

Collaborations
AMS,

Keywords and Comments
", "

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Measurement of the light component (p+He) energy spectrum with the DAMPE space mission

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Francesca Alemanno
Author and Co-Author
Francesca Alemanno, Paolo Bernardini | Antonio De Benedittis | Ivan De Mitri | Zhaomin Wang

Abstract
'The DArk Matter Particle Explorer (DAMPE) is a space-based particle detector launched in a Sun-synchronous orbit on December 17th, 2015 from the Jiuquan Satellite Launch Center, in China. It is taking data very smoothly since more than 5 years. Science goals of the DAMPE mission include the study of the electron-positron energy spectrum, the study of galactic cosmic-rays, gamma-ray astronomy, and indirect dark matter search. Performing precise measurements of light elements in space, the most abundant components of cosmic radiation, is necessary to address major problems in galactic cosmic ray acceleration and propagation mechanisms. Selecting a p+He sample (instead of protons or He alone) allows larger efficiency and purity, also minimizing systematic effects in the reconstruction of the energy spectrum, due to possible cross-contaminations. The use of looser analysis cuts allows collecting larger statistics thus extending the covered energy range and providing a link between direct and indirect cosmic-ray measurements. The measurement of the p+He energy spectrum up to about 100 TeV will be presented, along with a discussion on the features of the spectrum and a comparison with other experiments.'

Collaborations
DAMPE,

Keywords and Comments
", "

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

SuperTIGER Abundances of Galactic Cosmic Rays for the Atomic Number (Z) Interval 30 to 56

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Nathan Walsh
Author and Co-Author
Nathan Walsh | Brian Rauch | Martin Israel | W. Robert Binns | Richard Bose | Yosui Akaike | Terri Brandt | John Krizmanic | John W. Mitchell | A.W. Labrador | Jason Link | R.A. Mewaldt | Ryan Murphy | Kenichi Sakai | Makoto Sasaki | Wolfgang Zober | M.E.,

Abstract
'SuperTIGER (Super Trans-Iron Galactic Element Recorder) is a long-duration-balloon instrument that completed its first Antarctic flight during the 2012-2013 austral summer, spending 55 days at an average float altitude of 125,000 feet. SuperTIGER measured the relative abundances of Galactic cosmic-ray (GCR) nuclei with high statistical precision and well resolved individual element peaks from $_{10}$Ne to $_{40}$Zr. SuperTIGER also made exploratory measurements of the relative abundances up to $_{56}$Ba. Although the statistics are low for elements heavier than $_{40}$Zr, we present preliminary relative abundance measurements of charges $Z=41-56$ with individual element resolution. GCR measurements up to $_{40}$Zr support a source acceleration model where supernovae in OB associations preferentially accelerate refractory elements that are more readily embedded in interstellar dust grains than volatiles. In addition, injection into the GCR for both refractory and volatile elements appears to follow a charge dependence consistent with their grain sputtering cross sections. Our preliminary measurements of the $Z=41-56$ range suggest the existence of an alternative GCR source or acceleration model for $Z>40$ elements. We report progress in refining this interesting result.'

Collaborations
, SuperTIGER

Keywords and Comments
'cosmic ray; origin; acceleration; supernova; binary neutron star merger; long-duration balloon; Antarctica', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Cosmic-Ray Isotopes with the Alpha Magnetic Spectrometer

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Laurent DEROME
Author and Co-Author
Laurent DEROME, Mercedes Paniccia

Abstract
'The Alpha Magnetic Spectrometer (AMS-02) has been operating aboard the International Space Station (ISS) since May 2011. Lithium and Beryllium are expected to be mainly produced by the fragmentation of primary cosmic rays (CR) during their propagation. Therefore, their measurement is essential in the understanding of cosmic ray propagation and sources. Their isotopic composition can provide crucial complementary information. In particular, the 10Be/9Be ratio can be used as a radioactive clock providing the measurement of CR residence time in the Galaxy. In this contribution, the measurement of the lithium isotopes 6Li and 7Li fluxes and ratios and 7Be, 8Be, and 10Be fluxes and ratios based on data collected by AMS during the first 8.5 years of operation are presented.'

Collaborations
AMS,

Keywords and Comments
", "

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Anisotropy of Positron and Electron Fluxes Measured with the Alpha Magnetic Spectrometer on the ISS

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Miguel Molero Gonzalez
Author and Co-Author
Miguel Molero Gonzalez | Jorge Casaus Armentano | for the AMS Collaboration,

Abstract
'Analysis of anisotropy of the arrival directions of galactic positrons and electrons has been performed with the Alpha Magnetic Spectrometer on the International Space Station. These results differentiate between point-like and diffuse sources of cosmic rays for the explanation of the observed excess of high energy positrons. The AMS results of the dipole anisotropy are presented along with the discussion of the implications of these measurements'

Collaborations
AMS,

Keywords and Comments
", "

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Properties of Light Primary and Secondary Cosmic Rays He-C-O and Li-Be-B Measured with the AMS on the ISS

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Henning Gast
Author and Co-Author
Henning Gast | Stefan Schael | Valerio Formato,

Abstract
'We present precision high statistics measurements of the primary cosmic rays Helium, Carbon, and Oxygen and the secondary cosmic rays Lithium, Beryllium and Boron by the Alpha Magnetic Spectrometer in the rigidity range from 2 GV to 3 TV, based on 150 billion cosmic ray events collected by AMS during the first 8.5 years of operation aboard the International Space Station. The properties of the He-C-O and Li-Be-B fluxes are discussed. Comparisons with other measurements are shown.'

Collaborations
AMS,

Keywords and Comments
'AMS; Helium; Carbon; Oxygen; Lithium; Beryllium; Boron; primary cosmic rays; secondary cosmic rays', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Towards Understanding the Origin of Cosmic-Ray Positrons

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Zhili Weng
Author and Co-Author
Zhili Weng | For the AMS Collaboration,

Abstract
'The latest precision measurements on the cosmic ray positrons flux by the Alpha Magnetic Spectrometer on the International Space Station are presented. The positron flux exhibits complex energy dependence. Its distinctive properties are (a) a significant excess starting from 25 GeV compared to the lower-energy, power-law trend; (b) a sharp drop-off above 284 GeV; (c) in the entire energy range the positron flux is well described by the sum of a term associated with the positrons produced in the collision of cosmic rays, which dominates at low energies, and a new source term of positrons, which dominates at high energies; and (d) a finite energy cutoff of the source term at 810 GeV is established with a significance of more than 4σ. These experimental data on cosmic ray positrons show that, at high energies, they predominantly originate either from dark matter annihilation or from new astrophysical sources.'

Collaborations
AMS,

Keywords and Comments
'AMS; Cosmic Ray Positrons; Dark Matter', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

New result of Antideuteron search in BESS-Polar II

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Kenichi Sakai
Author and Co-Author
Kenichi Sakai | for the BESS Collaboration,

Abstract
'High precision cosmic-ray antiproton fluxes reported by BESS-Polar, PAMELA and AMS-02 are overall consistent with secondary production from interactions of primary cosmic rays with the interstellar medium. This severely constrains the possibility of antiprotons of primary origin such as annihilation or decay of supersymmetric dark matter or evaporation of primordial black holes. In the case of antideuterons, secondary production in collisions is strongly suppressed, especially at low energies, because of the very low production cross-section and strict kinematic requirements compared to antiproton production. The lack of secondary background would imply that there is still plenty of room to search for primary antideuterons from novel production processes. The most sensitive reported search used BESS flight data obtained during four BESS balloon flights from 1997 to 2000. By comparison, the BESS-Polar II LDB flight in 2007/2008 accumulated cosmic-ray data in near solar minimum conditions with more than ten times the statistics of one day flight for BESS97. We will report the result of a new search for antideuterons with unprecedented sensitivity using BESS-Polar II data.'

Collaborations
other (fill field below), BESS

Keywords and Comments
'Cosmic ray; Antideuteron; Superconducting spectrometer; BESS; Long-duration balloon flight', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Progress on Ultra-Heavy Cosmic-Ray Analysis with CALET on the International Space Station

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Wolfgang Zober
Author and Co-Author
Wolfgang Zober, Brian Rauch | Anthony Ficklin | Nicholas Cannady | for the CALET Collaboration

Abstract
'The Calorimetric Electron Telescope (CALET), launched to the International Space Station in August 2015 and continuously operating since, measures cosmic-ray (CR) electrons, nuclei and gamma-rays. CALET utilizes its main calorimeter charge detector to measure CR nuclei from $_{1}$H to $_{40}$Zr. In order to maximize the acceptance of the rare ultra-heavy (UH) CR above $_{30}$Zn, a special high duty cycle ($\\sim$90%) UH trigger is used that does not require passage through the 27 radiation length deep Total Absorption Calorimeter (TASC). This provides a 6x increase in geometry factor allowing CALET to collect in 5 years a UHCR data set with statistics comparable to those from the first flight of the balloon-borne SuperTIGER instrument but without the need for atmospheric corrections. Previous CALET UHCR analyses using time and position corrections based on $_{26}$Fe and a geomagnetic vertical cutoff rigidity selection have shown abundances of even nuclei in agreement with SuperTIGER. To further improve resolution and maximize statistics, a trajectory dependent geomagnetic rigidity selection has been employed here with further work being done to implement a Cash-Karp Runge-Kutta ray tracing method for an improved determination of effective cutoff rigidities. Additional work has also been done to analyze events from the smaller dataset of events that pass through the TASC, which provides energy information and a better charge assignment that will provide higher resolution UH measurements, albeit with lower statistics.'

Collaborations
CALET,

Keywords and Comments
", "

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Studies of cosmic ray anisotropies with DAMPE

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 426

Presenter
Shijun Lei
Author and Co-Author
Shijun Lei | Enrico Catanzani | Wei Jiang | Chuan Yue,

Abstract
'A small anisotropy in the arrival directions of comic rays has been consistently observed by ground detectors based on very large sample of events. The Dark Matter Particle explorer (DAMPE) has so far accumulated nearly 10 billion events above GeV with relatively high spatial and energy resolution, expected to be the space detector to observe the anisotropy of cosmic rays. We introduce in this poster our optimizations in the direction measurement, data sampling and anisotropy analysis. The anisotropy predicted by the east-west effect due to the Earth magnetic field and the Compton-Getting effect due to the Earth revolution are then applied to the validation of our analysis.'

Collaborations
DAMPE,

Keywords and Comments
'Anisotropy', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Measurement of the Boron to Carbon Flux Ratio in Cosmic Rays with the DAMPE Experiment

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Chuan Yue
Author and Co-Author
Chuan Yue, Zhanfang Chen | Mingyang Cui | Dimitrios Kyratzis | Libo Wu | For the DAMPE collaboration

Abstract
'The DArk Matter Particle Explorer (DAMPE), a space-based high energy particle detector, has been operated on-orbit for more than five years. The large geometric factor and good charge resolution enable DAMPE to have very good potential to measure cosmic-rays up to 100 TeV. Knowledge of the boron to carbon (B/C) flux ratio is very important in understanding the propagation of cosmic rays, especially in TeV energy range. In this contribution, the latest progress of the B/C flux ratio analysis based on the flight data collected by DAMPE will be presented.'

Collaborations
DAMPE,

Keywords and Comments
'CR Direct Detection; B/C Flux Ratio', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Precision Measurement of low energy positron fluxes by AMS

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 427

Presenter
maura graziani
Author and Co-Author
Fabian Machate, maura graziani | weiwei xu

Abstract
'The detailed measurement of the positron fluxes from May 20, 2011 to October 29, 2019 with the Alpha Magnetic Spectrometer on the International Space Station, is presented. Time variation of the fluxes on different time scales associated with the solar activity over half solar cycle 24 is shown. The measured effect of charge sign dependent effects on particles with the same mass is discussed.'

Collaborations
AMS,

Keywords and Comments
'', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Measurement of carbon and oxygen fluxes in cosmic rays with the DAMPE experiment

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Libo Wu
Author and Co-Author
Libo Wu, Mingyang Cui | Dimitrios Kyratzis | Andrea Parenti | Yifeng Wei | For the DAMPE collaboration

Abstract
'Direct measurements of cosmic-rays (CRs) is fundamental to achieve a better understanding of their origin, mechanism of acceleration and propagation in the Galaxy. Due to the hardening around a few hundred GeV/n in the spectrum of proton, helium and heavy nuclei from recent observations, it is of great importance to provide new and precise measurements of the region of transition for each nuclear species up to the TeV scale. The space experiment of DArk Matter Particle Explorer (DAMPE) is designed to measure CRs and gamma-rays in space, and since December 2015, it is collecting data with smooth and continuous operations. DAMPE has good potential to distinguish the elemental composition of CRs and measures CRs in the energy range of 50 GeV to 100 TeV. In this report, the selection criteria of the carbon and oxygen component will be presented; efficiency of event selections will be validated by Monte Carlo simulations and analysis of system error will be also demonstrated in this report.'

Collaborations
DAMPE,

Keywords and Comments
'CR Direct Detection; Carbon and Oxygen Fluxes', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Properties of Iron Primary Cosmic Rays: Results from the Alpha Magnetic Spectrometer

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 17 Nuclear CR spectra: theory and observations | CRD
Presenter Forum Table

Presenter
Yao Chen
Author and Co-Author
Yao Chen, Mercedes Paniccia | For the AMS collaboration

Abstract
'We report the observation of new properties of primary iron (Fe) cosmic rays in the rigidity range 2.65 GV to 3.0 TV with 0.62 million iron nuclei collected by the Alpha Magnetic Spectrometer experiment on the International Space Station. Above 80.5 GV the rigidity dependence of the cosmic ray Fe flux is identical to the rigidity dependence of the primary cosmic ray He, C, and O fluxes, with the Fe/O flux ratio being constant at 0.155±0.006. This shows that unexpectedly Fe and He, C, and O belong to the same class of primary cosmic rays which is different from the primary cosmic rays Ne, Mg, and Si class.'

Collaborations
AMS,

Keywords and Comments
'Cosmic-ray composition; Cosmic-ray spectra; Cosmic-ray sources; Cosmic-ray acceleration; Cosmic-ray propagation; Cosmic rays and astroparticles', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Searching for fractionally charged particles based on DAMPE

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 428

Presenter
Chengming Liu
Author and Co-Author
Chengming Liu, Pengxiong Ma | For the DAMPE Collaboration

Abstract
'The existence of fractionally charged particles (FCP) in present is some extensions to the Standard Model of particle physics, and their detection would be a significant breakthrough. Most of the previous cosmic-rays (CRs) studies are mainly focused on the secondary CRs from the extensive air shower, but there is rarely on-orbit study to search FCP from primary CRs. The DArk Matter Particle Explorer (DAMPE) was launched into space on the 17th December 2015, and it has been working well in space for more than five years with the purpose of measuring CRs and gamma-rays and as today a large amount of scientific data has been acquired. In this work the five years' on-orbit data of DAMPE have been analyzed for the search of 2/3 fractionally charged particle (FCP). The FCP is assumed to have high penetration capability, and therefore in the selections the particle is required to penetrate the entire detector from top to bottom. Two sub-detectors, the Plastic Scintillator Detector (PSD) and the Silicon Tungsten tracKer (STK), are used for charge discrimination. The Geant4 simulations toolkit is used to investigate the signal region and selection efficiency of 2/3 FCP in the detector. The detailed selection methods and progress will be presented and discussed.'

Collaborations
DAMPE,

Keywords and Comments
'Cosmic ray direct; Fractionally charged particles; New physics', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Interplay between eclipses and soft cosmic rays

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 429

Presenter
Shreya Roy
Author and Co-Author
Shreya Roy, Sayak Chatterjee | Sayan Chakraborty | Saikat Biswas | Supriya Das | Sanjay K. Ghosh | Sunil K. Gupta | Atul Jain | Indranil Mazumdar | Sibaji Raha

Abstract
'Astronomical events such as Solar and Lunar eclipses provide the opportunity for studying the disturbance produced in the atmosphere by these events and its effect on cosmic ray intensity. There are earlier reports on decrease in secondary cosmic gamma ray (SCGR) flux during solar eclipse and enhancement of the same during lunar eclipse. We present the results from the measurement of SCGR using NaI(Tl) scintillator detectors during a total solar eclipse, an annular solar eclipse and two lunar eclipses that took place during 2017-2019. For the total solar eclipse of August 21, 2017, visible in parts of North America, our aim was to examine if there are any variation in the SCGR flux at Kolkata, India due to the occurrence of the eclipse in America. There were decrement and increment in SCGR flux in certain energy regions, which are interpreted as effects of the Travelling Ionospheric Disturbances (TIDs) during the solar eclipse in America. The annular eclipse of December 26, 2019, visible from Ooty, India provided a great opportunity to verify its direct effect on cosmic rays. We present the results from analysis of SCGR data from Cosmic Ray Laboratory (CRL) at TIFR, Ooty. We have also measured the variation of SCGR flux during the lunar eclipse of 31 January, 2018 and of 27 July, 2018, that took place in India. Both the measurements have been carried out in the Detector laboratory of Bose Institute, Kolkata, India. We observed a slight increment of SCGR during the lunar eclipse of January, whereas no significant changes during lunar eclipse of July. Details of all the measurements and the results will be presented.'

Collaborations

Keywords and Comments
", "

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Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Cosmic-ray beryllium isotope ratio measured by BESS Polar-II

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Takuya Wada
Author and Co-Author
Takuya Wada | For the BESS Collaboration,

Abstract
'The cosmic-ray propagation in the Galaxy has not yet been understood in detail. The flux ratio of secondary to primary components among the cosmic radiation have been measured by many experiments providing important information to understand the average amount of interstellar material traversed by cosmic rays. However, such ratio cannot strongly constrain another essential parameter of the cosmic-ray confinement time. The most direct method to estimate the confinement time is to measure the abundance of radioactive component that has a decay time comparable to the confinement time. Among them, the most attractive one is beryllium which has two stable isotopes (7Be and 9Be) and one unstable 10Be with a decay time of 1.4 Myr. The 10Be/9Be ratio has not been measured, except for few cases such as ISOMAX, because of the small statistics of 10Be and the difficulty of distinguishing these isotopes.\r\nThe Balloon-borne Experiment with a Superconducting Spectrometer (BESS) has carried out precise observation of the low-energy cosmic rays. Using a tracking system (in a 0.8 T uniform magnetic field) with a rigidity resolution of ~0.4% at 1 GV and a time-of-flight system with a time resolution of 120 ps, the BESS instrument enables us to distinguish isotope events. In December-January 2007- 2008, BESS-Polar II achieved a 24.5-day observation during its balloon flight over Antarctica. By using 4.7 billion cosmic-ray event data obtained during the flight, rare 10Be events have been searched and analyzed. We will report the beryllium isotope ratio integrated in the BESS-Polar II analysis.'

Collaborations

Keywords and Comments
'cosmic ray; isotope; balloon experiment; propagation', ''

Branch CRD | Cosmic Ray Direct

Subcategory Experimental Results

Beam Test Results of the ISS-CREAM Calorimeter

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 430

Presenter
Hongguang Zhang
Author and Co-Author
Hongguang Zhang,

Abstract
'The Cosmic Ray Energetics And Mass experiment for the International Space Station (ISS-CREAM) was installed on the ISS to measure high-energy cosmic-ray elemental spectra for the charge range Z=1 to 26. The ISS-CREAM instrument includes a tungsten scintillating-fiber calorimeter preceded by carbon targets for energy measurements. The carbon targets induces hadronic interactions, and showers of secondary particles develop in the calorimeter. The calorimeter was calibrated with electron beams at CERN. This beam test included position, energy, and angle scans of electron and pion beams together with a high-voltage scan for calibration and characterization. Additionally, an attenuation effect in the scintillating fibers was studied. In this paper, beam test results, including corrections for the attenuation effect, are presented.'

Collaborations
ISS-Cream,

Keywords and Comments
'Cosmic Ray; ISS-Cream; Calibration; attenuation effect', ''

Branch CRD | Cosmic Ray Direct

Subcategory Future projects

The High Energy cosmic-Radiation Detection (HERD) facility on board the Chinese Space Station: hunting for high-energy cosmic rays

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 15 Future instrumentation | CRD-MM
Presenter Forum Table

Presenter
Fabio Gargano
Author and Co-Author
Fabio Gargano,

Abstract
'The High Energy cosmic-Radiation Detection (HERD) facility has been proposed as a space astronomy payload onboard the future China's Space Station (CSS) aimed to detect charged cosmic-rays and gamma-rays from few GeV to PeV energies.\r\nThe main science objectives of HERD are searching for dark matter particles, the study of cosmic ray chemical composition and high energy gamma-ray observations.\r\nHERD will extend high precision and high statistics spectral measurements of individual cosmic ray species up to few PeV, reaching the knee of the all-particle spectrum. It will also observe the gamma-ray sky from a few GeV up to 1 TeV contributing to multi-messenger astronomy together with ground-based high energy gamma-ray telescope and neutrino and gravitational waves detectors.\r\nThe heart of HERD is a very thick (3 lambda, 55 X0) cubic calorimeter made of small LYSO cubic crystals allowing 3D reconstruction. On the top and on the four sides of the calorimeter there are a silicon charge detector for nuclei identification, a plastic scintillator detector for veto and charge measurements and a tracker consisting of scintillating fibers. On one of the sides there is a Transition radiation detector for on-orbit calibration of the calorimeter.'

Collaborations
other (fill field below), HERD

Keywords and Comments
'high energy cosmic-rays; high energy gamma-rays; future experiments; space station;', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Future projects

Cosmic Antiproton Sensitivity for the GAPS Experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 432

Presenter
Field Rogers
Author and Co-Author
Field Rogers,

Abstract
'The General Antiparticle Spectrometer (GAPS) experiment is a balloon payload designed to measure low-energy cosmic antinuclei during at least three ~35-day Antarctic flights, with the first flight expected in December, 2022. With its large geometric acceptance and novel exotic atom-based particle identification method, GAPS will detect ~1000 antiprotons per flight and produce a precision cosmic antiproton spectrum in the kinetic energy range of 0.03 − 0.23 GeV at float altitude, corresponding to 0.085 − 0.30 GeV at the top of the atmosphere. With these high statistics in a measurement extending to lower energies than any previous experiment, and with orthogonal systematic uncertainty compared to a magnetic spectrometer, the GAPS antiproton measurement will be sensitive to physics including dark matter annihilation, primordial black hole evaporation, and cosmic ray propagation. The antiproton measurement will also validate the GAPS exotic atom technique for the antideuteron and antihelium rare-event searches and provide insight into models of cosmic particle attenuation in the atmosphere. This contribution demonstrates the GAPS sensitivity to antiprotons using a full instrument simulation, event reconstruction, and solar and atmospheric effects.'

Collaborations
GAPS,

Keywords and Comments
'GAPS; Antiproton; Dark Matter; Primordial Black Hole; Exotic Atom', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Future projects

Characterization of a prototype imaging calorimeter for the Advanced Particle-astrophysics Telescope from Anarctic balloon flight and CERN beam test data.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 433

Presenter
Zachary Hughes
Author and Co-Author
Zachary Hughes | for the APT collaboration, Yosui Akaike | Scott Nutter

Abstract
'We report the results and accompanying analysis methods from field-testing calorimeter prototypes for the Advanced Particle-astrophysics Telescope (APT) during the 2019 austral Antarctic balloon season and during a 2018 CERN beam test. The Advanced Particle-astrophysics Telescopeis a proposed space-based gamma- and cosmic-ray instrument that utilizes a novel dispersed imaging calorimeter for both particle tracking and energy reconstruction. The imaging CsI calorimeter (ICC) consists of a CsI:Na scintillator read out by (WLS) fibers in both the x- and y-planes. To function both as a gamma-ray and cosmic-ray instrument APT must operate over a large dynamic range, from the single photon-election regime for low energy gamma-ray events to electronics-saturating cosmic-ray events. Analysis from a 150 mm x 150 mm calorimeter prototype accompanying the 2019 SuperTIGER-2.3 flight demonstrates successful event reconstruction from the long scintillation tail of saturating cosmic-ray events by utilizing the deep memory depth available to the TARGET readout electronics. Spatial reconstruction of events are performed using a two-sided Voigt profile and show position localization within the imaging calorimeter plane to < 3 WLS fiber widths. Charge resolution was evaluated on a 50 mm x 50 mm prototype placed in the 150 GeV/nuc, A/Z = 2.2 CERN SPS beam line. Nuclei were tagged using HNX silicon-strip detectors and allowed for fragmentation cuts in the data. The vastly saturating signals were reconstructed from the CsI:Na scintillation tail and show an APT charge resolution up to Z = 12 (with experimental limitations preventing full evaluation for Z > 12) and linearity in the CsI:Na signal response up to lead.'

Collaborations
other (fill field below), APT

Keywords and Comments
'Cosmic rays; instrumentation; APT', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Methods

A Data-Driven approach for the measurement of ^{10}Be/^{9}Be flux ratio in Cosmic Ray with magnetic spectrometers

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 434

Presenter
Francesco Nozzoli
Author and Co-Author
Francesco Nozzoli | Cinzia Cernetti,

Abstract
'Cosmic Rays (CR) are a powerful tool for the investigation of the structure of the magnetic fields in the galactic halo and the property of the Inter-Stellar Medium.\r\nTwo parameters of the Cosmic Ray propagation models: the galactic halo thickness, H, and the diffusion coefficient, D, are loosely constrained by current CR flux measurements, in particular a large degeneracy exists being only H/D well measured.\r\nThe ^{10}Be/^{9}Be isotopic flux ratio (thanks to the 2 My lifetime of ^{10}Be) can be used as a radioactive clock providing the measurement of CR residence time in the galaxy. This is an important tool to solve the H/D degeneracy. \r\nPast measurements of ^{10}Be/^{9}Be isotopic flux ratio in CR are scarce, limited to low energy and affected by large uncertainties. Here a new technique to measure ^{10}Be/^{9}Be isotopic flux ratio with a Data-Driven approach in magnetic spectrometers is presented. \r\nAs an example by applying the method to Beryllium data collected and published by PAMELA collaboration it is now possible to determine this important measurement avoiding the prohibitive uncertainties coming from the Monte Carlo simulation. It is shown that the accuracy of PAMELA data permits to infer a value of the halo thickness H within 25\\% precision.'

Collaborations

Keywords and Comments
'radioactive cosmic rays; propagation models; halo thickness; beryllium', 'Here a new (preliminary) measurement of 10Be/9Be at "high" energy is obtained by analyzing old data with a new technique. Maybe this could be tagged also as "Experimental results".'

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Methods

A perturbative approach to a nonlinear advection-diffusion equation of particle transport

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 435

Presenter
Dominik Walter
Author and Co-Author
Dominik Walter | Horst Fichtner | Yuri Litvinenko | Frederic Effenberger,

Abstract
'We explore analytical techniques for modeling the nonlinear cosmic ray transport in various astrophysical environments which is of significant current research interest. While nonlinearity is most often described by coupled equations for the dynamics of the\r\nthermal plasma and the cosmic ray transport or for the transport of the plasma waves and the cosmic rays, we \r\nstudy the case of a single but nonlinear advection-diffusion equation. The latter can be approximately solved\r\nanalytically or semi-analytically, with the advantage that these solutions are easy to use and, thus, can \r\nfacilitate a quantitative comparison to data. We present our previous work in a twofold manner.\r\nFirst, instead of employing an integral method to the case of pure nonlinear diffusion, we apply an expansion\r\ntechnique to the advection-diffusion equation. We use the technique systematically to analyze the effect of nonlinear diffusion for the cases of constant and spatially varying advection \r\ncombined with time-varying source functions. Second, we extend the study from the one-dimensional, Cartesian\r\ngeometry to the radially symmetric case, which allows us to treat more accurately the nonlinear diffusion problems on larger scales\r\naway from the source. The results are compared to numerical solutions, which are also extended to more complex situations.'

Collaborations

Keywords and Comments
'', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Methods

Powerful Diagnostics of Cosmic-Ray Modified Shock by Hα Polarimetry

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 14 CRs and ISM | CRD
Presenter Forum Table

Presenter
Jiro Shimoda
Author and Co-Author
Jiro Shimoda | J. Martin Laming,

Abstract
'The acceleration of non-thermal particles in collisionless shocks, especially in supernova remnant shocks, is a long standing problem for revealing the origin of Galactic cosmic-rays. In the most relied scenario, the Galactic cosmic-rays originate in the diffusive shock acceleration mechanism, and the pressure of accelerated cosmic-rays should be large comparable to the ram pressure of upstream background protons to realize the maximum energy of Galactic cosmic-rays, 3 PeV. If the case, the upstream plasma is decelerated "before" entering the shock front (measured in the shock rest frame). This is called the cosmic-ray modified shock and one of the essential predictions for collisionless shocks efficiently accelerating cosmic-rays. Nevertheless, the modification has unfortunately never been observed yet. In numerical simulation, an inferred degree of velocity modification is just 10 percent level. Thus, we must examine this 10 percent modification of plasma located at a distance of kpc scale. We have found that the polarimetry of Hα emission at supernova remnants is a potentially powerful tool to quantify the velocity modification: the polarization direction of Hα is parallel to the shock normal vector in the modified shock case, while the direction is perpendicular without modification. Note that although observations of Hα in supernova remnants has been done in past decades, linearly polarized Hα is recently discovered by Sparks et al. (2015). We have also found that among observable values we calculated, only the polarization direction responds sensitively to the velocity modification (5 percent in our model). Therefore, the polarimetry of Hα will be a unique diagnostics of cosmic-ray modified shock and will bring new insights to particle acceleration physics in collisionless shocks.'

Collaborations

Keywords and Comments
'Supernova Remnants; Particle acceleration', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Methods

Interstellar cosmic-ray spectra (1) just outside the heliosphere and (2) in the local medium: are they the same?

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Elena Orlando
Author and Co-Author
Elena Orlando,

Abstract
'Interstellar cosmic ray (CR) spectra just outside the heliosphere are accessible thanks to direct measurements of CR, with uncertainties given by the solar modulation. Interstellar CR spectra in the local medium (i.e. within ~1 kpc around the Sun) are indirectly accessible thanks to observations of interstellar emissions in radio/microwaves and in gamma rays produced by \xa0CR interactions \xa0with \xa0the \xa0interstellar \xa0medium \xa0and the \xa0Galactic \xa0magnetic field. Observations of these interstellar emissions are an invaluable tool for understanding densities and spectra of CR in different places of our Galaxy. The derivation of both spectra depend on model assumptions. \r\nUntil very recently it was believed that CR as directly measured were resembling CR throughout the Galaxy, after accounting for solar modulation and propagation effects. However, present precise data and sophisticated modeling are posing significant challenges. If interstellar CR spectra just outside the heliosphere and in the local medium are the same is a question that has recently opened again. \r\nWe present here our effort in answering this question and our recent results.'

Collaborations

Keywords and Comments
'', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Methods

Simulating the galactic cosmic ray with non-uniform grids

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 436

Presenter
Yu-Hai Ge
Author and Co-Author
Yu-Hai Ge | Hua Yue | Su-Jie Lin | Hong-Bo Hu,

Abstract
'In the cosmic ray (CR) spectrum related studies, the CR propagation function was always numerically solved with the software that using the finite-difference method (FDM), i.e. GALPROP. In these solutions, the Galaxy is divided into uniform girds, which would require a huge amount of computing resources when the problem is related to the CR density nearby the solar system. For example, when we try to study how the local interstellar magnetic field within 50 pc influences the CR anisotropy, we need to divide the local area into $\\mathcal{O}(10)$ pc grids, which would occupy $\\sim$ 1000 times more memory than the usual cases.\r\n\r\nIn order to efficiently solve this kind of problem, we adopt a non-uniform-grid method. In this method, we design a set of non-uniform grids in which only the area around the solar system is finely divided while the area relatively far away is roughly divided, and then performed a nonlinear coordinate transformation to transform the problems into problems with uniform grids before applying the FDM.\r\n\r\nWith this method, we adopt the local interstellar magnetic field to predict the CR anisotropy and reach a reasonable result.'

Collaborations

Keywords and Comments
'Cosmic ray propagation; Cosmic ray anisotropy', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Methods

Cosmic rays in the GeV-TeV energy range from two types of supernovae

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Satyendra Thoudam
Author and Co-Author
Satyendra Thoudam | Björn Eichmann | Jörg P. Rachen,

Abstract
'The AMS-02 experiment has reported precise measurements of energy spectra of several cosmic-ray species in the energy range of ~ (0.5-2000) GeV/n. An intriguing finding is the differences in the spectral shape between the different species. Protons exhibit the steepest spectrum of all the species, and helium, carbon, oxygen and iron spectra are found to be harder than that of neon, magnesium and silicon. These observations are difficult to explain as diffusive shock acceleration, the currently most plausible theory for cosmic particle acceleration at high energies, expects independence of the spectral index from mass and charge of the accelerated particle. Moreover, propagation in the Galaxy has been shown to not being able to compensate for this discrepancy. In this work, we present an explanation based on two-component model for the origin of cosmic rays in the Galaxy. The first component originating from regular supernova remnants in the interstellar medium and the second component from Wolf-Rayet supernovae. Considering a recently proposed model for cosmic ray injection enhancement at astrophysical shocks and apply it (a) to interstellar-medium elemental abundances for the regular supernovae and (b) to the wind composition for the Wolf-Rayet component, we show that the combination of the two components may explained most of the behavior observed by the AMS-02 experiment.'

Collaborations

Keywords and Comments
'particle diffusion; supernova remnants; wolf-rayet stars; galaxy', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Explaining cosmic ray antimatter with secondaries from old supernova remnants

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Philipp Mertsch
Author and Co-Author
Philipp Mertsch, Andrea Vittino | Subir Sarkar

Abstract
'Despite significant efforts over the last decade, the origin of the cosmic ray positron excess has still not been unambiguously established. A popular class of candidates are pulsars or pulsar wind nebulae but these cannot account for the observed hard spectrum of cosmic ray antiprotons. We revisit the alternative possibility that the observed high-energy positrons are secondaries created by spallation in supernova remnants during the diffusive shock acceleration of the primary cosmic rays, which are further accelerated by the same shocks. The resulting source spectrum of positrons at high energies is then naturally harder than that of the primaries, as is the spectrum of other secondaries such as antiprotons. We present the first comprehensive investigation of the full parameter space of this model -- both the source parameters as well as those governing galactic transport. Various parameterisations of the cross-sections for the production of positrons and antiprotons are considered, and the uncertainty in the model parameters discussed. We obtain an excellent fit to the recent precision measurements by AMS-02 of cosmic ray protons, helium, positrons and antiprotons, as well as of various primary and secondary nuclei. The only notable deviation is an excess of antiprotons around ~10 GeV. This model thus provides an economical explanation of the spectra of all secondary species -- from a single well-motivated population of sources.'

Collaborations

Keywords and Comments
'Particle acceleration; Cosmic ray secondaries; Positrons; Anti-protons; AMS-02', 'https://arxiv.org/abs/2012.12853'

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

CR transport and feedback in galaxies

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 14 CRs and ISM | CRD
Presenter Forum Table

Presenter
Timon Thomas
Author and Co-Author
Timon Thomas | Christoph Pfrommer | Pakmor Ruediger,

Abstract
'Galactic winds can alter the evolution of a disk galaxy by launching outflows from the disk that move gas into the circumgalactic medium (CGM) so that the gas is unavailable to star formation while slowing the infall of fresh gas onto the disk. One agent that is able to drive these galactic winds are GeV cosmic rays (CR) injected by supernovae into the intersellar medium. Through a gyroresonant micro-scale plasma instability CRs drive Alfvén waves that couple their dynamics to the dynamics of their ambient medium. Galactic-scale winds are launched via the momentum transferred by the amplification of these astronomical unit-scale Alfvén waves. Once the CR passed the disk-halo interface their gyro-resonant Alfvén waves damp via various processes and heat the CGM. This heating has a significant contribution to the overall thermodynamics of the CGM and alters the kinematics of material contained in the CGM. The plethora of involved physical processes urges an investigation of the CR dynamics in galactic winds. We developed a two-moment fluid approximation for GeV-CR transport in an arbitrary magnetic field configuration and model their interaction with gyro-resonant Alfvén waves on grounds of the quasi-linear theory of this process. We present the results of high-resolution galaxy formation simulations that uses this this two-moment model. These simulation show that the majority of CRs are streaming with their self-generated Alfvén waves and that the CR diffusion-coefficient is a spatio-temporal varying quantity that cannot be approximated with the fiducial values of ~ 3e28 cm^2 / s.'

Collaborations

Keywords and Comments
'Galactic Winds; Cosmic Ray Hydrodynamics; Magnetohydrodynamics; Numerics', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Escape-limited maximum energy at perpendicular shocks in the interstellar magnetic field

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Shoma Kamijima
Author and Co-Author
Shoma Kamijima, Yutaka Ohira

Abstract
'The origin of cosmic rays is still a long-standing problem in astrophysics. Supernova remnants are plausible candidates of cosmic rays up to 10^15.5 eV. For cosmic ray nuclei, the maximum energy is limited by the escape from accelerators. In previous studies about the cosmic-ray escape, the diffusion approximation is assumed. However, the diffusion approximation cannot apply to investigate the escape process from a perpendicular shock region because the gyration can be important for a perpendicular shock acceleration. It is suggested that the diffusive shock acceleration at a perpendicular shock is a potential acceleration mechanism to accelerate particles up to PeV scale without the magnetic field amplification in the upstream region. However, the escape process and the escape-limited maximum energy at perpendicular shocks are still unknown. In this study, we investigate the escape process from a perpendicular shock region of supernova remnants in the interstellar magnetic field by using a test particle simulation. In this talk, we will report results about the escape process and the escape-limited maximum energy at a perpendicular shock region of supernova remnants in the interstellar magnetic field.'

Collaborations

Keywords and Comments
'Comic rays\r\nSupernova remnants\r\nInterplanetary particle acceleration', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

The cosmic ray content of superbubbles

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Thibault Vieu
Author and Co-Author
Thibault Vieu, Stefano Gabici | Vincent Tatischeff

Abstract
'Although most massive stars are thought to live inside clusters giving rise to galactic-scale superbubbles, a complete model of cosmic ray production in these objects is still missing in the literature. I present an attempt to model particles acceleration in these systems including all the relevant physical processes. The acceleration mechanisms taking place in superbubbles differ from that occuring at isolated supernova remnants in several aspects. The presence of a magnetized shell is expected to efficiently confine the particles, which may therefore experience successive reaccelerations at supernovae shocks. The medium is also though to be highly turbulent, which hardens the particle spectra and make shock acceleration nonlinear. Spectra are further shaped by losses, stellar winds, and the leakage of the interstellar cosmic rays through the superbubble shell. I will discuss typical superbubble spectra and detail the time-dependent emission of these objects.'

Collaborations

Keywords and Comments
'Particle acceleration; Supernova remnants; Superbubbles; Turbulence;', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Particle acceleration in colliding shocks and nonlinear reacceleration

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Thibault Vieu
Author and Co-Author
Thibault Vieu, Stefano Gabici | Vincent Tatischeff

Abstract
'Although supernovae remnants can accelerate cosmic rays up to PeV energies, the origin of more energetic particles remains uncertain. In particular, standard diffusive shock acceleration in isolated shocks does not explain some features in the spectrum such as the so-called "knee" and "ankle". Other acceleration mechanisms should therefore be considered. I describe the time-dependent acceleration of cosmic rays in two colliding shocks. These collisions may appear to be standard processes when supernovae interact with winds in compact stellar clusters. I show how this system can be solved semi-analytically in order to obtain the resulting spectrum of accelerated particles. Under certain conditions, the collision hardens the spectrum at high energies. I then show how nonlinear reacceleration can be solved when multiple shock acceleration takes place.'

Collaborations

Keywords and Comments
'Particle acceleration; Supernova remnants; Shock waves;', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Constraining positron emission from pulsars with AMS-02 data

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Luca Orusa
Author and Co-Author
Luca Orusa, MATTIA DI MAURO | Silvia Manconi | Fiorenza Donato

Abstract
'The cosmic-ray flux of positrons is measured with high precision by the space-borne particle spectrometers AMS-02. The hypothesis that pulsar wind nebulae (PWNe) can significantly contribute to the excess of the positron (e^+) cosmic-ray flux has been consolidated after the observation of a γ-ray emission at TeV energies of a few degree size around Geminga and Monogem PWNe. In this work we simulate pulsars populations adopting different distributions for the position in the Galaxy, the age, the spin-down period and the surface magnetic field of the sources, to overcome the incompleteness of the ATNF catalogue. We fit the AMS-02 data with the positron flux produced by these simulated populations, in order to constrain the values of the efficiency η and spectral index γ of the injectum spectrum of PWNe and to test different configurations of our Galaxy. We adopt a new parametrization of the two-zone diffusion model for the propagation of e^+ accelerated by the Galactic population of PWNe, with the diffusion around these PWNe suppressed by two orders of magnitude with respect to the average in the Galaxy. The attempt of obtaining information about PWNe from the analysis of the AMS-02 e^+ data, which facilitate the search for point sources or new physics with respect to the matter component, has never been performed with this level of accuracy.'

Collaborations

Keywords and Comments
'AMS-02; Particle acceleration; astrophysical sources; high energy physics; lepton; cosmic ray flux;', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

On the overflowing of cosmic rays from galaxies and the expansion of cosmic matter

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 437

Presenter
Antonio Codino
Author and Co-Author
Antonio Codino,

Abstract
'Particles of the cosmic radiation, electrons and nuclei, transport a dominant positive electric charge. A tiny fraction of these particles of extremely high energies in favorable conditions overflow from galaxies. The overflowing of positively charged cosmic nuclei into the intergalactic space uncovers an equal amount of negative charge in the parent galaxy. Negative charge is mainly stored by quiescent electrons. After adequate particle propagation neither the negative electric charge located in the galaxies nor the positive electric charge of the overflowed cosmic nuclei can be neutralized due to the enormous distances.\r\nIn several ways it is proved that the total electric charge retained by clusters of galaxies after an appropriate time interval generate a repulsive force between clusters which overwhelms gravity. After a few billions years of electrostatic repulsion, peripheral clusters attain relativistic velocities and their mutual distances increase accordingly. Several facts suggest that the expansion of the universe, as determined by optical observations since a century, has been caused by the electrostatic repulsion of the positively charged cosmic nuclei overflowed from galaxy clusters.'

Collaborations

Keywords and Comments
'''High-energy cosmic rays; Cosmology''', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

The low rate of supernova remnant pevatrons

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 14 CRs and ISM | CRD
Presenter Forum Table

Presenter
Pierre Cristofari
Author and Co-Author
Elena Amato | Pasquale Blasi | Pierre Cristofari,

Abstract
'Although supernova remnants remain the main suspects as sources of Galactic cosmic rays up to the knee, the supernova paradigm still has many loose ends. The weakest point in this construction is the possibility that individual supernova remnants can accelerate particles to the rigidity of the knee, ~ 106 GV. This scenario heavily relies upon the possibility to excite current driven non-resonant hybrid modes while the shock is still at the beginning of the Sedov phase. These modes can enhance the rate of particle scattering thereby leading to potentially very-high maximum energies. Here we calculate the spectrum of particles released into the interstellar medium from the remnants of different types of supernovae. We find that only the remnants of very powerful, rare core-collapse supernova explosions can accelerate light elements such as hydrogen and helium nuclei, to the knee rigidity, and that the local spectrum of cosmic rays directly constrains the rate of such events, if they are also source of PeV cosmic rays. The implications for the overall cosmic ray spectrum observed at the Earth and for the detection of PeVatrons by future gamma-ray observatories are discussed.'

Collaborations

Keywords and Comments
'particle acceleration; supernova remnants; galactic cosmic rays; pevatron; acceleration', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

GALPROP Framework for Galactic Cosmic Ray Propagation and Associated Photon Emissions

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Igor Moskalenko
Author and Co-Author
Igor Moskalenko | Gudlaugur Johannesson | Troy Porter,

Abstract
'The last decade brought spectacular advances in the astrophysics of cosmic rays (CRs) and gamma-ray astronomy. Improvements in sensitivity of new experiments and other technological breakthroughs allow them to explore unchartered territory, advancing in energy coverage, energy and angular resolutions, and probe subtle signatures of new physics. The accuracy of theoretical models becomes crucial in understanding our Galaxy and beyond, and identifying new phenomena. The state-of-the-art CR propagation code called GALPROP is designed to address exactly this challenge. Having 24 years of development behind it, the GALPROP code has become a de facto standard in astrophysics of CR, diffuse gamma rays, and searches of new physics. The GALPROP code uses information from astronomy, particle, and nuclear physics to predict CRs, gamma rays, synchrotron emission and its polarization in a self-consistent manner – it provides the modeling code unifying the results of individual measurements in physics and astronomy spanning in energy coverage, types of instrumentation, and the nature of detected species. The range of physical validity of the GALPROP code covers sub-keV–PeV energies for particles and from micro-eV–PeV for photons. The GALPROP framework includes the code and independently developed datasets, such as interstellar gas (H2,HI,HII), radiation and magnetic fields distributions as well as the nuclear and particle production cross sections. The code and the datasets are public and are extensively used by many experimental collaborations, and by thousands of individual researchers worldwide for interpretation of their data and for making predictions. We will present latest updates to the GALPROP framework that improve its accuracy and capabilities and will discuss its applications.'

Collaborations

Keywords and Comments
'GALPROP; Cosmic Rays; Gamma rays; diffuse emission; propagation', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

The Origin of Galactic Cosmic Rays as Revealed by their Composition

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Vincent Tatischeff
Author and Co-Author
Vincent Tatischeff, John C. Raymond | Jean Duprat | Stefano Gabici | Sarah Recchia

Abstract
'Galactic cosmic-rays (GCRs) are thought to be accelerated by the first order Fermi mechanism in strong shocks induced by massive star winds and supernova explosions sweeping across the interstellar medium (ISM). But the phase of the ISM from which the CRs are extracted has remained elusive up to now. Using the latest CR composition data from the AMS-02, Voyager-1 and SuperTIGER experiments, we show that the volatile elements of the CR material are mainly accelerated from a plasma of temperature of approximately 3 million Kelvin, which is typical of the hot and tenuous medium found in galactic superbubbles energized by the combined activities of massive star winds and core-collapse supernova explosions. In addition, we identify a CR component arising from acceleration of massive star winds in their termination shocks, which is responsible for the overabundance of 22-Ne in the GCR composition. The CR composition also shows evidence for a preferential acceleration of refractory elements contained in ISM dust. We suggest that this component arises from the acceleration of dust grains continuously injected into superbubbles through evaporation of adjacent molecular clouds. We derive the acceleration efficiencies for these various components and compare them to those predicted by the diffuse shock acceleration theory.'

Collaborations

Keywords and Comments
'Cosmic-ray composition; Particule acceleration; supernova remnants; Superbubbles', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

On the interpretation of the latest AMS-02 cosmic ray electron spectrum

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Fiorenza Donato
Author and Co-Author
Fiorenza Donato | Mattia Di Mauro | Silvia Manconi,

Abstract
'The latest AMS-02 data on cosmic ray electrons show a break in the energy spectrum around 40 GeV, with a change in the slope of about 0.1. We perform a combined fit to the newest AMS-02 positron and electron flux data using a model which includes production of pairs from pulsar wind nebulae (PWNe), electrons from supernova remnants (SNRs) and both species from spallation of hadronic cosmic rays with interstellar medium atoms. We demonstrate that the change of slope in the AMS-02 electron data is well explained by the interplay between the flux contributions from SNRs and from PWNe. In fact, the relative contribution to the data of these two populations changes by a factor of about 13 from 10 to 1000 GeV. The PWN contribution has a significance of at least 4σ, depending on the model used for the propagation, interstellar radiation field and energy losses. The effect of the energy losses alone, when the inverse Compton scattering is properly computed within a fully numerical treatment of the Klein-Nishina cross section, cannot explain the break in the e^- flux data, as recently proposed in the literature.'

Collaborations

Keywords and Comments
'', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Study Of Cosmic Ray Spectral Hardening Using GALPROP

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Hongyi Wu
Author and Co-Author
Hongyi Wu | Eun-Suk Seo | Vladimir Ptuskin,

Abstract
'Significant spectral hardening at around 200 GV magnetic rigidity has been reported by AMS-02, ATIC-2, CALET, CREAM, and PAMELA. This has been observed in high-accuracy measurements of various nuclei energy spectra of both primaries and secondaries. To explain the spectral hardening while maintaining proper B/C and p/He ratios, we study 3 approaches in a reacceleration model: adding a diffusion coefficient break, introducing extra injection spectra breaks, and a combination of both. We use the numerical code GALPROP to compute the propagation of cosmic rays with such parameter sets on the rigidity dependence of source and propagation parameters. Implications on the antiproton and positron spectra will be discussed.'

Collaborations

Keywords and Comments
'source spectra; propagation model; GALPROP;', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Galactic Molecular Clouds As Sources of Secondary Positrons

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 438

Presenter
Agnibha De Sarkar
Author and Co-Author
Agnibha De Sarkar | Sayan Biswas | Nayantara Gupta,

Abstract
'Secondary positrons produced inside Galactic Molecular Clouds (GMCs) can contribute significantly to the observed positron spectrum on earth. Multi-wavelength data on GMCs are particularly useful to build this model. Very recent survey implemented the optical/IR dust extinction measurements, to trace 567 GMCs within 4 kpc of Earth, residing in the Galactic plane. We use the updated list of GMCs reported in recent papers, which are distributed in the Galactic plane, to find the secondary positrons produced in them in interactions of cosmic rays with molecular hydrogen. Moreover, by analysing the \\textit{Fermi}-LAT data, new GMCs have been discovered near the Galactic plane. We also include some of these GMCs closest to the Earth where cosmic ray interactions are producing secondaries. It has been speculated earlier that cosmic rays may be reaccelerated in some GMCs. We select 7 GMCs out of 567 GMCs recently reported, within 4 kpc of Earth, where reacceleration due to magnetized turbulence is assumed. We include a hardened component of secondary positrons, produced from interaction of reaccelerated CRs in those 7 GMCs. We use publicly available code \\textbf{DRAGON} for our simulation setup to study CR propagation in the Galaxy and show that the observed positron spectrum can be well explained in the energy range of 1 to 1000 GeV by our self-consistent model.'

Collaborations

Keywords and Comments
'cosmic rays; gamma rays', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

PeV Cosmic Ray acceleration in the supernova post breakout expansion phase: kinetic-magnetohydrodynamic simulations

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Tsuyoshi Inoue
Author and Co-Author
Tsuyoshi Inoue | Alexandre Marcowith | Gwenael Giacinti,

Abstract
'Origin of cosmic rays (CRs) is still not known. In this work we argue that PeV cosmic rays can be accelerated during the early phase of a supernova blast wave expansion in dense red supergiant winds. We solve in spherical geometry a system combining a diffusive-convection equation which treats CR dynamics coupled to magnetohydrodynamics to follow gas dynamics. The fast shock expanding in a dense ionized wind is able to trigger the fast non-resonant streaming instability over day timescales. We investigate the maximum energy CRs can reach in this configuration accounting for pp losses. Multi-PeV energies can be reached if the progenitor mass loss rates are of the order of, or larger than, 10^{-3} solar masses/year. It has been recently invoked that prior to the explosion hydrogen rich massive stars can produce enhanced mass loss rates. These enhanced rates would then favor the production of a Pevatron phase in early times after the shock breakout. We discuss observational tests to probe our model using future radio and gamma-ray facilities.'

Collaborations

Keywords and Comments
'kinetic-MHD simulations; Pevatron; cosmic-ray streaming instability', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Studying the low-energy excess in cosmic-ray iron: a possible evidence of a massive supernova activity in the solar neighborhood via primary 60Fe

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 14 CRs and ISM | CRD
Presenter Forum Table

Presenter
Nicolo Masi
Author and Co-Author
Nicolo Masi, M. J. Boschini | Stefano Della Torre | Massimo Gervasi | Davide Grandi | G. Jóhannesson | Giuseppe La Vacca | I. V. Moskalenko | S. Pensotti | T.A. Porter | Lucio Quadrani | P.G. Rancoita | Davide Rozza | Mauro Tacconi

Abstract
'Since its launch the AlphaMagneticSpectrometer-02 (AMS-02) has delivered outstanding quality measurements of the spectra of cosmic-ray (CR) species, which resulted in a number of breakthroughs, including the spectrum of iron: because of the large fragmentation cross section and large ionization energy losses, most of CR iron at low energies is local, and may harbor some features associated with relatively recent supernova (SN) activity inside the Local Bubble. The analysis of new iron spectrum together with Voyager 1 and ACE-CRIS data revealed an unexpected bump in the iron spectrum and in the Fe/He, Fe/O, and Fe/Si ratios at 1–2 GV: the found excess fitted well with recent discoveries of radioactive 60Fe deposits in terrestrial and lunar samples, and in CRs. This was the first time such an excess was found in the spectrum of an element that is dominated by stable species, most notably 56Fe: it will be fundamental to measure the spectra of other heavy CR species to see if a similar spectral feature is present. Our calculations within the GALPROP–HELMOD framework provided an updated local interstellar spectrum (LIS) of iron in the energy range from 1 MeV/n to 10 TeV/n: starting from this LIS and the 60Fe/56Fe abundance measured by ACE-CRIS, Fe isotopes composition is estimated and compared to SN yields, along with the prediction of the important SubFe/Fe ratio for different scenarios.'

Collaborations
other (fill field below),

Keywords and Comments
'cosmic rays; iron; heliosphere; galprop; helmod; supernovae', ''

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Subcategory Theoretical Results

LOCAL TURBULENCE AND THE DIPOLE ANISOTROPY OF GALACTIC COSMIC RAYS

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Yoann GÉNOLINI
Author and Co-Author
Yoann GÉNOLINI, Markus Ahlers

Abstract
'The dipole anisotropy of multi-TeV cosmic rays exhibits a strong energy dependence that is at odds with the predictions of standard isotropic diffusion models. It has been argued that the observed variation in amplitude and phase is a consequence of the global distribution of cosmic ray sources in combination with anisotropic diffusion in our local environment. For a quantitative description\r\nof this effect it is necessary to understand the complicated interplay of cosmic ray diffusion on local and global scales. In this work we study the impact of isotropic magnetic turbulence realisations on cosmic-ray propagation and anisotropy. We define a novel methodology that allows us to quantify generic properties of local and global diffusion with the help of test-particle simulations. We confirm the emergence of local anisotropic diffusion that leads to an alignment of the cosmic ray dipole with the local magnetic field and a reduction of its amplitude in perpendicular directions. We discuss the phenomenological consequences of these findings.'

Collaborations

Keywords and Comments
'Cosmic-ray anisotropy; local turbulence; particle-test simulations', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Cosmic-ray propagation analyses and implications of current spallation cross sections parametrisations with the DRAGON2 code

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Pedro De la Torre Luque
Author and Co-Author
Pedro De la Torre Luque, Francesco Loparco | Fabio Gargano | Mario Nicola Mazziotta | Davide Serini

Abstract
'The transport of Galactic cosmic rays (CRs), governed by the magnetic collisionless interactions they suffer with interstellar plasma waves, is commonly studied as a diffusive movement, characterised by a diffusion coefficient following a power law as function of rigidity. The accuracy of current CR data allows us to precisely test our propagation models, usually by reproducing the secondary-to-primary CR flux ratios (e.g., B/C). Nevertheless, the precision of cross sections data for production of secondary CRs is very poor (>20%), considerably limiting our studies.\r\nTherefore, in this talk we explore the consequences of the spallation cross sections uncertainties in the evaluation of the secondary CRs B, Be and Li and in the determination of the Galactic halo size, in addition to compare different cross sections parametrisations. We also demonstrate that there is no hint of primary sources producing these secondary CRs and show that it is possible to reproduce the antiproton-over-proton spectrum considering these uncertainties. Then, we report the results of a Markov chain Monte Carlo analysis of the propagation parameters obtained from the ratios of B, Be and Li to C and O. Employing two different methods for including the uncertainties associated to the spallation cross sections we can simultaneously reproduce the flux ratios of these secondary CRs and find clear evidence that the cross sections describing Li production are highly discrepant with respect to B and Be.'

Collaborations

Keywords and Comments
'Cosmic ray transport; spallation cross sections; cross sections parametrizations; secondary cosmic rays', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Particle-in-Cell Simulations of Synchrotron Maser Emission and Associated Particle Acceleration in Relativistic Shocks

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Masanori Iwamoto
Author and Co-Author
Masanori Iwamoto, Takanobu Amano | Yosuke Matsumoto | Shuichi Matsukiyo | Masahiro Hoshino

Abstract
'Relativistic shocks are ubiquitous in the universe, in which synchrotron maser instability produces intense electromagnetic precursor waves. Recent one-dimensional Particle-in-Cell (PIC) simulations show that longitudinal electrostatic waves, which are called wakefields, are induced in the wake of the large-amplitude electromagnetic waves and that nonthermal particles are generated during the nonlinear collapse of the wakefields (Lyubarsky 2006; Hoshino 2008). This particle acceleration may explain the origin of ultra-high-energy cosmic rays (Chen et al. 2002).\r\n\r\nAlthough the synchrotron maser instability in the context of relativistic shocks are important for the cosmic ray acceleration, it has so far been discussed solely with one-dimensional PIC simulations (e.g., Langdon et al. 1988) and it is not well known whether the same mechanism can operate in more realistic multidimensional systems. However, our high-resolution two-dimensional PIC simulations (Iwamoto et al. 2017, 2018) showed that the wave emission continues with substantial amplitude for the first time. We confirmed that the large-amplitude electromagnetic precursor waves continue to persist and that the wakefields are indeed excited by the intense electromagnetic waves (Iwamoto et al. 2019). The wakefields collapse during the nonlinear process of the parametric decay instability in the near-upstream region, where both ions and electrons are accelerated by the motional electric field in the upstream and produce clear nonthermal tails in the particle energy spectra measured in the upstream rest frame. In this talk, we discuss this particle acceleration and wave-plasma interaction for more details.'

Collaborations

Keywords and Comments
'particle acceleration; plasma instabilities; shock waves', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Tracing the origin of low diffusivity and CR bubbles around sources

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 14 CRs and ISM | CRD
Presenter Forum Table

Presenter
Benedikt Schroer
Author and Co-Author
Benedikt Schroer, Pasquale Blasi | Damiano Caprioli | Colby Haggerty | Oreste Pezzi

Abstract
'Cosmic rays leave their sources mainly along the local magnetic field present in the region around the source and in doing so they excite both resonant and non-resonant modes through streaming instabilities. The excitation of these modes leads to enhanced particle scattering and in turn to a large pressure gradient that causes the formation of expanding bubbles of gas and self-generated magnetic fields. By means of hybrid particle-in-cell simulations, we demonstrate that, by exciting this instability, cosmic rays excavate a cavity around their source where the diffusivity is strongly suppressed. This phenomenon is general and is expected to occur around any sufficiently powerful cosmic ray source in the Galaxy. Our results are consistent with recent $\\gamma$-ray observations where emission from the region around supernova remnants and stellar clusters have been used to infer that the diffusion coefficient around these sources is $\\sim 10-100$ times smaller than the typical Galactic one.'

Collaborations

Keywords and Comments
'Cosmic rays; Cosmic ray propagation; Cosmic ray sources; Plasma instabilities; supernova remnants',
''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Cosmic Ray Small-Scale Anisotropies in Slab Turbulence

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Marco Kuhlen
Author and Co-Author
Marco Kuhlen | Philipp Mertsch | Vo Hong Minh Phan,

Abstract
'In the standard picture of cosmic ray transport the propagation of charged cosmic rays through turbulent magnetic fields is described as a random walk with cosmic rays scattering on magnetic field turbulence. This is in good agreement with the highly isotropic arrival directions as this diffusion process effectively isotropizes the cosmic ray distribution. However, high-statistics observatories like IceCube and HAWC have observed significant deviations from isotropy down to very small angular scales. This is in strong tension with this standard picture of cosmic ray propagation. By relaxing one of the assumptions of quasi-linear theory and explicitly considering the correlations between the fluxes of cosmic rays from different directions, we show that power on small angular scales is a generic feature of particle propagation through turbulent magnetic fields. We present a first analytical calculation of the angular power spectrum assuming a physically motivated model of the magnetic field turbulence and find good agreement with numerical simulations. We argue that in the future, the measurement of small-scale anisotropies will provide a new window to testing magnetic turbulence in the interstellar medium.'

Collaborations

Keywords and Comments
'Small-Scale Anisotropies; magnetic field turbulence; slab turbulence; propagation; transport;synthetic turbulence;', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Stochastic Fluctuations of Low-Energy Cosmic Rays and the Interpretation of Voyager Data

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Vo Hong Minh Phan
Author and Co-Author
Vo Hong Minh Phan | Philipp Mertsch | Stefano Gabici | Sarah Recchia | Florian Schulze,

Abstract
'The propagation distances of MeV cosmic rays is significantly limited due to ionisation loss in the interstellar medium. Therefore, the density of cosmic rays will depend sensitively on the exact distribution of the sources in space and time. For an ensemble of source distributions, the fluxes will follow a strongly non-Gaussian distribution. Here, we show that the typical flux, that is the median of the distribution, significantly deviates from the average flux, that is the expectation value of the distribution. Taking this into account allows for a consistent fit of data from Voyager 1 and AMS-02 without any unmotivated breaks in the source spectrum or mean-free path where earlier models needed to introduce those in an ad hoc fashion. We conclude with a discussion of the implication of these results for the discrepancy between the observed and predicted ionization rate induced by low-energy cosmic rays.'

Collaborations

Keywords and Comments
'Cosmic-Ray Transport; Supernova Remnants; Ionization Rate; Stochastic Fluctuations', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Interpretation of the spectral inhomogeneity in the 10TV region in terms of a close source

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Vladimir Yurovsky
Author and Co-Author
ilya kudryashov | Vladimir Yurovsky, farid gasratov | Alexander Panov | vasiliy latonov

Abstract
'The results of cosmic ray measuring experiments such as NUCLEON, HAWC, CREAM-III, DAMPE indicate a change in the index of the cosmic ray spectra near the magnetic rigidity of 10 TV.\r\nSuch an inhomogeneity in the regular CR spectra can be explained by several possible reasons: features of CR acceleration, specific features of CR propagation, or a contribution to the CR flux from a nearby source. In this work, the latter interpretation is considered.\r\nThe NUCLEON space experiment measured the structure of this spectral feature for each of the abundant primary CR components separately - which is important for understanding the nature of this feature. The DAMPE and the CREAM experiments significantly increased the amount of experimental statistics for light nuclei, and the ground-based HAWC experiment, which has a high statistical reliability of the result, measured a total spectrum of all particles in this area.\r\nTo test the hypothesis of the effect of a single source on the spectra, a mathematical model was created that takes into account the contribution of cosmic rays from a hypothetical close source to the total CR flux. The model is based on solving the problem of CR propagation in the diffusion approximation.\r\nThe result of the calculation is the area of \u200b\u200blocalization of a possible source on the age-distance surface and its expected power as well as its chemical composition. A feature of the model is the use of the penalty function method to correctly take into account the systematic error of the ground experiment.'

Collaborations

Keywords and Comments
'close source; diffusion', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Damping of self generated Alfvén waves in a partially ionized medium and the grammage of cosmic rays in the proximity of supernova remnants

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 14 CRs and ISM | CRD
Presenter Forum Table

Presenter
Sarah Recchia
Author and Co-Author
Sarah Recchia | Daniele Galli | Lara Nava | Marco Padovani | Stefano Gabici | Alexandre Marcowith | Vladimir Ptuskin | Giovanni Morlino,

Abstract
'We investigate the damping of Alfvén waves generated by the\r\ncosmic ray resonant streaming instability as due to ion-neutral\r\ndamping, turbulent damping and non linear Landau damping, in the\r\nwarm ionised and warm neutral phases of the interstellar medium.\r\nWe do so in the context of the cosmic ray escape and propagation\r\nin the proximity of supernova remnants. For the ion-neutral damping,\r\nstate-of-the-art damping coefficients are used, where the momentum\r\ntransfer and charge exchange cross sections between various species\r\nof ions and neutrals are computed in detail or measured. We\r\ninvestigate whether the self-confinement of cosmic rays nearby\r\nsources can appreciably affect the grammage. In fact, if this is\r\nthe case, the standard picture, in which CR secondaries are produced\r\nduring the whole time spent by cosmic rays throughout the Galactic\r\ndisk, should be deeply revisited. We show that the ion-neutral\r\ndamping and the turbulent damping effectively limit the residence\r\ntime of cosmic rays in the source proximity, so that the grammage\r\naccumulated near sources is found to be negligible. This also\r\nhappens in the most optimistic scenario where ion-neutral damping\r\nis less effective, namely in a medium with only neutral helium\r\nand fully ionized hydrogen, contrary to what was previously suggested.'

Collaborations

Keywords and Comments
'cosmic rays; ISM: general', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

A local fading accelerator and the origin of TeV cosmic ray electrons

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Sarah Recchia
Author and Co-Author
Sarah Recchia | Stefano Gabici | Felix Aharonian | Jacco Vink,

Abstract
'The total cosmic ray electron spectrum (electrons plus positrons) exhibits a break at a particle\r\nenergy of ~ 1 TeV and extends without any attenuation up to ~ 20 TeV. Synchrotron and inverse\r\nCompton energy losses strongly constrain both the age and the distance of the potential sources of\r\nTeV and multi-TeV electrons to ≈ 10^5 yr and ≈ 100 − 500 pc, depending on both the absolute value\r\nand energy dependence of the cosmic ray diffusion coefficient. This suggests that only a few, or just\r\none nearby discrete source may explain the observed spectrum of high energy electrons. On the\r\nother hand the measured positron fraction, after initially increasing with particle energy, saturates\r\nat a level well below 0.5 and likely drops above ~ 400−500 GeV. This means that the local source(s)\r\nof TeV electrons should not produce positrons in equal amount, ruling out scenarios involving\r\npulsars/pulsar winds as the main sources of high energy leptons. In this paper we show that a\r\nsingle, local, and fading source can naturally account for the entire spectrum of cosmic ray electrons\r\nin the TeV domain. Even though the nature of such source remains unclear, we discuss known\r\ncosmic ray accelerators, such as supernova remnant and stellar wind shocks, which are believed to\r\naccelerate preferentially electrons rather than positrons.'

Collaborations

Keywords and Comments
'cosmic rays', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

How well do we understand the properties of the Galactic cosmic ray accelerators and of cosmic ray propagation in the Galaxy ? A critical view.

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Paolo Lipari
Author and Co-Author
Paolo Lipari,

Abstract
'The Galactic cosmic ray (CR) fluxes observed in the vicinity of the Earth encode the space and time averaged properties of their sources and are also shaped by the effects of their propagation in the Galaxy.\r\nA combined study of the spectra of different particle types (protons, primary and secondary nuclei, electrons, positrons and antiprotons) is essential to determine the roles of the source and of propagation in the formation of the fluxes.\r\nSeveral authors are now claiming that these combined studies have essentially solved the problem, and that the source spectra for all particle types are now well determined in a broad energy range, with significant uncertainties only at high energy.\r\nThis conclusion obviously also imply that also the CR propagation is well understood.\r\nIn this contribution we analyze critically these results, and conclude that the problem of determining in good approximation the average CR source spectra (and therefore also the main properties of CR propagation)remains open, with very large uncertainties.\r\nSolving this problem has profound implications for the properties of the Galactic CR accelerators (that have not yet been firmly identified) and for our understanding of the Milky Way magnetic structure.\r\nFuture observations, especially of electrons and positrons in the multi--TeV range and of unstable isotopes like Beryllium in the few GeV range should soon allow to solve the problem.'

Collaborations

Keywords and Comments
'Galactic cosmic rays; Electrons; Positrons; antiprotons; Beryllium isotopes', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Cosmic Ray Transport, Energy Loss, and Influence in the Multiphase Interstellar Medium

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 14 CRs and ISM | CRD
Presenter Forum Table

Presenter
Chad Bustard
Author and Co-Author
Chad Bustard, Ellen Zweibel

Abstract
'The bulk propagation speed of GeV-energy cosmic rays is limited by frequent scattering off hydromagnetic waves, predominantly by waves that they generate themselves through a resonant streaming instability.\xa0\xa0In most simulations of galaxy evolution, cosmic rays are then assumed to be strongly coupled to the gas; however, when we zoom into the multiphase, frequently under-resolved ISM, we find a cosmic ray "obstacle course" of collisional targets and density inhomogeneities that induce cosmic ray decoupling. So how do cosmic rays navigate and influence such a medium, and can we constrain that transport with observations?\r\n\xa0\u2028\r\nIn this talk, I'll present a new set of idealized, high-resolution MHD+CR simulations that probes cosmic ray transport in multiphase gas. I'll discuss how cosmic rays sample the ISM and how they transfer energy and momentum to the gas, taking into account fast cosmic ray transport in partially neutral gas. Our simulations illuminate the important role of cloud interfaces in limiting cosmic ray streaming speeds, thereby generating steep cosmic ray pressure gradients that excite waves in opposition of ion-neutral damping, transfer energy to the thermal gas, and accelerate cold clouds in galactic winds. We also quantify differences in the density-weighted cosmic ray content and resulting gamma-ray emission, with and without taking into account gas ionization effects on cosmic ray transport. While the spatial footprints of gamma-ray emission clearly differ between models, the total gamma-ray luminosity is, interestingly, largely unchanged.'

Collaborations

Keywords and Comments
'Confinement; gamma-rays; galaxy evolution; galactic winds; ion-neutral damping; molecular clouds', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Turbulent Reacceleration of Streaming Cosmic Rays: Fluid Simulations

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 14 CRs and ISM | CRD
Presenter Forum Table

Presenter
Chad Bustard
Author and Co-Author
Chad Bustard, S. Peng Oh

Abstract
'We present MHD+CR simulations probing reacceleration of pre-existing cosmic rays by long-wavelength, subsonic, compressive turbulence. With purely diffusive transport, we recover the scaling relations of Ptuskin 1988, where the reacceleration time reaches a minimum at the ``sweet spot" diffusion coefficient of the sound speed times the outer turbulence scale, $D_{\\rm crit} \\sim c_{s}L$. For GeV energy cosmic rays, however, where self-confinement and streaming transport likely dominate, reacceleration rates are highly suppressed at low plasma $\\beta$; collisionless energy loss $\\propto v_{A} \\cdot \\nabla P_{CR}$ largely offsets energy gain, even when additional diffusion at the "sweet spot" value of $D_{\\rm crit}$ is included. At higher plasma $\\beta$ (when diffusive transport dominates), which may be appropriate in galaxy halo environments, the energy gain time is again quite short (as low as a few eddy turnover times). \r\n\r\nThis in-situ cosmic ray production, especially if coupled with reacceleration by large-scale shocks, can increase non-thermal pressure support in the circumgalactic medium, as required to explain COS-Halos absorption line measurements, and could leave an imprint in diffuse gamma-ray emission. In low-$\\beta$ environments like the interstellar medium, reacceleration of GeV-energy cosmic rays can likely be ignored. This may alleviate tension between current cosmic ray reacceleration models and recent observations by Voyager 1 and AMS-02 that favor pure diffusion / convection models.'

Collaborations

Keywords and Comments
'Confinement; reacceleration; turbulence; particle acceleration', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Particle acceleration by sound waves generated in the shock downstream region

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Shota Yokoyama
Author and Co-Author
Shota Yokoyama | Yutaka Ohira,

Abstract
'Diffusive shock acceleration (DSA) in supernova remnants is widely accepted as a plausible mechanism to produce galactic cosmic rays. However, several problems are pointed out to this picture and some modifications are needed to understand cosmic ray acceleration in SNRs. In our previous work (Yokoyama & Ohira, 2020), we considered a shock wave propagating to an inhomogeneous medium, although the conventional DSA assumed the shock upstream medium to be uniform. It was revealed that sound waves generated by the interaction between the inhomogeneous upstream medium and the shock wave can accelerate particles even in the shock downstream region and modify the energy spectrum of cosmic rays.\r\nHowever, because our simulations used linear solutions for the description of background plasma, nonlinear behaviors of sound waves are not included. In this talk, we introduce our recent simulations which solve particle diffusion and fluid equations simultaneously. The results show that weak shock waves formed by steepening of downstream sound waves can rapidly accelerate particles before they dissipate. We will discuss the spectral modification and the difference with the results of our previous simulations.'

Collaborations

Keywords and Comments
'Particle acceleration; shocks; supernova remnants', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

A unified picture for three different cosmic-ray observables.

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Daniele Gaggero
Author and Co-Author
Ottavio Fornieri | Daniele Gaggero | Daniel Guberman | Loann Brahimi | Pedro De la Torre Luque | Alexandre Marcowith,

Abstract
'We present here a unified scenario that connects together three peculiar spectral features recently reported in the spectra of charged cosmic rays (CRs).\r\n The spectral hardening measured by AMS-02 in the hadronic spectra above $\\sim 250 \\, \\mathrm{GeV}$ is here interpreted as a diffusion imprint, and modeled by means of a transport coefficient that smoothly hardens with rigidity. \r\n We implement such propagation framework to solve the transport equation with the {\\tt DRAGON2} numerical code in order to determine the large-scale contribution to the CR fluxes. \r\n On top of this solution we explore the hypothesis of a nearby, hidden Supernova Remnant (SNR) to be responsible for the high-energy (above $\\sim 100 \\, \\mathrm{GeV}$) all-lepton flux, in particular for the spectral break consistently measured by all the space-borne and ground-based detectors around $1 \\, \\mathrm{TeV}$. We compute such contribution analytically adopting the same propagation setup implemented for the large-scale background.\r\n Simultaneously, we find the signature of the same source in the peculiar \\textit{bump} structure observed by the DAMPE Collaboration in the proton spectrum, consisting of a strong hardening at $\\sim 500 \\, \\mathrm{GeV}$ and a softening at $13 \\, \\mathrm{TeV}$. \r\n We validate our hypothesis with the CR dipole-anisotropy (DA) amplitude and phase. In particular, we interpret the high-energy data (above $10 \\, \\mathrm{TeV}$) pointing towards the Galactic Center as the convolution of the directional fluxes of the large-scale-background sources, whereas the DA amplitude below that energy is compatible with the predictions of our model and is therefore considered as a signature of the nearby SNR that we invoke.'

Collaborations

Keywords and Comments
'cosmic-ray transport\r\ncosmic-ray sources', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Combined analysis of AMS-02 secondary-to-primary ratios: universality of cosmic ray propagation and consistency of nuclear cross sections

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Manuela Vecchi
Author and Co-Author
Manuela Vecchi, Eduardo Ferronato Bueno | Laurent Derôme | Yoann GÉNOLINI | David Maurin

Abstract
'The AMS-02 collaboration released several secondary-to-primary ratios of\r\nunprecedented accuracy. These ratios can be used to test the\r\nuniversality of propagation for different species, and also to test the\r\npresence of breaks in the diffusion coefficient. It was shown in Weinrich\r\net al. (A&A 639, 131, 2020) that the combined analysis of Li/C, Be/C,\r\nand B/C strengthens the case for a low-rigidity diffusion break. It was also\r\nshown that a standard propagation model successfully reproduces these\r\nratios (and also AMS-02 N/O and 3He/4He data), without the need for\r\nadditional sources of Li, Be, or B. However, significant modifications\r\n(~5-15%) of the production cross sections are required, though these\r\nmodifications remain within estimated nuclear uncertainties. We also\r\nextend our analyses to the recently published F/Si ratio and discuss\r\nhow much F at source can be accommodated by the data.'

Collaborations

Keywords and Comments
'cosmic rays; propagation;', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Unfolding of the vortical amplification of the magnetic field at inward shocks of Supernova remnant Cassiopeia A

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Federico Fraschetti
Author and Co-Author
Federico Fraschetti | Joe Giacalone | Satoru Katsuda | Toshiki Sato | J. Randy Jokipii,

Abstract
'Time variability of the X-ray flux of supernova remnants enables us to probe the evolution of the local magnetic field and the particle acceleration at interstellar shocks. High spatial resolution multiepoch (from 2000 to 2014) Chandra observations of Cassiopeia A supernova remnant have shown evidence of variation up to 50% of the 4.2-6 keV flux in six distinct regions located on the west side and toward the center of the remnant. We show that the [4.2-6] keV non-thermal flux increase traces the exponential growth of the magnetic field due to vortical amplification mechanism at reflection inward shocks colliding with inner outward clumps. The amplification occurs in the outer layer of the clumps where density gradient is non-vanishing (about 0.1 pc in this case). The fast synchrotron cooling as compared with shock-acceleration time scale qualitatively supports the flux decrease.'

Collaborations

Keywords and Comments
'Supernova remnants; magnetic field; X-ray emission', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Implications of Li to O data of AMS-02 on our understanding cosmic-ray propagation

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 18 Cosmic Ray Secondary nuclei: observations and impact on theories | CRD
Presenter Forum Table

Presenter
Michael Korsmeier
Author and Co-Author
Michael Korsmeier, Alessandro Cuoco

Abstract
'In the last decade, the space-borne experiment AMS-02 has determined cosmic-ray spectra with unprecedented precision, potentially providing new insights into cosmic-ray propagation in our Galaxy. However, the analysis of this increasingly precise cosmic-ray data requires more careful modeling of systematic uncertainties.\r\nI will review the conclusions from the analysis of the secondary cosmic rays of Li, Be, and B, and the primaries C, N, and O. To investigate the uncertainties in the propagation scenarios, we have considered five different propagation frameworks, including detailed analyses of the break in cosmic-ray diffusion coefficient at a rigidity of a few GV and models of Alfvenic reacceleration. Global fits of these propagation frameworks have been performed utilizing the GALPROP code to solve the diffusion equations of cosmic rays. Systematic uncertainties arising from the nuclear production cross sections of secondaries have been taken into account as nuisance parameters. Furthermore, the impact of correlations in the systematic uncertainties of the AMS-02 data is studied.\r\nWe find that, in particular, the uncertainties on the nuclear production cross sections prevent a deeper understanding of the properties of CR propagation. Nonetheless, we find robust constraints on the slope of the diffusion coefficient at intermediate rigidities of $\\delta\\simeq0.4-0.5$ and a lower bound on the half-height of the diffusion halo at $z_\\mathrm{h}>3\\;\\mathrm{kpc}$. In all considered propagation scenarios, the fits are compatible with zero convection.'

Collaborations

Keywords and Comments
'Galactic CR propagation', 'to be published in the next couple of weeks'

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Compact binary millisecond pulsars and the positron excess

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Manuel Linares
Author and Co-Author
Manuel Linares, Michael Kachelriess

Abstract
'We present an analytical model for the fluxes and spectra of positrons accelerated within the intrabinary shocks of compact binary millisecond pulsars (CBMSPs). We find that the minimum energy $E_{\\min}$ of the pairs that enter the shock is critical to quantify the energy spectrum with which positrons are injected into the interstellar medium. We measure for the first time the Galactic scale height of this new and growing population of nearby neutron stars ($z_\\mathrm{e}=0.4\\pm 0.1$ kpc) and use this to estimate their local density (5$-$9 kpc^{-3}). In the isotropic diffusion approximation, our model predicts only a minor contribution from CBMSPs to the diffuse positron flux at 100 GeV observed at Earth. We also quantify the effects of anisotropic transport due to the ordered Galactic magnetic field, which can change the diffuse flux from nearby sources drastically. We find that a single ``hidden'' CBMSP close to the Galactic plane can yield a positron flux comparable to the AMS-02 measurements at 600 GeV, if its line-of-sight to Earth is along the ordered Galactic field lines. Its combined electron and positron flux at higher energies would be close to the measurements of CALET, DAMPE and Fermi-LAT.'

Collaborations

Keywords and Comments
'cosmic ray theory; millisecond pulsars; neutron stars; particle acceleration', ''

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Large-scale simulations of antihelium production in cosmic-ray interactions

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 439

Presenter
Anirvan Shukla
Author and Co-Author
Anirvan Shukla | Philip von Doetinchem | Amaresh Datta | Diego-Mauricio Gomez-Coral | Carina Kanitz,

Abstract
'The possibility of antihelium production in interaction of cosmic rays with the interstellar gas is studied using large-scale Monte Carlo simulations. For this purpose, an energy-dependent coalescence mechanism developed previously is extended to estimate the production of light antinuclei (antihelium-3 and antihelium-4). The uncertainty in the coalescence parameter and its effect on the expected antiparticle flux is also investigated. The simulated background antihelium fluxes are found to be lower than the fluxes predicted by simplified models using numerical scaling techniques. Ongoing measurements to improve these results, at NA61/SHINE at CERN-SPS, are also discussed.'

Collaborations
, NA61/SHINE

Keywords and Comments
'Cosmic-ray propagation; Cosmic-ray spectra; Coalescence model', 'Full paper available at Phys. Rev. D 102, 063004'

Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Spectrally resolved cosmic rays in galaxy simulations

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 14 CRs and ISM | CRD
Presenter Forum Table

Presenter
Philipp Girichidis
Author and Co-Author
Philipp Girichidis,

Abstract
'We investigate the dynamical effects of cosmic rays (CRs) in isolated disc galaxies. CRs are included as a non-thermal component in the advection-diffusion approximation and are dynamically coupled to the gas in the magneto-hydrodynamical simulations. The CRs are spectrally resolved with a full spectrum ranging from sub-GeV to TeV in every computational cell. We can therefore account for energy-dependent losses and include an energy-dependent diffusive transport in every cell. We show the differences between a grey CR approximation and our new spectrally resolved CRs concerning galactic outflows and gamma ray mock observations. We highlight, where the steady state approximation for CR spectra is a valid approach as well as where and now strongly the spectra vary spatially in different regions of the galaxy and temporally over the course of several Gyr.'

Collaborations

Keywords and Comments
'galaxies; CR spectra; CR propsagation; outflows; spectral index', ''

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Branch CRD | Cosmic Ray Direct

Subcategory Theoretical Results

Origin of Cosmic Rays and Thought Travels with CR Particles in Galaxy and in the Universe

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 440

Presenter
Lev Dorman
Author and Co-Author
Lev Dorman,

Abstract
'We will show that Solar Energetic Particles (SEP), as well as energetic particles generated in magnetospheres of the Earth, Jupiter, Saturn and other planets, in interplanetary space, and in atmospheres of stars have the same nature as Galactic and Intergalactic CR: they are all runaway particles from the Maxwell-Boltzmann distribution of background plasma where they were generated. Energy of these run-away particles is much higher than average energy of background thermal particles. It is shown in this work that the energy of all these run-away particles have the same general nature: it is always transfer energy from the Macro-objects and Macro-processes directly to Micro World (to charged runaway particles). This transfer energy is formatted in dynamic plasma with frozen in magnetic fields: really magnetic fields 'glues' billions thermal background particles into Macro-objects and Macro-processes. So, thank to frozen in magnetic fields runaway particles can interact not only with thermal background particles (and loose energy), but also directly with Macro-objects and Macro-processes with very high macro-energy (many order higher than energy of run-away particle). Thermodynamically Macro-objects have much bigger “effective temperature” than runaway particles and though the energy always transferred from Macro World to runaway particles of Micro World. We also consider by thought travel together with CR particles of different energy how looked stars, planets, Galaxy and other objects.\r\nIt is important to understand what will be radiation hazards during real relativistic travels in future.'

Collaborations

Keywords and Comments
'CR origin', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

The Upgrade of Horizon-T Detector

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 1

Presenter
Dmitriy Beznosko
Author and Co-Author
Dmitriy Beznosko,

Abstract
'The Horizon-T experiment is located at the elevation of 3346 m above sea level near the city of Almaty, Republic of Kazakhstan. A thorough comparison of the spatial and temporal characteristics of charged components of Extended Air Showers (EAS) with delayed particles with the simulated EAS using CORSIKA simulation package has been conducted using the selection from the experimental data set of events with two pulses recorded by a detector at ~600 m distance from axis [1]. This comparison has shown that events with delayed particles cannot be described within existing simulation models.\r\n\r\nThe significance of these results prompted the upgrade of the Horizon-T experiment. New points have been added at the ~600m to enhance data at that distance. Fast glass-based detectors have been added to the detector center point for accurate measurements of the pulse widths with radiative material layer option. This poster covers these upgrades and the latest data statistics from the new Horizon-T detector from the physics run 2020-2021.\r\n\r\n[1] Rashid Beisembaev, et al., 2019. “Extensive Air Showers with Unusual Spatial and Temporal Structure.” In EPJ Web Conf., 208: Pp. 06002.'

Collaborations
other (fill field below), Horizon-T

Keywords and Comments
'upgrade; Horizon-T; cosmic rays; TSHASS; detectors', 'For the Horizon-T collaboration'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

ROBAST 3

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Akira Okumura
Author and Co-Author
Akira Okumura,

Abstract
'ROOT-Based Simulator for Ray Tracing (ROBAST) is an open source library designed to simulate complex optical systems used in Cherenkov and fluorescence telescopes. It has been used for the Cherenkov Telescope Array (CTA) more than 10 years to simulate hexagonal light concentrators and parabolic, Davies–Cotton, and Schwarzschild–Couder optical systems. In addition to CTA, ROBAST is also used in design study of future cosmic-ray telescope projects. The latest major revision, ROBAST 3, is able to simulate multilayer interference on optical components. Thus more detailed detector properties such as reflection on silicon photomultipliers, and UV-enhanced or IR-cut coating can be simulated. We report the current development status and the new functionality of ROBAST 3, and a few applications will be presented. Items to be shown are updates from our ROBAST 2 talk presented at ICRC2015.'

Collaborations

Keywords and Comments
'ROBAST; ray-tracing simulation; CTA; Cherenkov; Fluorescence; SiPM; Winston cone; IACT', 'https://robast.github.io/\r\nhttps://github.com/ROBAST/ROBAST/'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Electrical signals induced in detectors by cosmic rays: a reciprocal look at electrodynamics

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Philipp Windischhofer
Author and Co-Author
Werner Riegler | Philipp Windischhofer,

Abstract
'The method of "weighting fields" gives an efficient way to compute the signal produced in a detector by a passing charged particle. Originally based on (quasi-)electrostatic approximations, this so called Ramo-Shockley theorem is heavily used to calculate signals in detectors based on ionisation, like gas detectors or silicon sensors. I will present an extension of the method to encapsulate the full extent of Maxwell's equations, which renders it applicable to all devices that detect fields and radiation from charged particles. I will discuss possible applications of this method for the experimental study of cosmic rays, including consequences for the modelling of the detector signal produced by atmospheric showers.\r\n\r\nBased on https://doi.org/10.1016/j.nima.2020.164471'

Collaborations

Keywords and Comments
'atmospheric shower; electric signal; radio; simulation; modelling; radiation;', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Study of the energy spectrum of cosmic rays obtained at the Hadron 55 installation located at an altitude of 3340 m.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 2

Presenter
Tleu Berdykhalyk
Author and Co-Author
Tleu Berdykhalyk | Bakhtiyar Iskakov | Yernar Tautayev | Turlan Sadykov | Dmitriy Besnosko | A.kh. Argynova | V.V. Zhukov | O.A. Novolodskaya | V.V. Piscal | V.A. Ryabov | Zh.T. Sadykov | N.M. Salikhov | A.S. Serikkanov,

Abstract
'The complex installation "Hadron-55" is one of the installations of the Tien-Shan high-mountain scientific station. The installation consists of two blocks spaced 2.2 meters apart. Upper unit - gamma block comprises two rows of ionization chambers arranged in mutually perpendicular directions. This block is used in determining the energy of electron-photon component and in conjunction with all detectors determines the trajectories of particles. At the level of the gamma block, scintillation detectors are installed on an area of 350 m2. The lower unit consists of six rows of ionization chambers containing iron absorber. This unit is used to measure the energy of the neutral and charged components of cosmic radiation, as well as to determine the trajectory of particles. In this work, a brief description of the installation and calculation of the energy spectrum of cosmic rays, obtained by experimental data installation. In addition, the daily variation of cosmic ray energy is processed, which is planned to be used in the future for a new experiment on monitoring seismically dangerous zones.'

Collaborations

Keywords and Comments
'gamma; hadron; installation; energy; cosmic ray; spectrum', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Simulation of single, double, and triple layer GEM detectors

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Aera JUNG
Author and Co-Author
Aera JUNG | Yong BAN | Dayong WANG | Yue Wang | Licheng Zhang,

Abstract
"Originally Micro-Pattern Gas Detectors (MPGDs), a type of gaseous ionization detector, were developed for high energy physics.\xa0\xa0However applications have expanded to astrophysics, neutrino physics, neutron detection, and medical imaging. Over the past 20 years this led to the development of novel MPGD devices: the Micro-Strip Gas Chamber, Gas Electron Multiplier (GEM), Micromegas and many others, revolutionizing cell size limits for many gas detector applications and considerably improving reliability and radiation hardness.\xa0\xa0\r\nIn a gaseous detector an astronomical particle enters a gas cell and collides with an atom of gas, which emits a high energy electron. This electron creates an ionization tract whose electrons are drifted by a small electric potential across a gas cell onto a\xa0\xa0plate consisting of a double layered conductor separated by an insulator with a strong electric field difference between them. This bottom plate, called a GEM, has an array of tiny holes and the ionization tract electrons fortunate enough to pass though the holes are strongly accelerated causing them to create secondary cascades in the direction of a pixel readout array such as a CMOS ASIC chip.\xa0\xa0The major advantage of the GEM technology is that multiple GEMs (so far up to 5) can be stacked together yielding a very high effective gain while each individual GEM layer works at a lower electric potential thus avoiding discharge problems.\xa0\xa0Here we present a simulation study of single, double, and triple GEMs's to characterize the properties of gain, spatial resolution, energy resolution, efficiency, etc. using Garfield++ and ANSYS field solver to compare between the results of published experiments and simulations."

Collaborations

Keywords and Comments
'Gas Electron Multiplier (GEM); Micro-Pattern Gas Detector (MPGD); Garfield++; ANSYS', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

The Electron-Neutron Detector Array (ENDA), Status and Coincidence with LHAASO

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 4

Presenter
Bingbing Li
Author and Co-Author
Yuri StenKin | Fan Yang | Maoyuan Liu | Luobu Danzeng | Xinhua Ma | shuwang Cui | Liangwei Zhang | Denis Kuleshov | Vladimir Stepanov | Oleg Shchegolev | Cong Shi | Dixuan Xiao | Tianlu Chen | Bingbing Li | Liqiao Yin,

Abstract
'Hadrons are the “skeleton” of extensive air shower (EAS). They possess favorable information concerning the cosmic ray components and energy. The electron-neutron detector (EN-detector) can detect both electrons and thermal neutrons generated by EAS hadrons in surrounding matter. The electron-neutron detector array (ENDA) was proposed to add into the LHAASO project to improve its capability of EAS hybrid detection. Up to present 64 EN-detectors have been produced and are running in China. In 2018, a cluster (of 16 EN-detectors) was installed at Yangbajing (YBJ), Tibet. In 2019, another cluster so called ENDA-16-HZS was installed in LHAASO at Haizishan (HZS), Daocheng, Sichuan. Besides, 2 clusters are tested at Hebei Normal University (HNU), Shijiazhuang, Hebei. ENDA-16-HZS is running normally and get amount of EAS events at energy above 100 TeV. Moreover, a number of coincident events between ENDA and the LHAASO electron detector (ED) and muon detector (MD) arrays composed the KM2A, as well as Cherenkov detectors WFCTA and WCDA are obtained. The events with cores falling into ENDA were selected. The ED array and ENDA accurately offers the EAS directions and the core positions respectively. Both the lateral distributions of neutrons, electrons and muons and the longitudinal development of atmospheric Cherenkov lights are effectively sampled. A hybrid detection of EAS including thermal neutrons, electrons, muons and Cherenkov lights can provide a strong capability of cosmic nuclei discrimination as well as energy measurement with high resolution. In this report, the status of the clusters at the different places are summarized, and the preliminary results of coincident events between ENDA and the LHAASO array are presented.'

Collaborations
Lhaaso,

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Study of the Electron-Neutron Detector Array (ENDA) in Yangbajing, Tibet

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Dixuan Xiao
Author and Co-Author
Tian-Lu Chen | Vladimir Stepanov | Dangzeng Luobu | Fan Yang | Yuri StenKin | Oleg Shchegolev | Xin-Hua Ma | Denis Kuleshov | Dixuan Xiao | Liangwei Zhang | Maoyuan Liu | Shu-Wang Cui | Bing-Bing Li | Cong Shi,

Abstract
'To research the “knee” region of cosmic ray energy spectrum, we should clearly discriminate components of cosmic rays at the knee. EN-detectors (Electron-Neutron Detector) can detect both electrons and thermal neutrons generated in ground by EAS hadrons, so that the electron-neutron detector array (ENDA) can improve capability of primary components separation and energy measurement of LHAASO in the near future. At present, a cluster (of 16 EN-detectors) is running at the Yangbajing Cosmic Ray Observatory in Tibet to test performance at high altitude (4300 m above sea level).\r\nWith a period of stably operating at Yangbajing, we demonstrated the efficiency of thermal neutron detection is affected by environmental water— drier the weather, higher the efficiency. The difference between rain season and dry season could be about 10 percent. Therefore, in order to minimize seasonal effect, we designed a construction of so called “sand cube”, i.e., 1 cubic meter plastic tank filled with sand, on which one detector is mounted. The sand cube can apart detector from ground and reduce the seasonal effect. Moreover, because ingredient of sand is uniform and tested clearly, simulation of sand cube and detector can be more accurate so that the final systematic uncertainties can be reduced definitely. This report describes seasonal effect and the comparison of the performances between using sand cube and not.'

Collaborations
Lhaaso,

Keywords and Comments
'', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

A simulation study for one-pion exchange contribution on very forward neutron productions in ATLAS-LHCf common events

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Ken Ohashi
Author and Co-Author
Ken Ohashi, Yoshitaka Itow | Hiroaki Menjo | Takashi Sako

Abstract
'The mass composition is one of the key information to understand the origin of ultra-high energy cosmic rays. The interpretations of the mass composition from results by air shower experiments depend on hadronic interaction models used for the simulation. The uncertainties due to interaction models are reduced using recent experimental results at LHC. \r\nHowever, due to no experimental results of pion-proton or pion-nucleus collisions at high energy, uncertainties remain in these collisions and it affects predictions of muon productions in air showers. \r\nRecent results for very forward neutrons in pseudo-rapidity larger than 10.76 by the LHCf experiment show large differences from predictions by interaction models.\r\nAs a fundamental process of forward neutron production, the contribution of one pion exchange is proposed. \r\nThough LHC can not circulate the pion beam, a virtual pion emitted from a proton in a proton beam can collide with a proton in the other proton beam.\r\nIn this work, we discuss a possibility to measure contributions from one-pion exchange on very forward neutrons using ATLAS and LHCf detectors in LHC RUN 3.\r\nExpected energy resolution for neutrons and statistics in Run 3 are taken into account in the discussion. The prospect of measurements of one-pion exchange contributions is also presented.'

Collaborations

Keywords and Comments
'mass composition; hadronic interaction;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Telescope Array Cloud Ranging Test

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 6

Presenter
Takeshi Okuda
Author and Co-Author
Takeshi Okuda | For the Telescope Array Collaboration.,

Abstract
'The Telescope Array (TA) experiment detects air-showers induced by ultra high energy cosmic rays. The TA atmospheric Fluorescence telescopic Detector(TAFD) observes cosmic ray airshower, which is incident very far from the telescope. The observation does not take place in overcast night. However, the cloud status changes quickly and sometimes there are some isolated clouds. If the cloud is behind the airshower as viewed from the TAFD, the cloud presents no problem for airshower reconstruction. However if the cloud obscures the airshower, it does create a problem for airshower reconstruction. The problematic event can be rejected by airshower profile at reconstruction. However, the estimation of exposure with isolated cloud is difficult. And it should be affected more at higher energy event with relatively further from the telescope, which is lower statistics and more important for the ultra high energy cosmic ray physics. Therefore, to test the method for evaluating the correction of exposure, we installed stereo cloud cameras near one of FD sites. I report the status of the study of the Telescope Array Cloud Ranging Test.'

Collaborations
Telescope Array,

Keywords and Comments
'Airshower; Fluorescence Detector; Cloud', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Mass composition compatibility test using $X_{\rm max}$ distributions recorded by the Pierre Auger and Telescope Array Observatories

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 7

Presenter
Nicusor Arsene
Author and Co-Author
Nicusor Arsene,

Abstract
'In this paper we infer the mass composition of the ultra high energy cosmic rays (UHECRs) from measurements of $X_{\\rm max}$ distributions recorded at the Pierre Auger (2014) and Telescope Array (TA) (2016) Observatories, by fitting them with all possible combinations of Monte Carlo (MC) templates from a large set of primary species (p, He, C, N, O, Ne, Si and Fe) as predicted by EPOS-LHC, QGSJETII-04 and Sibyll 2.1 hadronic interaction models. We use the individual fractions of nuclei reconstructed from one experiment in each energy interval to build equivalent MC $X_{\\rm max}$ distributions which we compare with the experimental $X_{\\rm max}$ distributions of the other experiment, applying different statistical tests of compatibility: Kolmogorov - Smirnov (KS), Anderson – Darling (AD) and $p-value$ as goodness of fit.\r\nThe results obtained from both experiments confirm that the mass composition of the UHECRs is dominated ($\\gt 70\\%$) by protons and He nuclei on the entire energy spectrum. The indirect comparisons between the $X_{\\rm max}$ distributions recorded by the two experiments show that the two data sets are not compatible to each other on the entire energy range $\\lg E (\\rm eV) = [18.2 - 19.0]$. We obtain very low probabilities of compatibility ($< 10^{-5}$) especially at lower energies but becoming increasingly large around and above the \\textit{ankle} ($\\lg E (\\rm eV) \\sim 18.7$), obtaining excellent agreement in some high energy intervals.'

Collaborations

Keywords and Comments
'"mass composition; fitting fractions of X_{max} distributions"', '

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Radio-Morphing: a fast, efficient and accurate tool to compute the radio signals from air-showers

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table 8

Presenter
Simon Chiche
Author and Co-Author
Simon Chiche, Olivier Martineau | Kumiko Kotera | Krijn de Vries | Matías Tueros

Abstract
'The preparation of next generation large-scale radio detectors such as GRAND requires to run massive air-shower simulations to evaluate the radio signal at each antenna position. Radio-Morphing was developed for this purpose. It is a semi-analytical tool that enables a fast computation of the radio signal emitted by any air-shower at any location, from the simulation data of one single reference shower at given positions. Radio-Morphing was demonstrated to generate the electric field time traces with amplitudes in good agreement (<30% difference for two thirds of signals) with microscopic simulations, while reducing the computation time by several orders of magnitude. However, several features still needed to be addressed for the tool to be fully efficient and accurate. We present here major improvements on the Radio-Morphing method that have been implemented recently. The upgraded version is based on revised and refined scaling laws, derived from physical principles. It also includes a new spatial interpolation technique, thanks to which an excellent signal timing accuracy can be reached. We will present the methodology, performances and possible applications of this universal tool.'

Collaborations

Keywords and Comments
'Air-shower; numerical simulations; radio-signal parametrization; radio-detection', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

LOgging UnifieD for ASTRI Mini Array

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 9

Presenter
Federico Incardona
Author and Co-Author
Alessandro Costa | Kevin Munari | Federico Incardona, Pietro Bruno | Alessandro Grillo | Stefano Germani | Eva Sciacca | Gino Tosti | Joseph Schwarz | Fabio Vitello | Giuseppe Tudisco

Abstract
'The ASTRI (Astrofisica con Specchi a Tecnologia Replicante Italiana) Mini-Array project is a wide international effort led by the Italian National Institute for Astrophysics aiming at operating an array of nine ASTRI Cherenkov telescopes. The Mini-Array will operate in the energy range 1-100 TeV and beyond and will be dedicated to very high-energy gamma ray astrophysics and optical intensity interferometric observations of bright stars. It will be installed at the site of the Teide Observatory in Tenerife (Spain).\r\nThe core of the ASTRI Mini-Array is the Supervision Control and Data Acquisition (SCADA), the hardware and software system monitoring and controlling all the operations carried out at the ASTRI Mini-Array site. \r\nLOUD the LOgging UnifieD system is one of the main components of SCADA. LOUD is the subsystem that provides the service tailored to gather, filter, expose and persist log events collected by all the array devices and assemblies (telescopes, LIDAR etc.). We present here its architecture and the software stack explicitly designed for distributed computing environments employing Internet of Things technologies.'

Collaborations
other (fill field below), ASTRI

Keywords and Comments
'astri; astri-ma; monitoring; logging; alarms', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

FOV direction and real image size calibration of Fluorescence Detector using light source mounted on the UAV

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Arata Nakazawa
Author and Co-Author
Arata Nakazawa, Takayuki Tomida | Kengo Sano | Yuichiro Tameda | Yuya Oku | Daisuke Ikeda | for the Telescope Array Collaboration

Abstract
'We have developed the "Opt-copter" as a calibration device for fluorescence detectors (FDs). The Opt-copter is a UAV equipped with a light source. The Opt-copter is also equipped with a RTK-GPS of 10 cm position measurement resolution, which allows it to fly within the FD\'s field of view(FOV) while accurately measuring the position of the light source. This allows us to measure the optical properties of the FD in detail. In this paper, the results of the analysis of the FD\'s FOV direction and real image size using the data obtained by the opt-copter will be reported.'

Collaborations
Telescope Array,

Keywords and Comments
'UAV; Fluorescence detector; calibration;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Tools and Procedures for the ASTRI Mini-Array Calibration

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Teresa Mineo
Author and Co-Author
Teresa Mineo | Maria Concetta Maccarone | Filippo Ambrosino | Bruno Pietro Giuseppe | Andrea Bulgarelli | Milvia Capalbi | Osvaldo Catalano | Mauro Centrone | Andrea Di Paola | Marco Faccini | Valentina Giordano | Simone Iovenitti | Leto Giuseppe | Fabriz,

Abstract
'The ASTRI Mini-Array (ASTRI-MA) is an INAF project to construct and operate an array of Imaging Atmospheric Cherenkov Telescopes to study gamma-ray sources in the TeV range. The ASTRI-MA will consist of nine double-mirror telescopes that will be installed at the Teide Astronomical Observatory, Instituto de Astrofísica de Canarias, in Tenerife (Spain). Its main scientific goal is to perform very-high energy observations of galactic and extragalactic sources with sensitivity at multi-TeV energies better than any other telescopes currently in operation. Furthermore, the ASTRI-MA telescopes will also perform intensity interferometry observations of a selected sample of bright sources being each telescope equipped with a Stellar Intensity Interferometry Instrument.\r\nThe ASTRI-MA requires several calibration tasks, that concern specific subsystems (i.e., optical system, Cherenkov camera, intensity interferometry instrument), the entire telescope or the overall array. The ASTRI-MA calibration plan has the final aim to provide all the procedures and quantities necessary to correctly calibrate the scientific data. The calibration system will serve also to monitor the health of the telescopes and to provide the good time intervals during which the observational data can be considered of high quality.\r\nAlthough all the ASTRI-MA subsystems will be calibrated during the assembly, integration, verification and commissioning phases, some calibration tasks need to be performed periodically for maintenance and some others every observing night for monitoring instrumental parameters that can change on a short time scale. \r\nIn this contribution we present the ASTRI-MA calibration plan together with methods and auxiliary equipment currently under development and testing.'

Collaborations
other (fill field below), ASTRI Project

Keywords and Comments
'IACT \r\ncalibration', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Cosmic ray studies with SWGO

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Andrew Taylor
Author and Co-Author
Andrew Taylor | Gwenael Giacinti | Paolo Desiati | Andrea Chiavassa | Guiseppe Disciascio | Juan Carlos Arteaga Velazquez | Juan Carlos Diaz Velez,

Abstract
'A number of cosmic-ray observatories have measured a change in both phase and amplitude of the dipole component in the distribution of cosmic-ray arrival directions at ~ 100 TeV primary energy. We focus on probing the cosmic-ray dipole and multipole evolution in the energy region of ~ 1 TeV to beyond a PeV with a future large-area gamma-ray observatory, such as the Southern Wide-field Gamma-ray Observatory (SWGO). The ability to discriminate between different mass groups is essential to understand the origin of this evolution. Through a consideration of the energy and mass resolution for cosmic-ray detection by such an observatory, we estimate its separation power for decomposing the full-particle anisotropy into mass groups. In particular, we explore the feasibility of probing the dipole evolution with rigidity with SWGO. In this way, we demonstrate the great potential that this instrument offers for providing a deeper understanding of the origin of the cosmic-ray anisotropy.'

Collaborations
SWGO,

Keywords and Comments
'cosmic ray; anisotropy; TeV; PeV', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Zenith Angle Distribution of Incoherent Cosmic Ray Muon Flux Using CREDO Smartphones

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 10

Presenter
Tadeusz Wibig
Author and Co-Author
Tadeusz Wibig | Michał Karbowiak | for the CREDO Collaboration,

Abstract
'The Cosmic-Ray Extremely Distributed Observatory (CREDO) was established to detect and study ultra high-energy cosmic ray particles. In addition to making use of traditional methods for finding rare and extended cosmic ray events such as professional-grade EAS arrays, as well as educational ‘class-room’ detectors, CREDO also makes use of cameras in smartphones as particle detectors. Beyond the primary scientific goal of the CREDO project, to detect Cosmic Ray Ensembles, is the equally important educational goal of the project. To use smartphones for EAS detection, it is necessary to demonstrate that they are capable of effectively registering relativistic charged particles.\r\nIn this paper we have shown that the distribution of the zenith angle of particles responsible for the emergence of tracks in the smartphone captured images is in agreement with the expected distribution of the zenith angle of single, incoherent, cosmic ray muons. It is difficult, if not impossible, to imagine different mechanisms leading to such a distribution, and we believe it clearly demonstrates the suitability of smartphone-based detectors in supporting the more traditional cosmic ray detectors. We confirm the idea that smartphones can operate in practice as ’particle pocket detectors’, sensitive to charged relativistic cosmic particles and hence can be used effectively by the CREDO Project and other similar initiatives.'

Collaborations
, Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'particle detection; incoherent muons; zenith angle distribution', 'The main results covered by this article will be summarised in a highlight talk to be presented by a representative speaker of the CREDO Collaboration, if only the Conference Organizers agree that such a talk is given (an appropriate request will be sent

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Study Anti-correlation between Neutron Detection Efficiency of the Electron-Neutron Detector Array (ENDA) and Soil Moisture

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 11

Presenter
Bing-Bing Li
Author and Co-Author
Bing-Bing Li | Cong Shi | Xin-Hua Ma | Fan Yang | Shu-Wang Cui | Vladimir Stepanov | Liangwei Zhang | Tian-Lu Chen | Denis Kuleshov | Luobu Danzeng | Oleg Shchegolev | Mao-Yuan Liu | Dixuan Xiao | Yuri Stenkin,

Abstract
'The measurement of thermal neutrons generated by cosmic ray extensive air showers (EAS) on the Earth's surface provides a new method for studying the composition and energy of cosmic rays with energy in the so-called “knee” region. A new type of thermal neutron detector prototype array was installed in LHAASO, Haizishan, Daocheng, Sichuan, China. The array consists of 16 electron-neutron detectors (EN-detectors), so called ENDA-16-HZS, which utilize a new type scintillator based on a compound alloy of ZnS(Ag) and B2O3 with natural boron.\r\nAccording to our previous paper about the performance of EN-detectors in Yangbajing, Tibet, during the period from August 2019 to January 2020, the number of neutrons in periods of rain season is significantly (~10%) lower than that in periods of dry season. In order to quantify the anti-correlation between neutron detection efficiency and soil moisture, we adopts WKTSH1920-4G version of soil moisture meter. It works in frequency domain reflection (FDR) principle. With 4G network interface, the collected data can be uploaded to the TLINK cloud in real time, and users can obtain temperature and humidity data. Five soil moisture meters have been successfully installed at different depths inside ENDA-16-HZS in August 2020. By analyzing the data in September 2020, it is demonstrated that neutron detection efficiency of EN-detector is negatively correlated with soil moisture. The obtained anti-correlation parameters are beneficial for correction of neutrons detected in EAS events and then reduction of systematic uncertainties in the final energy spectrum recovering of different primary cosmic ray components.'

Collaborations
Lhaaso,

Keywords and Comments
", "

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Test of the Electron-Neutron Detector Array (ENDA) in Laboratory

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Fan Yang
Author and Co-Author
Tian-Lu Chen | Shu-Wang Cui | Iuobu Danzeng | Denis Kuleshov | Bing-Bing Li | Mao-Yuan Liu | Xin-Hua Ma | Oleg Shchegolev | Cong Shi | Yuri Stenkin | Vladimir Stepanov | Dixuan Xiao | Fan Yang | Liangwei Zhang,

Abstract
'The measurement of thermal neutrons generated by cosmic ray extensive air showers (EAS) on the Earth’s surface provides a new method for studying the composition and energy of cosmic rays with energy in the so-called “knee” region. The electron-neutron detector (EN-detector) utilizes a new type scintillator based on a compound alloy of ZnS(Ag) and B2O3 with natural boron. Totally 64 EN-detectors were produced at the laboratory in Hebei Normal University (HNU), Shijiazhuang, Heibei, China. At present 2 clusters (32 detectors) are kept at the laboratory. The performance test of the EN-detector mainly includes the relative gain calibration, the neutron detection efficiency, and comparison of detection efficiencies between different types of the reflection layer. The triggered EAS events of the two clusters are recorded and analyzed offline in order to compare with ones at high altitude.'

Collaborations
Lhaaso,

Keywords and Comments
", "

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

A drone-borne installation for studying the composition of cosmic rays in the range of 1-1000 PeV by registering the reflected Cherenkov light of EAS

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Igor Vaiman
Author and Co-Author
Igor Vaiman | Dmitry Chernov | Dmitry Podgrudkov | Elena Bonvech | Vladimir Galkin | Tatiana Roganova | Vladimir Ivanov | Vasilisa Latypova | Miroslav Finger | Michael Finger,

Abstract
'Here we present the current technical design of the SPHERE project’s new detector. The SPHERE project is aimed at primary cosmic ray studies in the 1-1000 PeV energy range using reflected Cherenkov light. The concept of a drone-mounted detector with a photosensitive camera based on silicon photomultipliers is discussed. The combination of the reflected CL registration method with specific data analysis approaches is a unique feature of this project. The developed earlier event-by-event data analysis approach allows to carry out primary particle mass reconstruction and PCR mass composition studies with high accuracy. This is achieved through careful analysis of each EAS CL lateral distribution function without building any kind of intermediate distributions of any “typical” characteristics.'

Collaborations

Keywords and Comments
'cosmic rays; extensive air showers; cherenkov light; high energy cosmic rays', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Current status and prospects of surface detector of the TAx4 experiment

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Eiji Kido
Author and Co-Author
Eiji Kido | for the Telescope Array Collaboration,

Abstract
'Telescope Array (TA) is the largest ultrahigh energy cosmic-ray (UHECR) observatory in the Northern Hemisphere. A surface detector (SD) array covers approximately 700 km^2, and the SD array is surrounded by three fluorescence detector (FD) stations. TA has found evidence for a cluster of cosmic rays with energies greater than 57 EeV from the TA SD data. In order to confirm this evidence with more data, we started the TAx4 experiment which expands the detection area using new SDs and FDs. We started construction of new SDs which are arranged in a square grid with 2.08 km spacing at the north east and south east of the TA SD array. More than half of the new SDs are already deployed and running. In this talk, we present the current status of the TAx4 SD and the data that have already been collected.'

Collaborations
Telescope Array,

Keywords and Comments
'Ultrahigh energy cosmic rays; Extensive air shower array', 'This presentation contains results we would like to include in a TA highlight talk.'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Updates from the OVRO-LWA: Commissioning a Full-Duty-Cycle Radio-Only Cosmic Ray Detector

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 12

Presenter
Kathryn Plant
Author and Co-Author
Kathryn Plant | Andres Romero-Wolf | Washington Rodrigues de Carvalho | Konstantin Belov | Gregg Hallinan,

Abstract
'The Owens Valley Radio Observatory- Long Wavelength Array (OVRO-LWA) in Eastern California is currently undergoing an expansion to 352 dual-polarization antennas and new signal processing infrastructure. The upgraded array will operate a full-duty-cycle cosmic ray detector simultaneously with a variety of radio astronomy observations. Expanding the methods introduced in a previous demonstration, this detector will operate on the radio signals alone to trigger data capture, identify cosmic rays in the presence of radio-frequency interference (RFI), and reconstruct the air shower properties: energy, direction, and Xmax. When fully commissioned, the OVRO-LWA will observe thousands of cosmic rays per year at energies 10^17-10^18 eV and will constrain the cosmic ray composition across the cosmic ray spectrum's second knee with a typical Xmax precision of <20g/cm^2 per air shower, thereby offering new composition information across the energy limits of Galactic accelerators. Commissioning for the OVRO-LWA is ongoing and is planned for completion in late 2021. I will present the trigger design, RFI flagging strategy, and a progress update from early commissioning.'

Collaborations

Keywords and Comments
'"radio; airshowers"', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Sensitivity of the Tibet hybrid experiment (Tibet-III + MD) for primary proton spectra between 30 TeV and a few hundreds of TeV's

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Daichi Kurashige
Author and Co-Author
Daichi Kurashige, Ding Chen | Naoki Hotta | Jing Huang | Yusaku Katayose | Kazumasa Kawata | Munehiro Ohnishi | Toshiharu Saito | Takashi Sako | Makio Shibata | Masato Takita

Abstract
'We are observing extensive air showers using Tibet-III air shower array located at 4300 m above sea level. Such situation at high altitude enables us to measure the chemical composition of cosmic rays above several tens TeV by analyzing the shower profiles. A water-Cherenkov Muon Detector array (MD) was added in 2014 to measure the muon intensity of air showers and performance of particle identification was improved. We have developed a method to select proton air shower events with the energy between 30 TeV and a few hundreds of TeV's by the difference of number of muons in the air shower using MD. The sensitivity of the detector for primary proton spectra was investigated by Monte Carlo simulation with both primary composition models and the interaction models. Using the number of muons measured by the MD, it was found that the protons could be selected with 90% purity. The systematic errors between these models were summarized as less than ±36% in total, indicating that the accuracy is sufficient to study the shape of the proton spectra.'

Collaborations
other (fill field below), Tibet ASg

Keywords and Comments
'Proton spectra; knee; muon; etc.', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

The Fluorescence Telescope on board EUSO-SPB2 for the detection of Ultra High Energy Cosmic Rays

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Giuseppe Osteria
Author and Co-Author
Giuseppe Osteria | For the JEM EUSO Collaboration, Jim Adams | Matteo Battisti | Alexander Belov | Mario Bertaina | Francesca Bisconti | Francesco Cafagna | Donatella Campana | Rossella Caruso | Marco Casolino | Mark Christl | Toshikazu Ebisuzaki | Johannes Eser | Francesco Fenu | George Filippatos | Cla

Abstract
'The Fluorescence Telescope is one of the two telescopes on board the Extreme Universe Space Observatory on a Super Pressure Balloon II (EUSO-SPB2). EUSO-SPB2 is an ultra-long-duration balloon mission that aims at the detection of Ultra High Energy Cosmic Rays (UHECR) (E > 1 EeV) via the fluorescence technique (using a Fluorescence Telescope) and of Very High Energy (VHE) neutrinos (E > 10 PeV) via Cherenkov emission (using a Cherenkov Telescope). The mission is planned to fly in 2023 and is a precursor of the Probe of Extreme Multi-Messenger Astrophysics (POEMMA).\r\nThe Fluorescence Telescope is a second generation instrument preceded by the telescopes flown on the EUSO-Balloon and EUSO-SPB1 missions. It features Schmidt optics and has a 1-meter diameter aperture. The focal surface of the telescope is equipped with a 6912-pixel Multi Anode Photo Multipliers (MAPMT) camera covering a 37.4 x 11.4 degree Field of Regard. Such a big Field of Regard, together with a flight target duration of up to 100 days, would allow, for the first time from suborbital altitudes, detection of UHECR fluorescence tracks.\r\nThis contribution will provide an overview of the instrument including the current status of the telescope development.'

Collaborations
, JEM-EUSO

Keywords and Comments
'UHECR; fluorescence detection technique of extensive air showers; Ultra Long Duration Balloon payload; new detector', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Muon number rescaling in simulations of air showers

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Dariusz Gora
Author and Co-Author
Dariusz Gora, Borodai Nataliia | Ralph Engel | Tanguy Pierog | Jan Pekala | Markus Roth | Jaroslaw Stasielak | Michael Unger | Darko Veberic | Henryk Wilczynski

Abstract
'The number of muons in extensive air showers predicted using LHC-tuned hadronic interaction models, such as EPOS-LHC and QGSJetII-04, is smaller than observed in showers recorded by leading cosmic rays experiments. In this paper, we present a new method to derive muon rescaling factors by analyzing reconstructions of simulated showers. The z-variable used (difference of initially simulated and reconstructed total signal in detectors) is connected to the muon signal and is roughly independent of the zenith angle but depends on the mass of primary cosmic ray. The performance of the method is tested by using Monte Carlo shower simulations for the hybrid detector of the Pierre Auger Observatory. Having an individual z-value from each simulated hybrid event, the corresponding signal at 1000 m, and using a parametrization of the muon fraction in simulated showers, we can calculate the multiplicative rescaling parameters of the muon signals in the ground detector even for an individual event, and study its dependence as a function of zenith angle and the mass of primary cosmic ray. This gives a possibility not only to test/calibrate the hadronic interaction models, but also to derive the beta exponent, describing an increase of the number of muons as a function of primary energy and cosmic-ray mass. Detailed simulations show dependence of beta on hadronic interaction properties, thus the determination of this parameter is important to understand the muon deficit problem.'

Collaborations

Keywords and Comments
'cosmic rays; hadronic interactions; extensive air showers', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

A study on UV emission from clouds with Mini-EUSO

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
Alessio Golzio
Author and Co-Author
Alessio Golzio | Matteo Battisti | Mario Bertaina | Marco Casolino | Claudio Cassardo | Roberto Cremonini | Silvia Ferrarese | Massimiliano Manfrin | Laura Marcelli | Kenji Shinozaki, for the JEM-EUSO Collaboration

Abstract
'Mini-EUSO is the first mission of the JEM-EUSO program located on the International Space Station. One of the main goals of the mission is to provide valuable scientific data in view of future large missions devoted to studying Ultra-High Energy Cosmic Rays (UHECRs) from space by exploiting the fluorescence emission generated by Extensive Air Showers (EAS) developing in the atmosphere. A space mission like Mini-EUSO experiences continuous changes in atmospheric conditions, including the cloud presence. Therefore, the influence of clouds on space-based observation is an important topic to investigate from the EAS point of view as it might alter the instantaneous exposure for EAS detection or deteriorate the quality of the EAS images with consequences on the reconstructed EAS parameters. For this purpose, JEM-EUSO planned to have an IR camera and a lidar as part of its Atmosphering Monitoring System. At the same time, it would be extremely beneficial if the UV camera itself would detect the presence of clouds, at least in some specific conditions. For this reason, we are performing a few case studies with Mini-EUSO by comparing the variation of pixel count rates during orbits with re-analyses of the atmospheric state, namely the cloud cover in different height bands and its optical depth, performed employing the global model Global Forecast System (GFS). GFS is already used to supply the real-time forecasts of the atmosphere during the Mini-EUSO sessions; here, it is paired with different satellite products such as MODIS Terra-Aqua or VIIRS. The results of this analysis will be reported.'

Collaborations

Keywords and Comments
'Mini-EUSO; UV detector; cloud cover; atmospheric observations; atmospheric models', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Reconstructing inclined extensive air showers from radio measurements

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table 13

Presenter
Tim Huege
Author and Co-Author
Tim Huege | Felix Schlüter,

Abstract
'We present a reconstruction algorithm for extensive air showers with zenith angles between 65° and 85° measured with radio antennas in the 30-80 MHz band. Our algorithm is based on a signal model derived from CoREAS simulations which explicitly takes into account the asymmetries introduced by the superposition of charge-excess and geomagnetic radiation as well as by early-late effects. We exploit correlations among fit parameters to reduce the dimensionality and thus ensure stability of the fit procedure. Our approach reaches a reconstruction efficiency near 100% with an intrinsic resolution for the reconstruction of the electromagnetic energy of well below 5%. It can be employed in upcoming large-scale radio detection arrays using the 30-80 MHz band, in particular the AugerPrime Radio detector of the Pierre Auger Observatory, and can likely be adapted to experiments such as GRAND operating at higher frequencies.'

Collaborations

Keywords and Comments
'extensive air showers; radio detection; reconstruction algorithms', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Estimation of aperture of the Tunka-Rex radio array for cosmic-ray air-shower measurements

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 14

Presenter
Vladimir Lenok
Author and Co-Author
Vladimir Lenok | for the Tunka-Rex Collaboration,

Abstract
'The recent progress in the radio detection technique for air showers paves the path to future cosmic-ray radio detectors. Digital radio arrays allow for a measurement of the air-shower energy and depth of its maximum with a resolution comparable to those of the leading optical detection methods. One of the remaining challenges regarding cosmic-ray radio instrumentation is an accurate estimation of their efficiency and aperture. We present a probabilistic model to address this challenge. We use the model to estimate the efficiency and aperture of the Tunka-Rex radio array. The basis of the model is a parametrization of the radio footprint and a probabilistic treatment of the detection process on both the antenna and array levels. In this way, we can estimate the detection efficiency for air showers as function of their arrival direction, energy, and impact point on the ground. In addition, the transparent internal relationships between the different stages of the air-shower detection process in our probabilistic approach enable to estimate the uncertainty of the efficiency and, consequently, of the aperture of radio arrays. The detail of the model and its application to the Tunka-Rex data will be presented in the contribution.'

Collaborations
other (fill field below), Tunka-Rex

Keywords and Comments
", "

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

A reconstruction procedure for very inclined extensive air showers based on radio signals

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 15

Presenter
Valentin Decoene
Author and Co-Author
Valentin Decoene, Olivier Martineau | Matias Tueros | Simon Chiche

Abstract
'Very inclined extensive air showers, with both down-going and up-going trajectories, are particularly targeted by the next generation of extended radio arrays, such as GRAND. However, the reconstruction of their\xa0incoming\xa0direction,\xa0core position, primary energy and composition, remains underdeveloped.\r\n\r\nTowards that goal, we present a new reconstruction procedure based on the arrival times and the signal amplitudes, measured at each antenna station. This hybrid reconstruction method, harness the fact that the emission is observed, at the antenna level, far away from the emission region, thus allowing for a point-like emission description. Thanks to this assumption, the arrival times are modelled following a spherical wavefront emission, which offers the possibility to reconstruct the radio emission zone as a fixed point along the shower axis. From that point the amplitude distribution at the antenna level is described through an Angular Distribution Function (ADF) taking into account at once all geo-magnetic asymmetries and early late effects as well as additional signal asymmetries featured by very inclined extensive air showers. This method shows promising results in terms of arrival direction reconstruction, within the 0.1° range, even when taking into account experimental uncertainties, and interesting possibilities for the energy reconstruction and primary composition identification.'

Collaborations
other (fill field below), GRAND

Keywords and Comments
'Extensive-Air-Shower ; Reconstruction ; Radio-Detection', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Discrimination of Muons for Mass Composition Studies of Inclined Air Showers Detected with IceTop

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 16

Presenter
Aswathi Balagopal V.
Author and Co-Author
Aswathi Balagopal V. | For the IceCube Collaboration,

Abstract
'IceTop, the surface array of IceCube, measures air showers from cosmic rays within the energy range of 1 PeV to a few EeV and a zenith angle range of up to ≈ 36°. This detector array can also measure air showers arriving at larger zenith angles at energies above 20 PeV. Air showers from lighter primaries arriving at the array will produce fewer muons when compared to heavier cosmic-ray primaries. A discrimination of these muons from the electromagnetic component in the shower can therefore allow a measurement of the primary group. A study to discriminate muons using Monte-Carlo air showers of energies 20-100 PeV and within the zenith angular range of 45°-65° will be presented. The discrimination is done using charge and time-based cuts which allows us to select muon-like signals in each shower. The methodology of this analysis, which aims at categorizing the measured air showers as light or heavy on an event-by-event basis, will be discussed.'

Collaborations
IceCube,

Keywords and Comments
'cosmic rays; air showers; IceTop; mass composition; muon discrimination', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Study of the effect of seismically-induced geoelectric and geomagnetic fields on secondary particle detection at a LAGO site.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 17

Presenter
Diego Alberto Coloma Borja
Author and Co-Author
Diego Alberto Coloma Borja | Edgar Carrera Jarrin | For The LAGO Collaboration,

Abstract
"The aim of this project is to study the potential effect that the changes in geoelectric and geomagnetic fields, produced by seismic activity, could have on the detection of secondary particles from extensive \u200bair showers in the atmosphere. For this purpose, simulations for flux of secondaries are performed using ARTI, a tool developed by the LAGO Collaboration that combines Magnetocosmics, CORSIKA, and Geant4 packages to account, respectively, for the propagation of a shower by a primary particle, the geomagnetic effect on particle flux, and the detector response. To run these simulations, the ground level is taken with reference to the position of the LAGO water Cherenkov tank at Universidad San Francisco de Quito (2200 m a.s.l.) in Ecuador. Regular conditions for the Earth's electromagnetic field are taken from records of fair-weathered days above the location. Variations from this regularity are introduced based on relevant studies on seismic activity. The results show that there exists an effect on the number of secondary particles at ground level, which could, in principle, be detected by a LAGO WCD detector."

Collaborations
other (fill field below), LAGO

Keywords and Comments
'Simulations; secondary particle detection Geoelectric Field; Geomagnetic field; Seismic Activity; LAGO;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

UCIRC2: EUSO-SPB2's Infrared Cloud Monitor

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 18

Presenter
Rebecca Diesing
Author and Co-Author
Rebecca Diesing | Alexa Bukowski | Noah Friedlander | Alex Miller | Stephan Meyer | Angela Olinto | for the JEM-EUSO Collaboration,

Abstract
'The second generation of the Extreme Universe Space Observatory on a Super Pressure Balloon (EUSO-SPB2) is a balloon instrument for the detection of ultra high energy cosmic rays (UHECRs) with energies above 1 EeV and very high energy neutrinos with energies above 10 PeV. EUSO-SPB2 consists of two telescopes: a fluorescence telescope pointed downward for the detection of UHECRs and a Cherenkov telescope pointed towards the limb for the detection of tau lepton-induced showers produced by up-going tau neutrinos and background signals below the limb. Clouds inside the field of view of these telescopes reduce EUSO-SPB2's geometric aperture, in particular that of the fluorescence telescope. For this reason, cloud coverage and cloud-top altitude within the field of view of the fluorescence telescope must be monitored throughout data-taking. The University of Chicago Infrared Camera (UCIRC2) will monitor these clouds using two infrared cameras centered at 10 and 12 microns. By capturing images at wavelengths spanning the cloud thermal emission peak, UCIRC2 will measure cloud color-temperatures and thus cloud-top altitudes. In this contribution, we provide an overview of UCIRC2, including an update on its construction and a discussion of the techniques used to calibrate the instrument.'

Collaborations

Keywords and Comments
'UHECR; EUSO-SPB2; clouds; IR camera', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Development of autonomous observation system for next-generation cosmic ray telescope

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Takayuki Tomida
Author and Co-Author
Takayuki Tomida, Yuya Nakamura | Katsuya Yamazaki | Ryosuke Saito | Hirokazu Iwakura | For the CRAFFT collaboration

Abstract
"CRAFFT is an atmospheric fluorescence telescope with wide viewing pixels for Ultra-High Energy Cosmic Rays next-generation observation facility.\u2028We have builded the automatic observation system (for the fluorescence detector) in order to expand detection area of the next generation observatory by the telescope with the fluorescence technique. In Japan, we made a testing machine that reproduces the actual observation equipment installed in Utah, USA.\u2028The observation automation system was installed with the testing machine in Japan and has been in operation for more than 9 months. This system also includes an environmental monitor for stable operation and smooth transition to start or stop observation automatically.\u2028In this presentation, we will report on the development status of CRAFFT's autonomous observation system."

Collaborations
, CRAFFT

Keywords and Comments
'UHECR; Fluorescence Telescope; Automation', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Progress in optimizing the detection surface structure of CRAFFT

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Yuto Kubota
Author and Co-Author
Yuto Kubota, Daisuke Ikeda | Takashi Kagitani | Takayuki Tomida | Yuichiro Tameda | Norimichi Shibata | for the CRAFFT Collaboration

Abstract
'A observatory for the next generation of ultra-high energy cosmic rays (UHECRs) should be expanded for clarifying the origin and nature of UHECRs. In order to realize a huge UHECR observatory, we are developing Cosmic Ray Air Fluorescence Fresnel lens Telescope (CRAFFT), which is a low-cost fluorescence telescope.We tested a performance of prototype CRAFFT at Telescope Array (TA) site, and succeeded to detect UHECR air showers synchronized with TA detectors in 2017.We are currently developing a reconstruction method based on waveform fitting with sufficient analysis accuracy, and optimizing the detector configuration to improve its performance with low cost.Progress in detector optimization, reconstruction method, and calibrations such as uniformity of PMT sensitivity will be discussed.'

Collaborations
other (fill field below), CRAFFT

Keywords and Comments
'UHECR; fluorescence telescope; fresnel lens; development;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

The atmospheric transparency of Telescope Array observation site by the CLF

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 19

Presenter
Takayuki Tomida
Author and Co-Author
Takayuki Tomida | Tomoyuki Nakamura, Katsuya Yamazaki | John Matthews | For the Telescope Array collaboration

Abstract
'The Telescope Array (TA) experiment continues to observe Ultra High Energy Cosmic Rays (UHECRs) both with its original TA detectors as well as with the new TAx4 expansion detectors. These observations employ Fluorescence Detectors (FDs) to capture the air shower induced by the primary UHECRs. The FD observes fluorescence light emitted from atmospheric nitrogen molecules excited by air shower particles. The observation of the FD extends over tens of kilometers, and the fluorescence light is attenuated by scattering from atmospheric molecules and aerosols during the propagation process. Seasonal dependence was found when assessing the attenuation of fluorescence by aerosols. We also captured the weather characteristics. We report on the effect of aerosols on the atmospheric transparency of the TA sites.'

Collaborations
Telescope Array,

Keywords and Comments
'Atmospheric transparency; Calibration; Laser', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Reconstruction of Events Recorded with the Water-Cherenkov and Scintillator Surface Detectors of the Pierre Auger Observatory

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 10 EAS reconstruction and analyses | CRI
Presenter Forum Table

Presenter
David Schmidt
Author and Co-Author
David Schmidt | For the Pierre Auger Collaboration,

Abstract
'With the knowledge and statistical power of over a decade and a half of measurements, the Auger Collaboration has developed, assessed, and refined robust methods for reconstructing the energies and arrival directions of the highest-energy cosmic rays from the signal and timing measurements of its surface detector array. Concurrently, the unearthing of an increasingly complex astrophysical scenario and tensions with hadronic interaction models have demanded the addition of primary mass as an observable measurable using the surface detector. Access to information on the mass hinges on the disentanglement of the electromagnetic and muonic components of extensive air showers. Consequently, an upgrade to the Observatory, AugerPrime, is being carried out by equipping each of the existing water-Cherenkov stations with a 3.8 m^2 Scintillator Surface Detector (SSD). The SSDs, with their high sensitivity to electrons and positrons, will provide samples of the lateral distribution of particles at the ground that complement those of the water-Cherenkov detectors, which are significantly more sensitive to muons. When used together, the two measurements enable extraction of the number of incident muons, which is a quantity that strongly correlates with primary mass. We describe the reconstruction methods applied to measurements of the surface detector of the Observatory with a particular focus on the enhancement of these methods with data of the SSDs of AugerPrime. Results from the reconstruction of thousands of high-energy events already measured with deployed SSDs are also shown.'

Collaborations
Auger,

Keywords and Comments
'surface detector; scintillator; water-Cherenkov detector; AugerPrime; reconstruction; air showers; ultra-high-energy cosmic rays; composition; mass', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Small shower array for education purposes. CREDO-Maze Project

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 20

Presenter
Michał Karbowiak
Author and Co-Author
Michał Karbowiak | Tadeusz Wibig | Jerzy Orzechowski | for the CREDO Collaboration,

Abstract
"We have noticed in many places around the world in recent years an increasing interest in small-scale extensive air shower experiments designed to satisfy young people's scientific curiosity and develop their interest in science and in physics in particular. It is difficult to think of ways and opportunities to introduce practical classes in modern high-energy physics, astrophysics, or particle physics into school curricula and after-school activities. Small EAS array experiments are just such a proposal. As part of the CREDO-Maze project, we plan to equip local high schools with sets of four small detectors, with a simple system for triggering, recording, and online communication with the world. Networked experiments from several schools add significant new educational value to the process of developing good behavior appropriate to scientific communities. Cooperation and competition at the stage of own research and information exchange are essential new and valuable values in educating young generation. Small local arrays connected to the global CREDO network will provide additional data and opportunities for important cosmic ray studies, what is an additional benefit of the CREDO-Maze Project.\r\nIn this paper we will present the characteristics of our detectors and the results of the EAS detections by CREDO-Maze prototype array."

Collaborations
, Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'cosmic ray ensembles; large scale cosmic ray correlations; extensive air showers; detectors; CREDO-Maze; physics education', 'The main results covered by this article will be summarised in a highlight talk to be presented by a representative speaker of the CREDO Collaboration, if only the Conference Organizers agree that such a talk is given (an appropriate request will be sent

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

The XY Scanner - A Versatile Method of the Absolute End-to-End Calibration of Fluorescence Detectors

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Christoph Schäfer
Author and Co-Author
Christoph Schäfer | for the Pierre Auger-Collaboration,

Abstract
'One of the crucial detector systems of the Pierre Auger Observatory is the fluorescence detector composed of 27 large-aperture wide-angle Schmidt telescopes.\r\nIn the past, these telescopes were absolutely calibrated by illuminating the whole aperture with a uniform large-diameter light source.\r\nThis absolute calibration was performed roughly once every three years, while a relative calibration was performed on a nightly basis.\r\nIn this contribution, a new technique for an absolute end-to-end calibration of the fluorescence telescopes is presented.\r\nFor this technique, a portable calibrated light source mounted on a rail system is moved across the aperture of each telescope, instead of illuminating the whole aperture at once.\r\nA dedicated setup for the absolute calibration of the light source has been built, which uses a combination of NIST traceable photodiodes to measure the mean intensity and a PMT for pulse-to-pulse stability tracking.\r\nAs a result of these complementary measurements, the pulse-to-pulse light source intensity can be known to the 3.5% uncertainty level.\r\nThe analysis of the readout of the PMT camera at each position of the light source together with the knowledge of the light source emission provides an absolute end-to-end calibration of the telescope.\r\nWe will give a brief overview of this novel calibration method and its current status, as well as preliminary results from the measurement campaigns performed so far.'

Collaborations
Auger,

Keywords and Comments
'Absolute calibration; light sensitivity; fluorescence detectors of cosmic rays', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Interferometric Air Shower Reconstruction With LOFAR

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 21

Presenter
Hershal Pandya
Author and Co-Author
Hershal Pandya | For the LOFAR CR-KSP,

Abstract
'LOFAR radio telescope and its scintillator array component regularly measure cosmic-ray air showers with energy more than 10^16.5 eV. The current standard air shower reconstruction method does a plane-wave fit for arrival direction reconstruction and a simulation-based radio footprint Chi^2 minimization for shower core and X_max reconstruction. In this conference proceeding, we present the first results from implementing interferometric reconstruction of air shower properties. We can achieve angular reconstruction at least as good as plane-wave fit and present the possibility and challenges in reconstructing X_max interferometrically.'

Collaborations
LOFAR,

Keywords and Comments
'radio emission in air showers; cosmic-ray air showers; beamforming; inteferometry; LOFAR;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Observing Ultra-High Energy Cosmic Rays using Camera Image Sensors

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 22

Presenter
Wakiko Takano
Author and Co-Author
Wakiko Takano, Hibino Kinya

Abstract
'We propose a new approach for observing UHECR by detecting charged particles in the core region of EAS using a cost-effective and compact detector with a CMOS camera image sensor. In general, the core region of EAS is excluded from the measurement due to the very high particle density at which the signal saturates. However, the results of the EAS simulation predict that the particle density in the core depends on the distance from the axis and the angular distribution depends on the arrival direction of the primary cosmic ray. Therefore, the core might be useful for collecting information about EAS effectively.\r\n\r\nMeanwhile, Camera image sensors are sensitive to ionizing radiations in addition to optical photons. It is advantageous to use thin and small sensors to detect particles in the dense region, such as the EAS core. The length of the particle-track is related to depletion thickness and incident angle to the surface of the sensor. If depletion thickness is evident, we can reconstruct the incident angles of primary particles roughly.\r\nWe demonstrate the result of simulation to show the characteristics of UHECRs core as well as the reaction of sensors for charged particles. We also report the result of our experiment using a prototype of the CMOS sensors with Raspberry PI to detect radiations.'

Collaborations

Keywords and Comments
'UHECR; EAS; CMOS sensor', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Reconstruction of sub-threshold events of cosmic-ray radio detectors using an autoencoder

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Pavel Bezyazeekov
Author and Co-Author
Polina Turishcheva | Alina Mikhaylenko | Pavel Bezyazeekov | Pyoter Ivanov | Alexey Kokhanovskiy | Dmitry Shipilov | Eva Sotnikova | Dmitriy Kostiunin | for the Tunka-Rex Collaboration,

Abstract
'Radio detection of air showers produced by ultra-high energy cosmic rays is a cost-effective technique for the next generation of sparse arrays. The performance of this technique strongly depends on the environmental background, which has different constituents, namely anthropogenic radio frequency interferences, synchrotron galactic radiation and others. These components have recognizable features, which can help for background suppression. A powerful method for handling this is the application of convolution neural networks with a specific architecture called autoencoder. By suppressing unwanted signatures, the autoencoder keeps the signal-like ones. We have successfully developed and trained an autoencoder, which is now applied to the data from Tunka-Rex. We show the procedures of the training and optimization of the network including benchmarks of different architectures. Using the autoencoder, we improved the standard analysis of Tunka-Rex in order to lower the threshold of the detection. This enables the reconstructing of sub-threshold events with energies lower than 0.1 EeV with satisfactory angular and energy resolutions.'

Collaborations
, Tunka-Rex

Keywords and Comments
'cosmic rays; air showers; radio arrays; deep learning; autoencoder', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Performance of the 433 m surface array of the Pierre Auger Observatory

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Gaia Silli
Author and Co-Author
Gaia Silli | Nicolás Gonzalez, For the Pierre Auger Collaboration

Abstract
"The Pierre Auger Observatory, located in western Argentina, is the world's largest cosmic ray observatory. While it was originally built to study the cosmic-ray flux above $10^{18.5}$ eV, several enhancements have reduced this energy threshold, thus extending significantly the Observatory's scientific capabilities significantly. One such enhancement, part of the AMIGA original proposal, is a dense surface array composed of a triangular grid of 19 water-Cherenkov detectors separated by 433 meters (SD-433) to explore the energies down to $\\sim 10^{16}$ eV. Currently, we are developing two research lines. Firstly, we will measure the energy spectrum in a region where previous experiments have shown evidence of the second knee. Secondly, we will search for UHE photons to study the PeV sources residing in the Galactic center.\r\nIn this work, we present the performance of the SD-433 derived from simulations. We show that the SD-433 reaches full efficiency near $4\\times 10^{16}$ eV for hadronic primaries with $\\theta < 35\\,^{\\text{o}}\r\n$, and we assess the accuracy of the event geometry reconstruction.\r\nWe also present the event set observed over seven years of operation and use them to parametrize the lateral distribution function of particles hitting the ground in terms of the zenith angle and shower size. \r\nOur studies indicate that with the SD-433, Auger will be able to extend the scientific output of the surface detector down to 10^{16} eV."

Collaborations
Auger,

Keywords and Comments
'Surface detector; Pierre Auger Observatory; SD-433; efficiency; resolution; event reconstruction', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Development of a scintillation and radio hybrid detector array at the South Pole

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Marie Oehler
Author and Co-Author
Marie Oehler | Roxanne Turcotte | For the IceCube Collaboration,

Abstract
'At the IceCube Neutrino Observatory a Surface Array Enhancement is planned, consisting of 32 hybrid stations, placed within the current IceTop footprint. This surface enhancement will considerably increase the detection sensitivity to cosmic rays in the 100 TeV to 1 EeV primary energy range, measure the effects of snow accumulation on the existing IceTop tanks and serve as R&D for the possible future large-scale surface array of IceCube-Gen2. Each station has one central hybrid DAQ, which reads out 8 scintillation detectors and 3 radio antennas. The radio antenna SKALA-2 is used in this array due to its low-noise, high amplification and sensitivity in the 70-350 MHz frequency band. Every scintillation detector has an active area of 1.5 m² organic plastic scintillators connected by wavelength-shifting fibers, which are read out by a silicon photomultiplier. The signals from the scintillation detectors are integrated and digitized by a local custom electronics board and transferred to the central DAQ. When triggered by the scintillation detectors, the filtered and amplified analog waveforms from the radio antennas are read out and digitized by the central DAQ. A full prototype station has been developed and built and was installed at the South Pole in January 2020. It is planned to install up to 7 stations in the Antarctic season 2021/2022 and to finish the installation of the full array by 2026. In this contribution the hardware design of the array as well as the installation plans will be presented.'

Collaborations
IceCube,

Keywords and Comments
'', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Towards a full and realistic simulation framework for the Extreme Energy Events experiment

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Stefano Grazzi
Author and Co-Author
Stefano Grazzi | Giuseppe Mandaglio | Marco Battaglieri,

Abstract
'The network of MRPC (Multi-gap Resistive Plate Chambers) telescopes of the Extreme Energy Events experiment (EEE) was designed to study very high energy cosmic rays mainly through the detection of secondary cosmic muons in the hadronic shower. To better understand and predict the behavior of such events, a GEANT4-based simulation framework that well reproduces the response of individual telescopes was built. Simulations are crucial to better understand the detectors performance in current set-up and how these are affected by surrounding materials into sites where are installed. This is the first step toward a full simulation framework that includes a realistic generation, now limited to muons, of secondary particles and propagation through the atmosphere of the shower produced by primary rays. This is obtained by integrating the single-muon generation, used to study the behavior of the single detectors, with the CORSIKA event generator program for a detailed simulation of extensive air showers initiated by high primaries. The current framework can be used to characterize and optimize the array of EEE telescopes, simulating not only the single detectors but also telescopes clusters, to study the sensitivity to extreme energy or rare events. CORSIKA and the extension of the simulation to clusters will allow to have a more realistic representation, compared to the current state, of the angular and energy distributions and of the events detected by the network of telescopes. In this contribution, the EEE simulation framework and future plans will be presented.'

Collaborations
other (fill field below), EEE Collaboration

Keywords and Comments
'cosmic rays; cosmic muons. MRPC; GEANT4; CORSIKA', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Machine learning aided noise filtration and signal classification of the CREDO smartphone data

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 23

Presenter
Łukasz Bibrzycki
Author and Co-Author
Łukasz Bibrzycki | Olaf Bar | Piotr Homola | Michał Niedźwiecki | Marcin Piekarczyk | Krzysztof Rzecki | Sławomir Stuglik | for the CREDO Collaboration,

Abstract
'The wealth of smartphone data collected by the Cosmic Ray Extremely Distributed Observatory (CREDO) greatly surpasses the capabilities of manual analysis. So, efficient means of rejecting the non-cosmic-ray noise and identification of signals attributable to extensive air showers are necessary. To address these problems we discuss a Convolutional Neural Network-based method of artefact rejection and complementary method of particle identification based on common statistical classifiers as well as their ensemble extensions. These approaches are based on supervised learning, so we need to provide a representative subset of the CREDO dataset for training and validation. According to this approach over 2300 images were chosen and manually labeled by 5 judges. The images were split into spots, tracks, worms (collectively named signals) and artefacts classes. Then the preprocessing consisting of luminance summation of RGB channels (grayscaling) and background removal by adaptive thresholding was performed. For purposes of artefact rejection the binary CNN-based classifier was proposed which was able to distinguish between artefacts and signals. The classifier was fed with input data in the form of Daubechies wavelet transformed images.\r\nIn the case of cosmic ray signal classification, the well-known feature-based classifiers were considered. As feature descriptors, we used Zernike moments with additional feature related to total image luminance.\r\nFor the problem of artefact rejection, we obtained an accuracy of 98%. For the 4-class signal classification, the best performing classifiers achieved a recognition rate of 92%.'

Collaborations
, Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'machine learning; pattern recognition; large scale cosmic ray correlations; extensive air showers', 'The main results covered by this article will be summarised in a highlight talk to be presented by a representative speaker of the CREDO Collaboration, if only the Conference Organizers agree that such a talk is given (an appropriate request will be sent

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Expected performance of interferometric air-shower measurements with radio antennas

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table 24

Presenter
Felix Schlüter
Author and Co-Author
Felix Schlüter | Tim Huege,

Abstract
'Interferometric measurements of the radio emission of extensive air showers allow reconstructing cosmic-ray properties. A recent simulation study with an idealised detector promised measurements of the depth of the shower maximum $X_\\mathrm{max}$ with an accuracy better than 10$\\,$g$\\,$cm^{-2}. \r\nIn this contribution, we evaluate the potential of interferometric $X_\\mathrm{max}$ measurements of (simulated) inclined air showers with realistically dimensioned, sparse antenna arrays. We account for imperfect time synchronisation between individual antennas and study its inter-dependency with the antenna density in detail. We find a strong correlation between the antenna multiplicity (per event) and the maximum acceptable inaccuracy in the time synchronisation of individual antennas. From this result, prerequisites for the design of antenna arrays for the application of interferometric measurements can be concluded. For data recorded with a time synchronisation accurate to 1$\\,$ns within the commonly used frequency band of 30 to 80$\\,$MHz, an antenna multiplicity of $\\geq 50$ is needed to achieve an $X_\\mathrm{max}$ reconstruction with an accuracy of 20$\\,$g$\\,$cm^{-2}. This multiplicity is achieved measuring inclined air showers with zenith angles $\\theta \\geq 77.5^\\circ$ with 1$\\,$km spaced antenna arrays, while vertical air showers with zenith angles $\\theta \\leq 40^\\circ$ require an antenna spacing below 100$\\,$m. Furthermore, we find no improvement in $X_\\mathrm{max}$ resolution applying the interferometric reconstruction to measurements at higher frequencies, i.e., up to several hundred MHz.'

Collaborations

Keywords and Comments
'Radio Detection; Interferometry; Extensive Air Showers; Ultra-high-energy cosmic rays; Reconstruction', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Extraction of the Muon Signals Recorded with the Surface Detector of the Pierre Auger Observatory Using Recurrent Neural Networks

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 25

Presenter
Juan Miguel Carceller
Author and Co-Author
Juan Miguel Carceller | For the Pierre Auger Collaboration,

Abstract
'We present a method based on the use of Recurrent Neural Networks to extract the muon component from the time traces registered with water-Cherenkov detector (WCD) stations of the Surface Detector of the Pierre Auger Observatory. The design of the WCDs does not allow one to separate, for all events, the contribution of muons to the time traces from those of photons, electrons and positrons. Separating the muon and electromagnetic components is crucial for the determination of the nature of the primary cosmic rays and properties of the hadronic interactions at ultra-high energies.\r\n\r\nWe trained the neural network to extract the muon and the electromagnetic components from the WCD traces using a large set of simulated air showers, with around 450 000 simulated events. For training and evaluating the performance of the neural network, simulated events with energies between $10^{18.5}$ eV and 10^{20} eV and zenith angles below 60 degrees were used. We also study the performance of this method on experimental data of the Pierre Auger Observatory and show that our predicted muon lateral distributions agree with the parameterizations obtained by the AGASA collaboration.'

Collaborations
Auger,

Keywords and Comments
'Astroparticle physics; Pierre Auger Observatory; cosmic rays; Cherenkov detectors; muon component; machine learning; neural networks; deep learning; recurrent neural networks', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

AugerPrime Upgraded Unified Board: The New Front-End Electronics

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Giovanni Marsella
Author and Co-Author
Giovanni Marsella,

Abstract
'Since 2015 the Pierre Auger Observatory has been undergoing an important upgrade. It consists of the addition of Scintillator Surface Detectors (SSD) on top of the existing Water-Cherenkov Detectors (WCDs), as well as Underground Muon Detectors (UMD), a small Photo-Multiplier Tube (sPMT) inside the WCDs and a Radio Detector antenna array, at each of the 1660 surface detector stations. To process the signals of all these detector systems and to increase the dynamic range and time resolution, new electronics, Upgraded Unified Boards (UUBs) have been developed and are being fabricated and deployed at the Observatory. \r\n\r\nThe combination of all of these new features of the Surface Detector (SD) will provide an enhanced capacity \r\nfor answering the still many open questions related to the nature of ultra-high energy cosmic rays.\r\n\r\nIn this work the main characteristics, the production chain, the performances and the status of the implementation of\r\nthe new Upgraded Unified Boards will be illustrated. The first data collected from the already \r\noperational upgraded stations in the array will also be presented.'

Collaborations
Auger,

Keywords and Comments
'Electronics; Detector; UHE Cosmic Rays', 'On behalf of AUGER collaboration'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Protons Spectrum from MAGIC Telescopes data

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
Petar Temnikov
Author and Co-Author
Galina Maneva | Petar Temnikov | Vassil Verguilov | Razmik Mirzoyan | Dominik Baack | for the MAGIC collaboration,

Abstract
'Abstract\tImaging Atmospheric Cherenkov telescopes (IACTs) are designed to detect cosmic gamma rays. As a by-product, IACTs detect Cherenkov flashes generated by millions of hadronic air showers every night. We present the proton energy spectrum from several hundred GeV to several hundred TeV, retrieved from the hadron induced showers detected by the MAGIC telescopes. The protons are discriminated from He and heavy nuclei with machine learning classification. The energy estimation is based on a specially developed deep neural network regressor. In the last decade, Deep Learning methods gained much interest in the scientific community for their ability to extract complex relations in data and process vast quantities of data in a short time. The proton energy spectrum obtained in this work is compared with the spectra obtained by modern cosmic ray experiments.'

Collaborations
MAGIC,

Keywords and Comments
'Cherenkov telescopes; Cosmic rays; Protons spectrum; Neural networks', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Monte Carlo simulations for the Pierre Auger Observatory using the VO Auger grid resources

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 26

Presenter
Eva Santos
Author and Co-Author
Eva Santos, For the Pierre Auger Collaboration

Abstract
"The Pierre Auger Observatory, located near Malargüe, Argentina, is the world's largest cosmic-ray detector. It comprises a $3000\\:\\mathrm{km}^{2}$ surface detector and 27 fluorescence telescopes, which measure the lateral and longitudinal distributions of the many millions of the air-shower particles produced in the interaction of a cosmic ray in the Earth's atmosphere. The determination of the nature of cosmic rays and studies of the detector performances rely on extensive Monte Carlo simulations describing the physics processes occurring in extensive air showers and the detector responses.\r\n\r\nThe Monte Carlo simulations task aim is to produce and provide the Auger Collaboration with reference libraries used in a wide variety of analyses. All multipurpose detector simulations are currently produced in local clusters using Slurm and HTCondor. The bulk of the shower simulations are produced on the grid, via the Virtual Organization Auger, using the DIRAC middleware. The job submission is made via python scripts using the DIRAC API.\r\n\r\nThe Auger site is undergoing a major upgrade, which includes the installation of new types of detectors, demanding increased simulation resources. The novel detection of the radio component of extensive air showers is the most challenging endeavor, requiring dedicated shower simulations with very long computation times, not optimized for the grid production.\r\n\r\nFor data redundancy, the simulations are stored on the Lyon server and the DPM and are accessible to the Auger members via iRODS and DIRAC, respectively. The CVMFS is used for software distribution where, soon, the Auger Offline software will also be made available."

Collaborations
Auger,

Keywords and Comments
'Grid usage; VO Auger; High Performance Computing', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Status and performance of the underground muon detector of the Pierre Auger Observatory

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Ana Martina Botti
Author and Co-Author
Ana Martina Botti | for the Pierre Auger Collaboration,

Abstract
'The Auger Muons and Infill for the Ground Array (AMIGA) is an enhancement of the Pierre Auger Observatory that aims to lower its energy threshold down to 10^{16.5} eV and to assess the muonic content of air showers directly. These measurements will significantly contribute to the determination of primary particle masses, to the study of hadronic interaction models with air showers, and, in turn, to the understanding of the muon puzzle. As a part of AMIGA, the underground muon detector consists of two triangular grids with spacings of 433 and 750 m; each grid position is equipped with a 30 m^2 plastic scintillator buried at 2.3 m depth. After the successful completion of the engineering array in early 2018 and general improvements to the design, the production phase commenced. This work aims to report on the status of the underground muon detector, particularly, the progress of its deployment, and the performance achieved after two years of data taking. The detector is foreseen to be fully commissioned by mid-2022.'

Collaborations
Auger,

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Universality of Cherenkov Light in EAS

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 27

Presenter
Isaac Buckland
Author and Co-Author
Isaac Buckland | Douglas Bergman,

Abstract
'Reconstruction of an EAS seen using non-imaging Cherenkov detectors requires simulating the Cherenkov yield of many EAS's with given shower parameters. Since Shower Universality parameterizes both the angular distribution and energy distribution of charged particles within a shower, one can calculate the Cherenkov photon yield (at a fixed point) from the Cherenkov cones of electrons. In this work, we compare both the CWLD (Cherenkov Width Lateral Distribution) and arrival time distributions from Cherenkov universality calculations with those from CORSIKA iact (imaging atmospheric Cherenkov telescope) simulations. Since universality calculations are much less computationally expensive than shower simulation programs like CORSIKA, reconstruction could be accomplished more efficiently using Cherenkov data.'

Collaborations
Telescope Array, nuSpaceSim

Keywords and Comments
'Cherenkov Universality', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Satellite Data for Atmospheric Monitoring at the Pierre Auger Observatory

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
Andrew Puyleart
Author and Co-Author
Andrew Puyleart | For the Pierre Auger Collaboration,

Abstract
'Atmospheric monitoring over the 3000 km^{2} Pierre Auger Observatory can be supplemented by satellite data. Methods for night-time cloud detection and aerosol cross-checking were created using the GOES-16 and Aeolus satellites respectively. The geostationary GOES-16 satellite provides a 100% up-time view of the cloud cover over the observatory. GOES-13 was used until the end of 2017 for cloud monitoring, but with its retirement a method based on GOES-16 data was developed. The GOES-16 cloud detection method matches the observatory's vertical laser cloud detection method at a rate of $\sim$ 90%. The Aeolus satellite crosses the Pierre Auger Observatory several times throughout the year firing UV-laser shots. The laser beams leave a track of scattered light in the atmosphere that can be observed by the light sensors of the observatory's fluorescence telescopes. Using a parametric model of the aerosol concentration, the laser shots can be reconstructed with different combinations of the aerosol parameters. A minimization procedure then yields the parameter set that best describes the aerosol attenuation. Furthermore, the possibility of studying horizontal homogeneity of aerosols across the array is being investigated.'

Collaborations
Auger,

Keywords and Comments
'Atmospheric Monitoring; Clouds; Aerosols; GOES; Satellite; Aeolus; Monitoring; Pierre Auger Observatory', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

TAx4 Hybrid Simulation and Reconstruction

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 10 EAS reconstruction and analyses | CRI
Presenter Forum Table

Presenter
Ricardo Gonzalez
Author and Co-Author
Ricardo Gonzalez, Dmitri Ivanov

Abstract
'The Telescope Array (TA) is the largest cosmic ray detector in the Northern Hemisphere. The experiment measures cosmic rays of energies above 1 EeV and is located in Millard County, Utah, USA. TA detectors consist of a surface detector (SD) of 507 plastic scintillation counters on a grid of 1.2 km, covering 700 sq. km that is overlooked by three fluorescence detector (FD) stations. Following the report of anisotropies in the Northern hemisphere above 10^{19} eV in the TA SD data, as well as the need for a larger data sample to accurately measure cosmic ray mass composition above 10^{19} eV, a fourfold extension of TA, known as the TAx4, began construction in 2018. TAx4 consists of additional plastic scintillator counters deployed on a square grid of 2.08 km spacing and additional fluorescence telescopes placed at the Northern and Southern TA FD sites. In this work, we present the simulation and reconstruction techniques of the TAx4 events detected in hybrid mode.'

Collaborations
Telescope Array,

Keywords and Comments
'telescope array; fluorescence detector; surface detector; hybrid;TAx4;Monte Carlo;', 'For the Telescope Array collaboration'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Feasibility Studies on improved Proton Energy Reconstruction with IACTs

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 28

Presenter
Alicia Fattorini
Author and Co-Author
Alicia Fattorini, Wolfgang Rhode | Dominik Elsaesser | Dominik Baack | Maximilian Noethe

Abstract
'Air showers induced by cosmic protons and heavier nuclei constitute the dominant background for very high energy gamma-ray observations of Imaging Air Cherenkov Telescopes (IACTs). Even for strong very high energy gamma-ray sources the signal-to-background ratio in the raw data is typically less than 1:5000. Therefore, a very large statistic of events, induced by cosmic protons and heavier nuclei, is easily available as a byproduct of gamma-ray source observations. In this contribution, we present a feasibility study on improved reconstruction of the energy of primary protons. For the latter purpose, we used a random forest method trained and tested by using Monte Carlo simulations of the MAGIC telescopes, for energies above 70GeV. We employ the aict-tools framework, including machine learning methods for the energy reconstruction. The open-source Python project aict-tools was developed at TU Dortmund and its reconstruction tools are based on scikit-learn predictors. Here, we report on the performance of the proton energy regression with the well-tested and robust random forest approach.'

Collaborations

Keywords and Comments
'protons; IACT; random forest; energy reconstruction; air shower', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Operations of the Pierre Auger Observatory

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 29

Presenter
Rossella Caruso
Author and Co-Author
Rossella Caruso | For the Pierre Auger Collaboration,

Abstract
'The construction of the first stage of the Pierre Auger Observatory, designed\r\nfor the research of ultra-high energy cosmic rays, began in 2001 with a\r\nprototype system. It has been collecting data since early 2004 and was\r\ncompleted in 2008. The Observatory is placed at 1400 m above sea level\r\nnear Malargüe, (Mendoza province) over a vast plain of 3000 km^2 covered by\r\ndetectors, known as the Pampa Amarilla in western Argentina. It is the first\r\nexperiment characterized by very high performance using the hybrid\r\ntechnique where 1660 water Cherenkov stations, forming the Surface\r\nDetector (SD), and 27 peripheral fluorescence telescopes, comprising the\r\nFluorescence Detector (FD), are operating. With time the Auger Observatory\r\nhas been enhanced with different R&D prototypes and recently subjected to\r\nan important upgrade (AugerPrime).\r\nIn the present contribution, the general operations of the SD and FD will be\r\ndescribed. In particular the FD shift procedure - executable locally in\r\nMalargüe or remotely by teams in control rooms abroad within the\r\nCollaboration - and the newly (operating since 2019) SD shifts will be\r\nexplained. Additionally, the SD and FD maintenance campaigns, as well as\r\nthe data taking and data handling at a basic level, will be reported.'

Collaborations
Auger,

Keywords and Comments
'Pierre Auger Observatory; Fluorescence Detector; Surface Detector; maintenance; shift; data taking; data handling.', ''

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Subcategory Experimental Methods & Instrumentation

Boosting the performance of the neural network using symmetry properties for the prediction of the shower maximum using the water Cherenkov Detectors of the Pierre Auger Observatory as an example

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 30

Presenter
Steffen Hahn
Author and Co-Author
Steffen Hahn | Markus Roth | David Schmidt | Darko Veberic,

Abstract
'To probe physics beyond the scales of human-made accelerators with cosmic rays demands an accurate knowledge of their primary mass composition. Using fluorescence detectors, one is able to estimate this by measuring the depth of the shower maximum $X_\\text{max}$. These, however, exhibit a very low duty cycle of typically below 15 %.\r\n\r\nInferring $X_\\text{max}$ from a surface detector array (SD) such as the water-Cherenkov array of the Pierre Auger Observatory is highly non-trivial due to the inherent complexity and fluctuations of the shower footprint. Moreover, the sheer amount of data makes it non-trivial to find hidden patterns in the spatial and temporal distributions of detector signals. Neural networks provide a straightforward way of tackling such a problem doing a data-driven analysis. \r\n\r\nRelying solely on geometrical quantities, timing, and the signal-time information of the SD stations, we show that by exploiting the symmetries due to their triangular arrangement, we are able to boost a standard analysis network significantly without modifying its architecture or training process. Furthermore, these considerations yield a standardization procedure which also enables us to encode the footprint's information in a memory-efficient way. The presented procedure can also be generalized and extended to systems whose setup has an underlying hexagonal geometry.'

Collaborations

Keywords and Comments
'pierre auger observatory; mass estimation of primary; neural network analysis', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Study of the calibration method using the stars measured by the EUSO-TA telescope

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 31

Presenter
Zbigniew Plebaniak
Author and Co-Author
Marika Przybylak | Zbigniew Plebaniak, Daniele Gardiol | Dario Barghini | Mario Bertaina | for the JEM-EUSO Collaboration | Lech Wiktor Piotrowski | Jacek Szabelski | Kenji Shinozaki | Roman Lipiec | Marco Casolino

Abstract
'EUSO-TA is a ground-based experiment, placed at Black Rock Mesa of the Telescope Array site as a part of the JEM-EUSO (Joint Experiment Missions for the Extreme Universe Space Observatory) program. The fluorescence detector with a field of view of about 11$^\\circ$ x 11$^\\circ$ consisting of 2304 pixels (36 Multi-Anode Photomultipliers, 64 channels each) works with 2.5-microsecond time resolution. An experimental setup with two Fresnel lenses allows for measurements of Ultra High Energy Cosmic Rays in parallel with the TA experiment as well as the other sources like flashes of lightning, artificial signals from UV calibration lasers, meteors or stars. The stars crossing the field of view as the point-like sources, increase counts on pixels. In this work, we discuss the method for calibration of EUSO fluorescence detectors based on signals from stars registered by the EUSO-TA experiment during several campaigns. As the star positions during measurements are known, the analysis of signals gives an opportunity to determine the pointing of the detector. This can be applied to space-borne or balloon-borne EUSO missions. We describe in details the method of the analysis which provides information about detector parameters like the shape of the point spread function and is the way to perform absolute calibration of EUSO cameras.'

Collaborations
, JEM-EUSO

Keywords and Comments
'Cosmic Rays; EUSO-TA; Fluorescence Detector; Absolute calibration; Star UV measurements', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Reconstruction the production depth of muon in air shower

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 32

Presenter
liping wang
Author and Co-Author
liping wang, lingling Ma | cunfeng Feng

Abstract
'One possible way to determine the mass of cosmic rays is to study the longitudinal development of the air shower. The depth of the muon production maximum is sensitive to the nature of the primary particles and also helps to provide insight on whether new physics phenomena take place. The muon detectors of KM2A in Large High Attitude Air Shower Observation (LHAASO) record hitting time and number of muons which reach the ground. The arrival times of the muons allow the reconstruction of their geometrical production heights along the shower axis. The air shower is simulated using CORSIKA with QGSJETII-04 and EPOS-LHC models for the energy of shower about 10 PeV and zenith about 45°, KM2A detectors is simulated with GEANT4. The time decay due to kinematic effect and muon production are studied by tracking the muon in CORSIKA. The distance of muon to the shower core is optimized in order to keep the geometry time delay is the dominant factors. Using the KM2A simulation data, the muon production depth in the air shower is reconstructed according the geometry effect. The reconstructed depth will compare with the production depth of muon in CORSIKA to validate the reconstruction method.'

Collaborations

Keywords and Comments
'Muon production depth', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

A study of analysis method for the identification of UHECR source type

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 33

Presenter
Fugo Yoshida
Author and Co-Author
Fugo Yoshida, Yuichiro Tameda | for the Telescope Array Collaboration

Abstract
'The autocorrelation analysis using the arrival direction of Ultra High Energy Cosmic Rays (UHECRs) has been previously reported by the Telescope Array (TA) experiment. It is expected that the autocorrelation function reflects the source distribution. We simulate the expected arrival direction distribution of the cosmic rays using the catalogs of candidate sources. We take into account random deflection in the magnetic fields, with the magnitude of deflection determined by the charge and energy of the cosmic rays, coherence length and magnitude of the extragalactic magnetic field, and by distance to source. In addition, in order to compare with the results of TA, we consider the TA exposure. We compare the autocorrelation of the arrival directions corresponding to different source catalogs with the isotropic distribution. We calculate the autocorrelation function for each type of source candidates using this procedure. We will discuss the ability of this method to identify the source type of UHECRs.'

Collaborations
Telescope Array,

Keywords and Comments
'UHECR; anisotropy; EGMF; radio galaxy; autocorrelation', ''

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Subcategory Experimental Methods & Instrumentation

K-EUSO detector with refractive optical system

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 34

Presenter
Sergei Sharakin
Author and Co-Author
Sergei Sharakin, Pavel Klimov | Yoshiyuki Takizawa | Anastasiia Perevoznikova

Abstract
'The K-EUSO detector is the central project of the JEM-EUSO international collaboration, the purpose of which is to measure the UV fluorescence due to extensive air shower produced by ultra-high-energy cosmic rays from the ISS. Over the years, the design of the detector has undergone various changes associated with both funding constraints and technical difficulties. In particular, to meet the requirements for the transportation and deployment of the equipment, a new engineering model was developed with a rectangular aperture of 120 by 240 cm, which made it possible to minimize the number of optical segments. In this case, the most natural variant of the optical design turned out to be a two-lens telescope, in which three of the four optical surfaces are Fresnel, and the fourth one is a diffractive. We present the values of the parameters of all surfaces obtained as a result of optimization in Zemax in a field of view of 36 degrees are given. All optical surfaces are spherical with a radius of curvature of 5.5 m, the concave focal surface has a radius of curvature of 2 m. A more detailed assessment of the characteristics of the optical system (efficiency, image size and resolution) was made with special ray tracing code. The full exposure of the K-EUSO telescope, taking into account portion of night measurements at the level of 14%, will be almost 2*10^4 km2 sr year.\r\nThe possibility of manufacturing lenses with a Fresnel and diffractive structure of this type is shown. At present, the production of the first lens from PMMA material transparent in the near UV on RIKEN high-precision equipment has begun.'

Collaborations
other (fill field below), JEM-EUSO

Keywords and Comments
'Orbital detector; UV telescope; Optical system', ''

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Subcategory Experimental Methods & Instrumentation

Atmospheric depth Models in the Field of View of LHAASO-WFCTA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 35

Presenter
J.J Xia
Author and Co-Author
J.J Xia, H.Y Jia | F.R Zhu

Abstract
"Tne of the main components of the Large High Altitude Air Shower Observatory\xa0(LHAASO) located in Daocheng, China. WFCTA detects cosmic rays by detecting photons generated by secondary particles of atmospheric showers. Changes in atmospheric depth in WFCTA's field of view will lead to changes in the number of photons in WFCTA. Therefore, the variation of atmospheric depth in the WFCTA is of great significance for the quantitative study of the variation of cosmic ray observation by WFCTA. In this paper, the temporal variation of atmospheric depth at LHAASO is studied based on the MSISE-90 atmospheric model, and the comparison of MSISE-90 atmospheric model with the American standard atmospheric model, satellite experimental data, and meteo data at LHAASO station. We fitted MSISE model data in the operation period of WFCTA to develop a new LHAASO Atmospheric depth model."

Collaborations
Lhaaso,

Keywords and Comments
", "

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Subcategory Experimental Methods & Instrumentation

Study of Longitudinal Development of Cosmic-Ray Induced Air Showers with LHAASO-WFCTA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 36

Presenter
hu liu
Author and Co-Author
hu liu,

Abstract
'The Wide Field of View Cherenkov Telescope Array (WFCTA) is an important component of Large High Altitude Air Shower Observatory(LHAASO), which aims to measure the individual energy spectra of cosmic rays from ~30TeV to a couple of EeV. WFCTA consisting of 18 imaging air Cherenkov telescopes, each have 32 × 32 pixels, covering a field of view 16o × 16o (each pixel corresponding to 0.5o × 0.5o), The first telescope started in operation since February 2019, up to now, there are 16 telescopes in operation. Since the Cherenkov photon detected by different pixels were generated at different height (or different traversed material), we reconstruct a function from the image of WFCTA, which describe the air shower longitudinal development along the shower axis (similar to the longitudinal distribution function of air shower). In this paper, the energy reconstruction and particle identification will be studied based on this function with MC simulated events. Comparison of the development function between data and MC will also be shown.'

Collaborations
Lhaaso,

Keywords and Comments
'longitudinal development; Cherenkov telescope; energy reconstruction; particle identification', ''

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Subcategory Experimental Methods & Instrumentation

Study of Energy Measurement of Cosmic Ray Nuclei with LHAASO

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
hu liu
Author and Co-Author
hu liu,

Abstract
'The Large High Altitude Air Shower Observatory(LHAASO) is a hybrid extensive air shower(EAS) array with an area of about 1km2 at an altitude of 4410 m a.s.l. in Sichuan province, China. It contains three sub-detectors: 1 km2 array (LHAASO-KM2A) composed of electromagnetic particle (ED) and muon detectors (MD); water Cherenkov detector array(LHAASO-WCDA) and 18 wide field-of-view air Cherenkov telescopes(LHAASO-WFCTA). One of the main scientific goals is measuring the individual energy spectra of cosmic rays from ~30TeV to a couple of EeV. Up to now, the whole WCDA, ¾ of KM2A, 16 telescopes have been in operation. In this paper, the energy reconstruction method and result of cosmic ray nuclei based on KM2A and WFCTA simulated events will be shown, the reconstructed energy difference between KM2A and WFCTA is also compared between data and MC.'

Collaborations
Lhaaso,

Keywords and Comments
'LHAASO; Nuclei; Energy reconstruction', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Current Status of electromagnetic particle detectors for LHAASO-KM2A

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table 37

Presenter
jia liu
Author and Co-Author
jia liu | Xiangdong Sheng | Xiaopeng Zhang | Jing Zhao | 超 侯 | Hongkui Lv | Quanbu Gou,

Abstract
'The Large High Altitude Air Shower Observatory (LHAASO) is a new generation hybrid cosmic ray observatory which is expected to reveal the mystery of the origin of cosmic rays. The one square kilometer array (KM2A) containing 5242 Electromagnetic particle Detectors (ED) and 1188 Muon Detectors (MD) is a sub-array of the LHAASO. The EDs are designed to measure the density and arriving time of the secondary particles of cosmic rays.\r\n 1/2 scale KM2A have been in operation from Decemember 2019 to November 2020. KM2A reaches its 3/4 scale by December 2020. 3978 electromagnetic particle detectors (EDs) and 917 muon detectors (MDs) are now in stable operation. In this paper, we will introduce the construction process of ED, the performances and long-term stability of the detectors.'

Collaborations
Lhaaso,

Keywords and Comments
'LHAASO-KM2A; Electromagnetic particle detector; performance; long-term stability', ''

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Subcategory Experimental Methods & Instrumentation

Optimization of CoREAS simulations for the GRAND project

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 38

Presenter
Chao Zhang
Author and Co-Author
Chao Zhang | Tim Huege | Tanguy Pierog for the GRAND collaboration,

Abstract
"Abstract: A planned array of 200,000 antennas covering an area of 200,000 km^{2} - the GRAND project - is proposed to detect cosmic-ray,gamma-ray, and neutrino primaries in the energy range beyond 10^{17}eV. The GRAND array will be able to detect upward-going air showers initiated by neutrino interactions in the rocks on its mountainous site, furthermore, it may also detect very inclined and atmosphere-skimming air showers initiated by cosmic rays. So the corresponding shower geometry differs from the other experiments and asks for a detailed investigation. To meet the requirements of GRAND, we develop an update of CORSIKA7 for the simulation of upward-going air showers. Furthermore, we apply today's best knowledge of parameters of the GRAND project, in particular realistic on-site atmospheres, in an extensive library of inclined air showers. Finally, we evaluate expected signal-to-noise ratios and detection thresholds for the GrandProto300 phase of GRAND."

Collaborations
other (fill field below), GRAND

Keywords and Comments
'GRAND; CoREAS; CORSIKA7; Upward-going air shower; S/N ratio', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Design and simulation of a cost-affordable Cosmic Ray Muon Tomographer

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 39

Presenter
Javier Rengifo Gonzáles
Author and Co-Author
Javier Rengifo Gonzáles, Jose Bazo

Abstract
'Atmospheric muons can be used to image a volume due to multiple Coulomb scattering and absorption of different materials. This work presents the design and CORSIKA/Geant4 simulation of a prototype composed of an array of detectors. The detectors are based on plastic scintillators and silicon photomultipliers targeting new and cost-affordable technology. In order to image a volume we study the possibility to discriminate different materials (e.g. lead, concrete, iron, water, aluminum) by measuring the absorption and incoming and outgoing angles of muons passing through these materials. We optimize the geometry and angular resolution of the array using simulations with the aim to scan structures such as large buildings and natural formations with muon tomography.'

Collaborations

Keywords and Comments
'Simulation; Cosmic Rays; Muons; Tomography; Detectors', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Update of the Offline Framework for AugerPrime

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 40

Presenter
Lukas Nellen
Author and Co-Author
Lukas Nellen | for the Pierre Auger Collaboration,

Abstract
'Work on the Offline Framework for the Pierre Auger Observatory was started in 2003 to create a universal framework for event reconstruction and simulation. The development and installation of the AugerPrime upgrade of the Pierre Auger Observatory require an update of the Offline Framework to handle the additional detector components and the upgraded Surface Detector Electronics.\r\n\r\nThe design of the Offline Software proved to be sufficiently flexible to accommodate the changes needed to be able to handle the AugerPrime detector. This flexibility has been a goal since the development of the code started. The Framework separates data structures from processing modules. The detector components map directly onto data structures. It was straightforward to update or add processing modules to process the additional information from the new detectors.\r\n\r\nWe will discuss the general structure of the Offline Framework, explaining the design decisions that provided its flexibility and point out the few of the features of the original design that required deeper changes, which could have been avoided in hindsight. Given the disruptive nature of the AugerPrime upgrade, the developers decided that the update for AugerPrime was the moment to change also the language standard for the implementation and move to the latest version of C++, to break strict backward compatibility eliminating deprecated interfaces, and to modernize the development infrastructure. We will discuss the changes that were made to the structure in general and the modules that were added to the Framework to handle the new detector components.'

Collaborations
Auger,

Keywords and Comments
'Air Shower; Software', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

The upgrade of the Pierre Auger Observatory with the Scintillator Surface Detector.

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Gabriella Cataldi
Author and Co-Author
For the Pierre Auger Collaboration | Gabriella Cataldi,

Abstract
'Since its full commissioning in 2008, the Pierre Auger Observatory has consistently demonstrated its scientific productivity. A major upgrade of the Surface Detector array (SD) improves the capabilities of measuring the different components of extensive air showers. One of the elements of the upgrade consists of new Scintillator Surface Detectors (SSD) placed on top of the Water-Cherenkov stations of the SD. At the Observatory, the integration of the SSD components and their deployment in the array is well advanced. In this paper, the main challenges and characteristics of the construction and installation will be reviewed. Started in 2016, an Engineering Array of twelve upgraded stations has been taking data in the field. In addition, 77 SSDs started data acquisition in March 2019, increasing the wealth of events at higher energies. The performance for several different stations will be discussed. The data collected so far demonstrate the quality of the new detectors and the physics potential of the upgrade project.'

Collaborations
Auger,

Keywords and Comments
'Pierre Auger Observatory; Ultra High Energy Cosmic Rays; UHECR; Extensive air showers; AugerPrime; Instrumentation and Methods for Astroparticle Physic; Pierre Auger Observatory upgrade', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

TA SD energy and arrival direction estimation using deep learning

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 41

Presenter
Oleg Kalashev
Author and Co-Author
Oleg Kalashev,

Abstract
'A novel ultra-high-energy cosmic rays energy and arrival direction reconstruction method for Telescope Array surface detector is presented. The analysis is based on a deep convolutional neural network using detector signal time series as the input and the network is trained on a large Monte-Carlo dataset. This method is compared in terms of statistical and systematic energy and arrival direction determination errors with the standard Telescope Array surface detector event reconstruction procedure.'

Collaborations
Telescope Array,

Keywords and Comments
'ultra-high-energy cosmic rays; machine learning; event reconstruction;Telescope Array surface detector', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

A lightning detection system for studying transient phenomena in cosmic rays observatories

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
Jesús Peña-Rodríguez
Author and Co-Author
Jesús Peña-Rodríguez | Luis A. Núñez | Pedro Salgado-Meza | Leonardo Flórez-Villegas,

Abstract
'Transients of the atmospheric electric field could cause anomalous events in the surface particle detectors of cosmic ray observatories. A better understanding of these incidents requires more accurate lightning data at the observation sites. We present the design and implementation of a monitoring system capable of detecting and storing lightning discharges. The acquisition window per event contains information of the first return stroke and the subsequent ones during 1.2 seconds at a sampling frequency of 100 kHz. The acquisition timing resolution (10 ns) allows a lightning strike location error < 10 m. The station also records environmental data, containing temperature, barometric pressure, relative humidity, and steady-state atmospheric electric field. A GPS receiver provides the absolute time of the station. 3-dimensional mapping of lightning discharge can be reconstructed in detail using a monitoring network of at least three stations. \r\nWe present preliminary measurements during a thunderstorm episode (2019-11-09). The event lasts about 2 hours, recording a maximum electric field peak $\\sim$-15 kV/m. The atmospheric potential was $\\sim$27 MV with an estimated thunderstorm cloud-base height of $\\sim$2 km. At least four lightning events occurred during the thunderstorm period. Such discharges released an electric field >5 kV/m.'

Collaborations

Keywords and Comments
'lightning detection; cosmic ray observatories; fake events', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Reconstruction of Nearly-Horizontal Muons in the HAWC Observatory

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 10 EAS reconstruction and analyses | CRI
Presenter Forum Table

Presenter
R. Wayne Springer
Author and Co-Author
R. Wayne Springer | for the HAWC Collaboration,

Abstract
'The volcanoes surrounding the HAWC observatory provide varying material depths from open sky to over 15 km of rock for nearly-horizontal muon trajectories. The measurement of the rate of muons as a function of arrival direction near the horizon thereby provides a means to measure the muon flux as a function of material depth. A Hough transform algorithm is used to identify nearly-horizontal muons traversing the HAWC observatory by finding a line in the 3d point cloud of PMT hits (x_{i},y_{i}, and ct_{i}). The arrival direction of the muon can be estimated from this line. Background Extensive Air Shower (EAS) fragments are identified by the presence of a lateral extension of PMT hits in a plane normal to the muon candidate trajectory. A geometry-based simulation has been developed to improve and estimate arrival direction reconstruction resolution and effective area. A description of the reconstruction techniques and estimates of detector resolution, backgrounds, and effective area as a function of arrival direction, will be provided.'

Collaborations
HAWC,

Keywords and Comments
'Cosmic Rays Muons', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

The status of the TALE surface detector array and a TALE infill project

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Shoichi Ogio
Author and Co-Author
Shoichi Ogio | For the Telescope Array collaboration,

Abstract
'Routine hybrid observations of the surface detectors (SD) in conjunction with the fluorescence detectors (FD) of the Telescope Array Low-energy Extension (TALE) began in November 2018. In this presentation, we will describe the simulation studies of detector aperture and resolution of the TALE SD, and report on the latest observation results other than the energy spectrum. We are also in the process of expanding the experiment by 50 SDs, with even smaller nearest-neighbor spacing, in order lower the energy threshold to match that of the Cherenkov-dominated events seen by the FD. Details of the upgrade and expected performance of this new extension will be discussed.'

Collaborations
Telescope Array,

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Geometry and optics calibration of WFCTA telescopes using star light

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 42

Presenter
Suhong Chen
Author and Co-Author
Suhong Chen | Lingling Ma | Yudong Wang | Shoushan Zhang,

Abstract
'Wide field of view of Cherenkov telescope array (WFCTA) is one of main detectors of LHAASO project. The main scientific goal of WFCTA is to study the energy spectrum and composition of cosmic rays. The primary energy reconstruction and mass sensitive parameter (e.g. length and width), relies on the shape of the Cherenkov image on the camera. The pointing accuracy of each telescope is crucial for the direction reconstruction for the primary particles. UV bright stars are used to calibrate the pointing of the telescope and to study the optical properties of the camera, the spot size of the mirror. The first WFCTA telescope started its operation at the end of January 2019 at LHAASO site, eight more in January 2020 and sixteen more in January 2021. The preliminary results of the pointing and the optical properties of the camera will be shown in the paper.'

Collaborations
Lhaaso,

Keywords and Comments
", "

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

An Advanced Triggerless Data Acquisition System for GRAPES-3 Muon Detector

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Atul Jain
Author and Co-Author
Atul Jain,

Abstract
'The GRAPES-3 experiment operated in Ooty, India is designed to record the electron and muon components of extensive air showers (EAS). The signal processing and DAQ system have been going through systematic upgrades. Currently, GRAPES-3 is operating 400 plastic scintillators of size 1 m^2 spread over an area of 25000 m^2 and 3712 proportional counters (PRCs) divided into 16 modules with a total area of 560 m^2 providing for an angular resolution of ~4$^\\circ$. The muon detector is being doubled in area through the addition of another 16 modules. An advanced triggerless muon DAQ with a design based on compact embedded system has been developed to enhance physics capabilities. This will open a new window on several physics fronts such as, a) precise measurement of the muon flux for thunderstorm studies, b) study of large angle EAS using the muon component, c) search for exotic particles characterised by early or delayed arrivals. Some of the key salient features of the new triggerless DAQ system are – continuous recording of signals from all PRCs, precise time stamp with a resolution of 10 ns with GPS synchronization, enabling the generation of any physics motivated triggers offline. The system has negligible dead time (~0.001% compared to ~11% for the legacy DAQ system) and it has been already deployed for 4 muon modules consisting of 928 channels. The design and features of this system will be presented.'

Collaborations
, GRAPES-3

Keywords and Comments
'GRAPES-3; FPGA; Embedded systems; DAQ', 'For the GRAPES-3 collaboration'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Adaptive predictor as trigger mechanism for cosmic ray radio signals corrupted by Gaussian noise

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Clara Watanabe
Author and Co-Author
Clara Watanabe, João de Mello Neto | Paulo Diniz

Abstract
'Adaptive filtering belongs to the realm of learning algorithms, so widely used in our daily life when we hear about machine learning, artificial intelligence, pattern recognition, etc. It is formally defined as a self-designing device with time-varying parameters that are adjusted recursively in accordance with the input data.\r\n\r\nThe trigger mechanism is known to be a central task in radio detection experiments as it selects among all the voltages traces events that reach the antennas, a cosmic ray induced signal. \r\n\r\nIn this work, it is presented the efficiency of a trigger mechanism developed using the adaptive predictor filter technique, since its capability is well known in the usage for time series prediction. It is also independent of an external detector, considering only the online temporal series that arrives in the antennas in a simulated data set and Gaussian noise.'

Collaborations
other (fill field below), GRAND

Keywords and Comments
'radio; trigger; adaptive filters', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

"Chronotron" timing detectors for EAS studies

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 43

Presenter
Aliya Baktoraz
Author and Co-Author
Aliya Baktoraz | Nurzhan Saduyev | Orazaly Kalikulov | Dmitriy Beznosko | Yerzhan Mukhamejanov | Saken Shinbulatov | Shynbolat Utey | Nurzhan Yerezhep | Askhat Zhumabayev | Valeriy Zhukov | Alexander Shepetov,

Abstract
'The EAS detector system consisting of timing detection is being built for the reconstruction of the EAS axis direction using chronotron timing information. This system consists of eight scintillator-based individual detectors (100 x 100 x 1 cm) using wavelength shifting fibers for light collection. The goal of the project is to supplement the Horizon-T detector system that is located at the elevation of 3340 m at the TSHASS near the city of Almaty, Kazakhstan, with the system of detectors with fast timing. To improve the pulse time resolution beyond the several ns that is available for the scintillator-based systems, the approach to use the optical glass as the particle detection medium is also being tested. This work presents the current design, the characteristics from the simulation and the performance of the prototype.'

Collaborations

Keywords and Comments
'EAS; cosmic rays', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Denoising cosmic rays radio signal using Wavelets techniques

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Clara Watanabe
Author and Co-Author
Clara Watanabe, João de Mello Neto | Tim Huege | Diniz Paulo

Abstract
'*Fourier* transform of a signal *f* computes the correlation between *f* and the (frequency ranged) orthogonal basis of sines. Although this brings relevant information, the limitation is clear when we want to detect singularities in the signal. The uncertainty principle states that the energy spread of a function and its *Fourier* transform cannot be simultaneously arbitrarily small. As the *Fourier* transform, the *Wavelet* transform computes the correlation between *f* and the orthogonal basis of a *Wavelet* mother. In other words, a single wavelet mother is stretched, expanded, and translated in time. It can measure the time-frequency variation of spectral components, but it has a different time-frequency resolution, allowing the characterization of transients with a zooming procedure across scales.\r\nThe estimation of a signal embedded in noise requires taking advantage of any prior information about the signal and noise. Until recently, signal processing estimation was mostly Bayesian and linear. Non-linear smoothing algorithms existed in statistics, but these procedures were often ad-hoc and complex. Donoho and Johnstone proved that a simple thresholding algorithm on an appropriate basis can be a nearly optimal non-linear estimator. A radio signal induced from cosmic ray, is very well described, for example, by the Daubechies wavelets as a basis, allowing the thresholding to be as safe (or more) as a linear estimation. The performance of thresholding may also be improved with the best basis search or a pursuit algorithm that adapts the basis to the noisy data.\r\nThis work presents the wavelets as a denoising technique both for narrowband and gaussian background reduction in radio signals induced from cosmic rays, presenting its efficiency in energy reconstruction.'

Collaborations

Keywords and Comments
'radio signals cosmic rays; denoising; wavelets', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

The EOSC-Synergy cloud services implementation for the Latin American Giant Observatory (LAGO)

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 44

Presenter
Hernán Asorey
Author and Co-Author
Antonio Juán Rubio Montero | Raúl Pagán Muñoz | Iván Sidelnik | Hernán Asorey | Rafael Mayo García | for the LAGO Collaboration,

Abstract
"The Latin American Giant Observatory (LAGO) is a distributed cosmic ray observatory at a regional scale in Latin America, by deploying a large network of Water Cherenkov detectors (WCD) and other astroparticle detectors in a wide range of latitudes from Antarctica to México, and altitudes from sea level to more than 5500 m a.s.l.\r\n\r\nDetectors telemetry, atmospherics conditions and flux of secondary particles at the ground are measured with extreme detail at each LAGO site by using our own-designed hardware and firmware (ACQUA). To combine and analyse all these huge amounts of data produced by ACQUA, LAGO developed ANNA, our data analysis framework. Additionally, ARTI, a complete framework of simulations was designed and implemented to simulate the expected signals in our detectors coming from primary cosmic rays entering the Earth atmosphere, allowing a precise characterization of the sites at different atmospheric, geomagnetic and detector conditions.\r\n\r\nAs the measured and simulated data started to flow, we are facing a challenging scenario given the large amount of data emerging from our detectors and from the computational simulations we performed on a diversity of computing architectures and e-infrastructures. All these data need to be transferred, analyzed, catalogued, preserved, and provided for internal and public access and data-mining under an open e-Science environment. In this work, we present and describe the implementation of ARTI on the EOSC-Synergy cloud-based services as the first example of LAGO' frameworks that will follow the FAIR principles, enabling the provenance, data-curation and re-using of data. Moreover, we show how this deployment could help not only LAGO data production and analysis but other data-intensive cosmic rays observatories and muography experiments."

Collaborations
other (fill field below), LAGO

Keywords and Comments
'Big-dat; cloud-services; EOSC; astroparticle data; astroparticle simulations', "Don't know why co-authors are not allowed. This contribution has one presenter but five main authors and the collaboration"

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Expected performance of the AugerPrime Radio Detector

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 45

Presenter
Felix Schlüter
Author and Co-Author
Felix Schlüter,

Abstract
'The AugerPrime Radio Detector will significantly increase the sky coverage of mass-sensitive measurements of ultra-high energy cosmic rays with the Pierre Auger Observatory. The detection of highly inclined air showers with the world’s largest 3000 km^2 radio-antenna array in coincidence with the Auger water-Cherenkov detector provides a clean separation of the electromagnetic and muonic shower components. The combination of these highly complementary measurements yields a strong sensitivity to the mass-composition of cosmic rays.\r\nWe will present the first results of an end-to-end simulation study of the performance of the AugerPrime Radio Detector. The study features a complete description of the AugerPrime radio antennas and reconstruction of the properties of inclined air showers, in particular the electromagnetic energy. The performance is evaluated utilizing a comprehensive set of simulated air showers together with recorded background. The estimation of an energy- and direction-dependent aperture yields an estimation of the expected 10-year event statistics. The potential to measure the number of muons in air showers with the achieved statistic is outlined. Based on the achieved energy resolution, the potential to discriminate between different cosmic-ray primaries is presented.'

Collaborations
Auger,

Keywords and Comments
'Cosmic Ray; Mass separation; Reconstruction; Extensive Air Shower; Radio', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

TAROGE experiment and reconstruction technique for near-horizon impulsive radio signals induced by Ultra-high energy cosmic rays

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table 46

Presenter
Yaocheng Chen
Author and Co-Author
Yaocheng Chen | Pisin Chen | Jian-Jung Huang | Ming-Huey A. Huang | Chung-Yun Kuo | Tsung-Che Liu | Jiwoo Nam | Yu-Shao Shiao | Min-Zu Wang | Shih-Hao Wang | Yu-Hsin Wang,

Abstract
'Taiwan Astroparticle Radiowave Observatory for Geo-synchrotron Emissions (TAROGE) is antenna arrays sitting on high coastal mountains of Taiwan, pointing to the Pacific Ocean for the detection of near-horizon extensive air showers (EAS) induced by ultra-high energy cosmic rays and Earth-skimming tau neutrinos. TAROGE would improve the detection capability by collecting both the direct-emissions and the ocean-reflected signal on a vast area of ocean which is visible from Taiwan's high mountains. Four TAROGE stations in Taiwan have been deployed in the past few years. Except for the first station, which is a prototype station for the purposes of radio survey and optimization of instrument parameters, other three stations are still operating.\r\nWe develop a new angular reconstruction method based on a deconvolution of radio reflection on the ground which is an important systematic effect for the near-horizon events. The response of the ground reflection is measured with a drone-borne calibration pulser. We achieved a sub-degree angular resolution for near horizon event. In this paper, we discuss details of the method and the results. A brief status report of the TAROGE project will also be reported.'

Collaborations
other (fill field below), TAROGE

Keywords and Comments
'Ultra high energy cosmic rays; Radio wave; Angular reconstruction; Drone-borne calibration', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

High-mountain hybrid installation for multicomponent detection of air-showers induced by ultra-high energy cosmic rays

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 47

Presenter
Saken Shinbulatov
Author and Co-Author
Saken Shinbulatov | Nurzhan Saduyev | Dmitriy Beznosko | Orazaly Kalikulov | Valeriy Zhukov | Yerzhan Mukhamejanov | Dmitriy Kostunin | Aliya Baktoraz | Nurzhan Yerezhep | Shynbolat Utey | Askhat Zhumabayev | Pavel Bezyazeekov | Oleg Fedorov,

Abstract
"Measuring the fluxes of ultra-high energy cosmic rays is a unique tool for studying and testing physics beyond the standard cosmological and elementary particle interaction models. The observation of their fluxes above PeV is of particular interest, since the detection of extensive air-showers produced by these particles allows testing the energy range that is beyond the reach of modern colliders.\r\nIt is proposed to deploy a new setup consisting of several high-frequency antennas and combine it with the existing Horizon-T setup into a single complex, which allows simultaneous studies of the phenomena of charged particles delayed from the air-shower front.\r\nThe modernized hybrid installation will detect the charged particles and radio emission from air-showers, which allows us to probe in high-resolution space and time distributions in the air-shower cores arriving at the installation at zenith angles up to 85°. This will make it possible to search for exotic particles and new processes beyond standard model that arise during the propagation of cosmic rays through the Earth's atmosphere.\r\nIn this work we present our plans on the development and deployment of a new hybrid installation and the details of the technical implementation of new detectors."

Collaborations

Keywords and Comments
'cosmic rays; extensive air showers; exotic particles; antenna;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Development of bases and qualification tests of Photomultiplier Tubes for the AugerPrime scintillation detectors

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 48

Presenter
Julian Rautenberg
Author and Co-Author
Karl-Heinz Becker | Urs Grosse-Rhode | Karl-Heinz Kampert | Stephan Keller | Christian Pauly | Jannis Pawlowsky | Dennis Pfeifer | Julian Rautenberg | Simon Strotmann | Rukije Uzeiroska | Natalia Weimer,

Abstract
'We describe two test benches that were designed and constructed to perform a set of acceptance tests for about 1200 Photomultiplier Tube (PMT) units to be operated in the surface scintillation detectors of AugerPrime. Besides robustness, long-term reliability, and low power consumption, the dynamic range of the PMT-unit is required to cover signals ranging from a single to more than 20,000 minimum ionizing particles with not more than 5% deviation from linear response. This poses a particular challenge that was met by combining a specially selected 1.5“ PMT type with a custom-made Cockcroft Walton type base. The characteristics of the PMT units and qualification results obtained for a large quantity will be presented and discussed.\r\nBesides measuring the gain and linearity for each PMT-unit for different supply voltages, we also measured for a sub-sample of about 10% the quantum-efficiency of the photocathode as a function of wavelength and its homogeneity across the full photocathode area with 1 mm spatial resolution. The latter is of importance because of the fiber-optical readout of the scintillation detectors.'

Collaborations

Keywords and Comments
'PMT qualification test setup; high linearity photon detection; quantum-efficiency homogeneity', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Simulating the signal of the AMIGA underground detectors of the Pierre Auger Observatory

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 49

Presenter
Ana Martina Botti
Author and Co-Author
Ana Martina Botti | Federico Sánchez | Markus Roth | Alberto Etchegoyen,

Abstract
'In this work, we present a detailed description of the simulation development and validation of the underground detector signal for the Auger Muons and Infill for the Ground Array (AMIGA), a low-energy enhancement at the Pierre Auger Observatory. To this aim, the detection system was thoroughly characterized in the laboratory. It consists of plastic-scintillator strips with optical fibers that conduct light towards silicon photomultipliers whose output is then processed with two complementary read-out channels. These measurements allowed us to design a fast and reliable simulation chain that fully reproduces the signal of single muons impinging on the scintillators.'

Collaborations

Keywords and Comments
'', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Influence of Simultaneous particles on the LAGO's Water Cherenkov Detectors

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 50

Presenter
Luis Otiniano
Author and Co-Author
Luis Otiniano | Franz Machado | Christian Sarmiento Cano | Mauricio Suárez-Durán | Hernán Asorey | for the LAGO Collaboration,

Abstract
"The Latin American Giant Observatory (LAGO), operates an extensive network of Water Cherenkov Detectors (WCD) by a non-centralized and collaborative network of Universities and Research Institutes in Iberoamerica. To estimate the charge distribution produced by secondaries particles interacting with WCDs, LAGO developed a simulation framework (ARTI). ARTI comprises a chain of simulations that starts with the well known primary flux of galactic cosmic rays that reach Earth and finish estimating the expected WCDs signals at any site on ground.\r\n\r\nBased on the first stage of ARTI, that uses COSIKA to simulate the expected flux of secondaries that reach LAGO sites, we re-analyze this flux searching for simultaneous particles reaching the detectors. We perform a spatial analysis of CORSIKA's simulated air showers in the field of view of four typical WCD in extreme sites of the LAGO network and in time windows of the electronic acquisition system.\r\n\r\nWe have found that simultaneous particles reaching the WCD modify the deposited energy distribution into the detector even for low energy range and low altitude sites, compared with the previous single-particle approach. This result impacts the WCD's calibration and could play an important role in discriminating primaries and defining observables for GRBs detection at high altitude LAGO sites."

Collaborations
, LAGO

Keywords and Comments
'LAGO; WCD; secondary cosmic rays', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Calibration system of EAS Cherenkov arrays using commercial drone helicopter.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 51

Presenter
Almaz Fazliakhmetov
Author and Co-Author
Dmitry Voronin | Almaz Fazliakhmetov,

Abstract
'EAS Cherenkov arrays are a powerful instrument for studies of primary cosmic rays in a wide range of energy. In this approach the Earth’s atmosphere is used as a calorimeter providing EAS Cherenkov arrays high energy resolution. Another advantage of the method is its high time resolution which results in a good angular resolution. Usually EAS Cherenkov array is a sparsely instrumented array with a distance of 100 m (or more) between individual Cherenkov photon detectors (optical stations/modules) covering hundreds of square meters or a few thousands of square kilometers. So, to calibrate such arrays is not simple task. We developed a calibration system of EAS Cherenkov arrays based on a single fast light source on board of remotely controlled commercial drone helicopter. The light source is based on a single high power blue InGaN LED driven by avalanche transistors driver. The light source provides light pulses with 2-3 ns (FWHM) width and 10^10-10^11 photons per pulse. Preliminary results of test flights of the calibration system are presented.'

Collaborations

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Application of the nitrogen laser calibration system in LAASO-WFCTA

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Xin Li
Author and Co-Author
Xin Li, Lisi Geng | Qinning Sun | Junji Xia | Long Chen | Hu Liu | Yang Wang | Fengrong Zhu | Yong Zhang

Abstract
"The nitrogen laser calibration system for the Wide Field of View Cherenkov Telescope Array (WFCTA) is one of the most important components of the Large High Altitude Air Shower Observatory (LHAASO). This calibration system is composed of three parts, including a high-precision 3D lifting and rotating platform (HiRoP), a nitrogen laser and the wide field of view Cherenkov telescope prototypes. The accuracy of the HiRoP is of great importance for the precise calibration of WFCTA since it controls the laser beam's pointing direction. A home-made HiRoP was then introduced and the measurements showed the angular and lifting accuracies of HiRoP were better than 0.004° and 0.075 mm, respectively. In addition, the corresponding repeatabilities of HiRoP were better than 0.003° and 0.025 mm, respectively. Furthermore, the pulse energy stability of the nitrogen laser beam is another remarkably important factor. The nitrogen laser system with a wavelength of 337.1 nm located in a high-precision temperature and humidity's controlling container, resulting in a pulse energy fluctuation less than 3 percent. Besides, the method of a standard zero verification was employed to improve the long-term accuracy of the beam pointing direction. Finally, we obtained the repeatability of 0.049° for the focal imagines on the camera in the WFCT after a 15-day's statistical measurements. These results indicate that our calibration system meets the requirements of the LHASSO for a long-term observation."

Collaborations

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

First results from the AugerPrime Radio Detector

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table 52

Presenter
Tomáš Fodran
Author and Co-Author
Tomáš Fodran,

Abstract
'The Pierre Auger Observatory investigates the properties of the highest-energy cosmic rays with unprecedented precision. The aim of the AugerPrime upgrade is to improve the sensitivity to the primary particle type. The improved mass sensitivity is the key to exploring the origin of the highest-energy particles in the Universe. The purpose of the Radio Detector (as part of AugerPrime) is to extend the sensitivity of the mass measurements to zenith angles above 60°. A radio antenna, sensitive in two polarization directions and covering a bandwidth from 30 to 80 MHz, will be added to each of the 1661 surface detector stations over the full 3000 km² area, forming the world's largest radio array for the detection of cosmic particles. Since November 2018, an engineering array\r\ncomprised of ten stations has been installed in the field.\r\nThe radio antennas are calibrated using the Galactic (diffuse) emission. The sidereal modulation of this signal is monitored continuously and is used to obtain an end-to-end calibration from the receiving antenna to the ADC in the read-out electronics. The calibration method and first results will be presented.\r\nThe engineering array is also fully integrated in the data acquisition of the Observatory and records air showers regularly. The first air showers detected simultaneously with the water-Cherenkov detectors and the Radio Detectors will be presented. Simulations of the detected showers, based on the reconstructed quantities, have been conducted with CORSIKA/CoREAS. A comparison of the measured radio signals with those predicted by simulations exhibits satisfying agreement.'

Collaborations
Auger,

Keywords and Comments
'comic rays; air showers; radio detector; galactic calibration', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Calibration of LHAASO-WFCTA

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Long Chen
Author and Co-Author
Long Chen, Lisi Geng | Xin Li | Hu Liu | Qinning Sun | Yang Wang | Junji Xia | Fengrong Zhu | Yong Zhang

Abstract
'The Wide Field of View Cherenkov Telescope Array (WFCTA) of Large High Altitude Air Shower Observatory(LHAASO) is designed to measure the extensive air showers created by cosmic rays from ~30 TeV to several EeV. In order to employ an end-to-end calibration method for WFCTA, four laser lidar systems have been developed successfully and installed at the LHAASO. Two N2 lasers with the 337.1 nm wavelength have been operating continuously since October 2019 and a YAG laser with wavelength of 355 nm, has been running since December 2020. In this presentation, the performance of the N2 and YAG lasers at the an altitude of 4410 m are introduced in detail. Great cares were taken to select the laser events data observed by telescopes at clear nights for our analyses with the help of infrared cloud instrument on-site. After excluding the inconsistency of all SiPMs of telescope, we are able to obtain the calibration gains or the detection efficiency for each telescope by matching the observed light flux with the expected one at the entrance of the telescope. Furthermore, we will discuss the systematic uncertainties for the calibration of WFCTA.'

Collaborations

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

The YAG Lidar System Applied in LHAASO

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Qinning Sun
Author and Co-Author
Qinning Sun, Lisi Geng | Xin Li | Junji Xia | Long Chen | Hu Liu | Yang Wang | Fengrong Zhu | Yong Zhang

Abstract
'The atmospheric quality plays an import role in the air shower observation by the Wide Field of View Cherenkov Telescope Array (WFCTA) of LHAASO. A YAG imaging lidar system was developed to continuously monitor the calorimetric information. The accuracy of atmospheric monitoring is dependent on the pulse energy, the YAG laser's beam parameters and the angular repeatability of a High-precision 3D\xa0lifting Rotating Platform (HiRoP). Therefore, we designed an optical system for this lidar with a beam splitter to divide the laser beam into a reference beam and a calibrating beam with a certain ratio and coupled the beam paths with the movement of HiRoP. Thus, every pulse energy of the calibrating beam, which has the same energy fluctuation with respect to the reference beam recorded by a power meter, could be calculated by the ratio of the two beams. Great cares were also taken to characterize the beam size, polarization and divergence of the laser. Meanwhile, a high-precision home-made thermotank was designed to control the temperature and humidity to improve the performance and stability of our laser system, which resulting in a thermal fluctuation less than 2 0C inside the container in the winter at an altitude of 4410 m. Finally, the pulse energy fluctuation of the calibrating beam was about 1.5%, much less than that of 9% without the thermotank. As a result, we have successfully attained distinguishable full-WFCTA-view scanning Laser images in different air conditions, which could be used for the atmospheric quality analysis in further.'

Collaborations
Lhaaso,

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Efficiency estimation of self-triggered antenna clusters for air-shower detection

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Pavel Bezyazeekov
Author and Co-Author
Pavel Bezyazeekov | Oleg Fedorov | Yuliya Kazarina | Dmitriy Kostiunin | Vladimir Lenok | Stanislav Malakhov | Olga Kopylova,

Abstract
'Air-shower radio array operate in low signal-to-noise ratio conditions, which complicates the autonomous measurement of air-shower signals without using an external trigger from optical or scintillator detectors. A simple threshold trigger for radio can be efficiently applied only in radio-quiet conditions, because for other cases this trigger detects a high fraction of noise pulses. In the present work, we study aspects of independent air-shower detection by dense antennas clusters with a complex real-time trigger system. For choosing the optimal procedures for the real-time analysis, we study the dependence between trigger efficiency, count rate, detector hardware and geometry. For this study, we develop a framework for testing various methods of signal detection and noise filtration for arrays with various specifications (geometry, hardware, background conditions etc.) and the hardware implementation of these methods based on field programmable gate arrays. The framework provides flexible settings for the management of station-level and cluster-level steps of detecting the signal, optimized for the hardware implementation for real-time processing. It includes data-processing tools for the initial configuration and tests on pre-recorded data, tools for configuring the trigger architecture and tools for preliminary estimates of the trigger efficiency at given thresholds of cosmic-ray energy and air-shower pulse amplitude. We show examples of the trigger pipeline developed with this framework and discuss the results of tests on simulated data.'

Collaborations

Keywords and Comments
'Self-triggering; radio detection; air-showers', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Pulse Shape Discrimination for Online Data Acquisition in Water Cherenkov Detectors Based on FPGA/SoC

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Luis Guillermo Garcia Ordonez
Author and Co-Author
Luis Guillermo Garcia Ordonez | Romina Soledad Molina | Maria Liz Crespo | Sergio Carrato | Giovanni Ramponi | Andres Cicuttin | Ivan Morales | Hector Perez | Maynor Ballina | Rodrigo Sacahui,

Abstract
'Discrimination of secondary particles produced in extensive air showers is needed to study the composition of primary cosmic rays. High speed data acquisition and the increase in resources in modern FPGAs with the addition of a microprocessor in System-on-Chip (SoC) technologies allow to implement complex algorithms for digital signal analysis. Pulse Shape Discrimination (PSD) can be carried out in real-time on the digital front-end of the detector. Online data analysis leads to save computational resources in post-processing and transmission bandwidth. We describe two methods for PSD, the first based on artificial neural network (ANN) using the novel hls4ml, and the other based on a correlation approach using finite impulse response (FIR) filters. Both methods were implemented and tested on Xilinx FPGA SoC devices ZU9EG Zynq Ultrascale+ and ZC7Z020 Zynq. Data from a Water Cherenkov Detector (WCD) were acquired with a 500 Mhz, 8 bits high speed analog to digital converter acquisition system. Experimental results obtained with both methods are presented along with accuracy, resources utilization and power consumption analysis.'

Collaborations
other (fill field below), LAGO

Keywords and Comments
'FPGA; SoC; WCD; neural network ; FIR; pulse shape discrimination.', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

The Carpet-3 EAS array: a current status

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table

Presenter
Viktor Romanenko
Author and Co-Author
Viktor Romanenko | For the Carpet-3 Collaboration,

Abstract
'The Carpet-3 extensive air shower array is now under construction at the Baksan Neutrino Observatory. The array is located at an altitude 1700 meters above sea level, and it consists of surface detection stations, situated close to each other for best sensitivity to extensive air showers with lower energy, and of an underground muon detector with a continuous area of 410 sq. m. The energy threshold for vertical muons is 1 GeV. The main aim of the array is to study the primary gamma radiation with energy above 100 TeV. After the final accomplishment of this array, it can be competitive in its class and will have a chance to get one of the world-best limits on the diffuse flux of cosmic gamma rays. The design of the Carpet-3 EAS array gives a possibility to carry out research on the composition of primary cosmic rays around the knee. It is planned that the Carpet-3 EAS array will be in full operation by the end of 2021. An overview of the current state of the experiment is presented, and its prospects are discussed.'

Collaborations
, Carpet-3 Collaboration

Keywords and Comments
'Gamma-ray; experiment; Carpet-3; air-shower detector', 'Viktor Romanenko for the Carpet-3 collaboration.'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Hybrid cosmic ray measurements using the IceAct telescopes in coincidence with the IceCube and IceTop detectors

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 53

Presenter
Merlin Schaufel
Author and Co-Author
Larissa Paul | Matthias Plum | Merlin Schaufel | For the IceCube Collaboration, Thomas Bretz | Giang Do | John Hewitt | Frank Maslowski | Florian Rehbein | Johannes Schäfer | Adrian Zink

Abstract
'IceAct is a proposed surface array of compact (50 cm) and cost-effective Imaging Air Cherenkov Telescopes installed at the site of the IceCube Neutrino Observatory at the geographic South Pole. Since January 2019, two IceAct telescope demonstrators, featuring 61 silicon photomultiplier (SiPM) pixels have been taking data in the center of the IceTop surface array during the austral winter. We present the first analysis of hybrid cosmic ray events detected by the IceAct imaging air-Cherenkov telescopes in coincidence with the IceCube Neutrino Observatory, including the IceTop surface array and the IceCube in-ice array. By featuring an energy threshold of about 10 TeV and a wide field-of-view, the IceAct telescopes show promising capabilities of improving current cosmic ray composition studies: measuring the Cherenkov light emissions in the atmosphere adds new information about the shower development not accessible with the current detectors, enabling significantly better primary particle type discrimination on a statistical basis. The hybrid measurement also allows for detailed feasibility studies of detector cross-calibration and of cosmic ray veto capabilities for neutrino analyses. We present the performance of the telescopes, the results from the analysis of two years of data, and an outlook of a hybrid simulation for a future telescope array.'

Collaborations
IceCube,

Keywords and Comments
'Astroparticle physics; Cosmic Rays; Imaging Air Cherenkov Telescope; Hybrid detection', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

CoREAS simulations of inclined air showers predict refractive displacement of the radio-emission footprint

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 54

Presenter
Marvin Gottowik
Author and Co-Author
Marvin Gottowik | Tim Huege | Julian Rautenberg | Felix Schlüter,

Abstract
"Simulating the radio emission of inclined extensive air showers for a ground based radio-antenna array we find a systematic displacement of the radio emission with respect to the Monte-Carlo shower impact point. We corrected the radio-emission footprint for the asymmetries due to the superposition of geomagnetic and charge-excess radiation as well as for the early-late effect. The remaining displacement is found to be \\SI{\\sim 1500}{m} along the ground plane for showers with a zenith angle of \\SI{85}{\\degree}, which is relevant for air shower detectors.\r\nA model describing this displacement by refraction in the atmosphere based on Snell's law yields good agreement with our observations from CoREAS simulations.\r\nWe thus conclude that the displacement is caused by refraction in the atmosphere."

Collaborations

Keywords and Comments
'Radio-detection of cosmic rays; inclined air shower; refractivity; CoREAS simulation', 'Subcategory would be more phenomenology.'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Acquisition of data from a Water Cherenkov Detector based on an on purpose acquisition card

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Eduardo Moreno Barbosa
Author and Co-Author
Eduardo Moreno Barbosa | Enrique Varela Carlos | Ruben Conde Sanchez | Jorge Cotzomi Paleta | Victor Acametitla Lopez,

Abstract
"Cosmic rays when interacting with atoms in the Earth's atmosphere generate Extensive Atmospheric Showers (EAS) that can be recorded in a water Cherenkov detector (WCD). The average lifetime of the recorded signals of these events are in the order of ~ 10-9s, so ultra-fast electronics are necessary for their detection. In this work we present the operation, processing and capture of EAS with a development card based on an FPGA, Red Pitaya, which has the capacity to acquire up to 125 MSPS at 12 bits of resolution and 12 bits DAC."

Collaborations

Keywords and Comments
'Photodetection; Instrumentation; Cosmic Rays', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

First results from the TRAGALDABAS Cosmic ray detector at the Univ. of Santiago de Compostela

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 55

Presenter
Juan A. Garzón
Author and Co-Author
Hector Alvarez-Pol | Marwan Ajoor | Alberto Blanco | Pablo Cabanelas | Filomena Clemencio | Miguel Cruces | José Cuenca | Julian Flores | Paulo Fonte | Yanis Fontenla | Damián García-Castro | Juan A. Garzón | Georgy Kornakov | Teresa Kurtukian | Luis Lop,

Abstract
'TRAGALDABAS is a high performance, high granularity, tracking detector of the Trasgo family. It is installed at the Univ. of Santiago de Compostela (42.876N, 8.560W), Spain. The detector is based on the RPC technology (Resistive Plate Chamber) offering a surface of 1.8m2 with granularity of 120 cells, multitracking capability, time resolution of ~0.4ns, an angular resolution close to 3º and an angular acceptance of 40º.\r\nAs a significant feature, the detector offers muon-electron separation capability with a rough electron calorimetry. This is attained by means of a software algorithm based on the analysis of the shape of the associated electromagnetic showers.\r\n\r\nThe detector is now taking data regularly at a rate of about 7 millions of events per day. After the detector calibration, efficiency evaluation and atmospheric corrections, preliminary results on cosmic ray rates with different multiplicities and the angular distribution dependence will be presented. We will show how a Trasgo detector is capable of measuring the properties of both isolated and bundles of particles, opening a new way of analyzing cosmic rays from the Earth surface.'

Collaborations

Keywords and Comments
'Tracking detector; Resistive Plate Chamber; secondary cosmic rays; ground detector; muons; electrons', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Muography for the Colombian Volcanoes

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 10 EAS reconstruction and analyses | CRI
Presenter Forum Table

Presenter
Luis Nunez
Author and Co-Author
Luis Nunez, Hernán Asorey | Rolando Calderón-Ardila | Andrei Jaimes-Motta | Jesús Peña-Rodríguez | Jose David Sanabria-Gomez | Christian Sarmiento-Cano | David Sierra-Porta | Mauricio Suárez-Durán | Alejandra Vesga-Ramirez | Adriana Vásquez Ramírez | Ricardo deLeón-

Abstract
"We describe the Muography Program to study the Colombian volcanoes. Mainly, we discuss the adopted criteria for designing, building, and commissioning *MuTe*: a hybrid Muon Telescope. *MuTe* implements a composite detection technique combining a hodoscope for particle tracking and a water Cherenkov detector for enhancing the muon-to-background-signal separation due to the high energy component of extended air showers. We discuss the detailed *MuTe* digital twin employed to estimate the instrument's response to the muon flux and its impact on its design and performance. The impinging muon flux calculation and its corresponding signals in the detector considers three critical factors with different spatial and time scales: the geomagnetic effects, the development of extensive air showers in the atmosphere, and the detector response at a particular geographic point. Next, we examine the structural --mechanical and thermal-- behaviour of *MuTe*, its first calibration measurements and identify the possible volcano candidate with the best observation points. *MuTe* incorporates particle-identification techniques for reducing the background noise sources and discrimination of fake events by a picosecond *Time-of-Flight* system. Finally, we also discuss some optimization algorithm to improve the volcano internal density distribution measured by our instrument."

Collaborations

Keywords and Comments
'Muography; Muon tomography; Muon radiography; Volcanoes\r\nCosmic ray techniques', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

A photomultiplier tube model for the water Cherenkov detectors of the LAGO

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 56

Presenter
Jesús Peña-Rodríguez
Author and Co-Author
Jesús Peña-Rodríguez | Yesid León-Carreño | Sandra Hernández-Barajas | Luis A. Núñez | Luis Otiniano,

Abstract
"The Latin American Giant Observatory (LAGO) is an international experiment spanning over 10 Latin American countries and Spain. LAGO scientific objectives include the study of gamma-ray bursts and space weather phenomena using water Cherenkov detectors (WCDs) deployed at different latitudes and altitudes. Large area (8-9 inches) photomultiplier tubes (PMTs) sense the Cherenkov radiation produced by secondary particles, induced by primary cosmic particles in the atmosphere, crossing the WCDs.\r\n\r\nWe present a photomultiplier model applied to the Hamamatsu R5912 tube used in the LAGO' WCDs. The ARTI simulation framework, developed by the LAGO collaboration, can incorporate it. The model depends on the number of dynodes, the bias voltage, the number of incident photons, the photodetection efficiency, and the bias network. The model implementation includes a simulation of the LAGO's front-end, allowing the system linearity evaluation under different conditions. \r\n\r\nThe model was validated with data recorded by the MuTe-Chitagá (Bucaramanga, LAGO-Colombia) and Nahuelito (Bariloche, LAGO-Argentina) WCDs. The ARTI simulation chain estimates the number of Cherenkov photons arriving at the detector's PMT. We compare the anode/dynode pulse amplitude ratio predicted by the model with detector measurements. We also contrast the estimated and measured vertical equivalent muon signal. The estimated vertical-muon charge (321.6 UADC) differs by 4% from the measured by the MuTe WCD (333 UADC)."

Collaborations
, LAGO

Keywords and Comments
'photomultiplier tube; mathematical model; water Cherenkov detector; front-end electronics', ''

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Subcategory Experimental Methods & Instrumentation

Assessment of moisture reserves by CR secondary neutrons sounding method

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 57

Presenter
Lev Dorman
Author and Co-Author
Lev Dorman,

Abstract
'The technique of monitoring the moisture content in soil using CR neutron detectors of special design is being actively developed. For mountainous areas and northern countries, monitoring of the thickness of the snow cover is also relevant. The technology makes it possible to bridge the gap between local measurements and remote sensing on a catchment scale (100×100 km2) using spacecraft. It provides an opportunity to measure in real time the content of soil moisture and the thickness of the snow cover on a scale of ten hectares, determined by the range of neutrons travel in the lower atmosphere, which is ~ 250 m. We used data from two types of such detectors: 1) an epithermal neutron detector with 6 boron counters, counting rate about 13 pps (pulses per second) and 2) a thermal neutron detector (a single counter without a moderator, 2 pps). We estimated the amount of moisture in the soil and on its surface in the form of snow. Having a long series of measurement data for epithermal and thermal neutrons (since 2010), in this work we considered in detail the results for 2018-2021. Special attention is paid to the method of introducing various corrections. The method used to estimate moisture is relative and therefore requires the calibration of such a detector. For the winter period, such a calibration was carried out. The thickness of the snow cover in the periods under consideration reached 11 g/cm2 (including melting), the error is estimated as \uf0b10.2 (stat) \uf0b10.4 (sys) g/cm2.'

Collaborations

Keywords and Comments
'cosmic ray application agriculure', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Development of drone-borne aerial calibration pulser system for radio observatories of ultra-high energy air showers

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Chung-Yun Kuo
Author and Co-Author
Jiwoo Nam | Chung-Yun Kuo | Bokkyun Shin | Pisin Chen | Yaocheng Chen | Jian-Jung Huang | Ming-Huey A. Huang | Tsung-Che Liu | Yu-Shao Shiao | Min-Zu Wang | Shih-Hao Wang | Yu-Hsin Wang | DAVE Z. Besson | Alexander Novikov | Hornhuber Christian,

Abstract
'We develop a drone-borne aerial calibration pulser system for radio observatories for air-showers induced by ultra-high energy (UHE) cosmic rays (CRs) and cosmic neutrinos (CNs). The system is designed to provide a highly practical method for system calibration which transmits high power impulsive radio signals from various locations. We use a solid-state impulse generator and a wide-band bicone antenna with bandwidth of 150-500 MHz attached on a commercial drone. The system is equipped with a differential GPS receiver which provides an accuracy of centimeter level. We implement a high power attenuation shielding box with an extreme light-weight in order to reduce radio interference. In this paper, we report system design, production, laboratory tests, and in-situ performance in TAROGE observatories in Taiwan and Antarctica. Possible applications of this system to next generation radio detectors for UHE CRs and CNs are also discussed.'

Collaborations
other (fill field below), TAROGE

Keywords and Comments
'Ultra high energy cosmic rays; Radio wave; Angular reconstruction; Drone-borne calibration', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Methods & Instrumentation

Status of the novel CORSIKA 8 air shower simulation framework

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Antonio Augusto Alves Junior
Author and Co-Author
Antonio Augusto Alves Junior,

Abstract
'The simulation program CORSIKA is the leading tool for the research in air shower physics for over 30 years. It is recently undergoing a huge development effort, driven by the migration from FORTRAN77 to modern C++17, in order to achieve the highest performance and functionality, deploying parallelism and engaging different platforms like GPU and many-core CPU, using efficient and multithread-ready techniques. The radio emission framework within CORSIKA 8 is, for example, designed to work in a model-agnostic way which will allow for the first time to in-depth compare all possible emission models. CORSIKA 8 is also a platform to develop novel algorithmic solutions, e.g. generative networks. A status report and near-term outlook of the project is given. Some ongoing important design choices, like output management and the simulation of showers in different media, are also highlighted and illustrated with an exotic application to cosmic-ray showers in the Martian atmosphere. Moreover, the first examples and comparisons with previously existing codes are presented. The roadmap to a first physics production release is presented.'

Collaborations
CORSIKA-8,

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The lateral distribution of vertical and inclined showers during thunderstorms at LHAASO observatory

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
Xunxiu Zhou
Author and Co-Author
Lin Chen | Kegu Axi | Xunxiu Zhou | Daihui Huang | Zhicheng Huang | Peihan Wang,

Abstract
'Ground-based cosmic ray observatories generally record the information on the arrival time and location of each hit to reconstruct the primary direction of the shower event. During thunderstorms, the direction of secondary charged particles is changed due to the acceleration and deceleration of the particles when they cross layers of electric field. The thunderstorm field also has a secondary effect on the photons generated via bremsstrahlung, emitted by the high-energy positrons and electrons. So, the lateral distribution of ground cosmic rays could be influenced during thunderstorm. In this work, we performed Monte Carlo simulations by using CORSIKA to study the effects of near-earth thunderstorms electric field on the lateral distribution of vertical and inclined showers at LHAASO (4410 m a. s. l., Daocheng, Sichuan, China). We found the lateral distribution of secondary positrons, electrons and photons changed in field. The variation amplitude is not only dependent on electric field, but also highly correlated with the primary energy and direction of the shower event. Our simulation results are useful to understand the acceleration mechanisms of secondary particles caused by an atmospheric electric field, as well as the experimental data obtained by ground-based detectors (such as LHAASO, ARGO-YBJ).'

Collaborations

Keywords and Comments
'Near-earth thunderstorms electric field; Lateral distribution; Monte Carlo simulations; Cosmic rays', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Characteristics of thunderstorm activity at LHAASO observatory

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 58

Presenter
Daihui Huang
Author and Co-Author
Peihan Wang | Daihui Huang | Xunxiu Zhou | Zhicheng Huang | Hucheng Feng | Ruolin Huang | Gerui Chen | Kai Wu | Tao Yan | Kegu Axi | Lin Chen,

Abstract
'Thunderstorms are common weather phenomena at high altitudes, accompanying with lightning, strong winds, floods and other disasters. During thunderstorms, the strength of atmospheric electric fields could be up to 1000 V/cm or even higher. The intensity fluctuates violently and the polarity could change multiple times. So, direct measurement of the thunderstorm electric field is a quite challenging work. The High Altitude Cosmic Ray Observatory (LHAASO), under the construction of a project at Daocheng (4410 m a.s.l, Sichuan, China), is featured with frequent thunderstorms, especially in summer. The distribution of thunderstorm parameters is presented by analyzing the near-earth atmospheric electric field of the LHAASO station in this work. The polarity and intensity variation characteristics of the electric field in the early, mature and dissipating stages of thunderstorm are also discussed. The results show that the thunderstorms mainly occur in the period of a time from early afternoon to evening. They are more frequent and stronger in summer. During the mature stage, the field changes more dramatically. Our results could be helpful in understanding the variations of cosmic rays at LHAASO during thunderstorms, and provide valuable information for studying global thunderstorm activity.'

Collaborations
Lhaaso,

Keywords and Comments
'Thunderstorm activity; Atmospheric electric fields; Variations; Cosmic rays; LHAASO observatory', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Revealing supernova remnant G106.3+2.7 as a PeVatron

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Ruo-Yu Liu
Author and Co-Author
Ruo-Yu Liu | Chong Ge | Shu Niu | Yang Chen | Xiang-Yu Wang,

Abstract
'We analyze the data of Chandra and XMM-Newton in the region of SNR G106.3+2.7 and find the spectrum is dominated by non-thermal X-ray radiation of electrons. The X-ray surface brightness profile of the SNR indicates that the X-ray-emitting electrons in the tail region of the SNR is accelerated by the SNR shock, implying the SNR is an efficient particle accelerator. Based on the multiwavelength data of the SNR, we suggest that the tail region of the SNR is likely a proton PeVatron.'

Collaborations

Keywords and Comments
'SNR; Cosmic ray; Non-thermal radiation', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

New Constraints on Cosmic Particle Populations at the Galactic Center using X-ray Observations of the Molecular Cloud Sagittarius B2

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 59

Presenter
Field Rogers
Author and Co-Author
Field Rogers | Shuo Zhang | Kerstin Perez | Afura Taylor,

Abstract
'Measurements of cosmic particle fluxes are key to indirect dark matter detection and to modeling galactic transport of cosmic rays, but all direct measurements have been made within or near our solar system, i.e. $\\sim$8 kpc from the center of the Milky Way. In this work, we constrain MeV to GeV scale electron and proton populations within the central 100 pc of the Galaxy on the basis of X-ray emission from ionizing particle interactions in the Galactic Center Molecular Cloud Sagittarius B2 (Sgr B2). X-ray emission from Sgr B2, including the characteristic Fe K$\\alpha$ fluorescence line at 6.4 keV, has previously been dominated by a variable component attributed to reflection of a past outburst from the supermassive black hole Sagittarius A*. Meanwhile, any local low energy particles would also produce X-rays in Sgr B2 via ionization and excitation of the molecular gas, contributing a constant baseline flux. Since the year 2001, Fe K$\\alpha$ emission from Sgr B2 has decreased by $>$ 90%, raising the possibility that it may now be dominated by particle interactions. Measurements of cosmic particle populations near the Galactic Center could help constrain models of cosmic particle transport in the Galaxy.'

Collaborations

Keywords and Comments
'Cosmic-ray protons; Cosmic-ray electrons; Galactic center; Molecular cloud; Sagittarius B2;', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Estimation of depth of maximum by relative muon content in air showers with energy greater than 5 EeV measured by the Yakutsk array

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Igor Petrov
Author and Co-Author
Stanislav Knurenko | Igor Petrov,

Abstract
'Characteristics of muons with a threshold $\\varepsilon_{thr} \\geq$ 1 GeV based on the air showers data in Yakutsk array were analyzed. Quantitative estimation of muons at different distance from the shower axis and the ratio of muon and charged particles at a distance of 600 m are obtained. An empirical relationship between the fraction of muons and longitudinal development – the depth of maximum development X_{max} is found. Calculations of the muon fraction are performed using the QGSjetII-04 for different primary nuclei, and compared with experiment. Mass composition of primary particles induced air showers of highest energies is estimated from the muon component.'

Collaborations

Keywords and Comments
'air showers; air shower muons; relative muon content; depth of maximum; mass composition.', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

On the nature of primary particles producing air showers with energies greater than 5 EeV

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 60

Presenter
Igor Petrov
Author and Co-Author
Igor Petrov | Stanislav Knurenko,

Abstract
'To study the nature of particles with energies greater than 5 EeV, the database of the Yakutsk array was analyzed. The array has been operating continuously for 50 years, and during this time period, unique material has been collected on the main components of air showers: the electron-photon component, muons, Cherenkov and radio emissions. Including the arrival directions of primary cosmic rays that produce cascades of secondary particles of relativistic energies in the atmosphere. Attention is drawn to the time sequence of the air showers arrival within 24 hours of continuous observations at the array. A small-scale variation in showers with an average period of 8 hours was found. Physical characteristics of consecutive showers: energy, zenith and azimuthal angles were in one case close or slightly different in magnitude. In addition very close relative muon number in these showers. For example, there were pairs of showers with a low muon content, i.e. showers "poor in muons". According to model calculations, these showers are probably produced by primary ultrahigh-energy gamma rays. Therefore, it can be assumed that double showers are formed by primary particles of the same or similar nature of origin.'

Collaborations

Keywords and Comments
'EAS; ultra high energies; cosmic rays; arrival directions; Yakutsk.', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Update on the large-scale cosmic-ray anisotropy search at the highest energies by the Telescope Array Experiment

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Toshihiro Fujii
Author and Co-Author
Toshihiro Fujii | for the Telescope Array Collaboration,

Abstract
'Large-scale anisotropy at the highest energies is essential for the understanding the transition from cosmic rays of galactic origin to those of extra-galactic origin, along with the magnetic fields in the galaxy and those beyond. Motivated by a significant detection of the large-scale anisotropy above 8 EeV by the Pierre Auger Observatory (Auger), we have previously reported, using 11 years of Telescope Array (TA) surface array data, a result compatible with both that of Auger, and with a isotropic source distribution [ApJL, 898:L28, (2020)]. In this contribution, we will show latest results to search for the large-scale anisotropy at the highest energies.'

Collaborations
Telescope Array,

Keywords and Comments
'Ultra-high-energy cosmic rays; extensive air shower; large scale anisotropy; dipole; magnetic field', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Looking for long-range correlations among the EEE telescopes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 61

Presenter
Paola La Rocca
Author and Co-Author
Paola La Rocca,

Abstract
'The search for long-range correlations among air showers is one of the main goal of the Extreme Energy Events (EEE) Project. The existence of such events has only been supposed theoretically through several physical mechanisms, the most convincing being the so-called GZ effect, based on the photodisintegration of a heavy primary nucleus in the solar field. Even with a large detector coverage current rate expectations are of few events per year.\r\nTo measure time correlations among distant air showers, sparse arrays of detection stations spread over large areas are needed. A very limited number of experimental setups can perform this measurement and few experimental results have been reported over the past years.\r\nStarted in 2006 the EEE project is a network of 61 cosmic muons tracking telescopes made by 3 wide area MRPCs, sensitive to the direction of incident charged cosmic particles. The telescopes are distributed over the whole Italian territory, thus making the EEE array an ideal tool for the detection of long-range time correlations between extensive air showers.\r\nI will describe the analysis strategies adopted to search for such rare correlation events, together with the results obtained analysing the full statistics collected by the EEE telescopes in 10 years of operations.'

Collaborations
other (fill field below), EEE (Extreme Energy Events)

Keywords and Comments
'long-range correlations; GZ effect; sparse array; MRPC telescope;', 'if the abstract is not accepted for a talk, please consider it for a poster contribution.'

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Photon decay in UHE air showers: a stringent bound on Lorentz violation

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 57 New Physics | CRD-CRI-DM-GAD-GAI-NU-MM-SH
Presenter Forum Table

Presenter
Fabian Duenkel
Author and Co-Author
Fabian Duenkel | Marcus Niechciol | Markus Risse,

Abstract
'In extensive air showers induced by ultra-high energy (UHE) cosmic rays, secondary photons are expected to be produced at energies far above those accessible by other means. It has been shown that the decay of such photons, as possible in certain theories allowing the violation of Lorentz invariance, can lead to significant changes of the shower development. Based on observations of the average depth of shower maximum $\\langle X_\\text{max}\\rangle$, a stringent bound on the violation of Lorentz invariance has been placed in a previous work. In this contribution, we include the shower-to-shower fluctuations $\\sigma(X_\\text{max})$ as an additional observable. The combined comparison of $\\langle X_\\text{max}\\rangle$ and $\\sigma(X_\\text{max})$ to shower observations allows a much stricter test of the possible decay of UHE photons, improving the existing bound by a factor 50.'

Collaborations

Keywords and Comments
'Lorentz-violation; UHE air showers; cosmic rays; photon decay; CONEX', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

UHECR mass composition from anisotropy of their arrival directions with the Telescope Array SD

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 62

Presenter
Mikhail Kuznetsov
Author and Co-Author
Mikhail Kuznetsov | for the Telescope Array Collaboration,

Abstract
'We propose a new method for the estimation of ultra-high energy cosmic ray (UHECR) mass composition from a distribution of their arrival directions. The method employs a test statistic (TS) based on a characteristic deflection of UHECR events with respect to the distribution of luminous matter in the local Universe modeled with a flux-weighed 2MRS catalog. Making realistic simulations of the mock UHECR sets, we show that this TS is robust to the presence of galactic and non-extreme extra-galactic magnetic fields and sensitive to the mass composition of events in a set. While the statistical power of the method depends somewhat on the magnetic fields parameters, this dependence decreases with the growth of statistics. We apply the method to the Telescope Array surface detector data and derive new independent constraints on UHECR mass composition at highest energies.'

Collaborations
Telescope Array,

Keywords and Comments
'UHECR; mass composition; anisotropy', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The ASTRI-Horn telescope: comparison with the auxiliary UVscope measurements as calibration tool.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 63

Presenter
Antonio Alessio Compagnino
Author and Co-Author
Antonio Alessio Compagnino | Teresa Mineo | Maria Concetta Maccarone | Osvaldo Catalano | Domenico Impiombato | Salvatore Giarrusso | for the ASTRI Project,

Abstract
'ASTRI-Horn is an Image Atmospheric Cherenkov Telescope located at the INAF "M.C. Fracastoro" observing station (Mt. Etna, Italy) characterized by a dual-mirror optical system and a curved focal surface equipped with SiPM sensors managed by an innovative fast front-endelectronics based on the peak detector technique.\r\nASTRI-Horn represents the prototype of nine similar telescopes developed for the ASTRI-MiniArray project that will be installed at the Teide Astronomical Observatory, in Tenerife (Canary Islands, Spain). The ASTRI-Horn camera is almost blind to the diffuse night sky background (NSB) but is able to detect the (Poissonian) fluctuations produced by the NSB. The noise generated by this effect is proportional to the level of the NSB.\r\nIn this work, we present the analysis of the background data collected in ASTRI-Horn observations during the period December 2018-March 2019 and the comparison of the results with the absolute night sky background levels measured by the UVScope instrument, which is capable of counting individual photons in the range 300-650nm, with a time resolution of 10ns. The instrument is mounted on the external structure of the ASTRI-Horn telescope.\r\nThe main result of this work is a strong correlation between the absolute flux measured by UVScope and the fluctuations measured by the ASTRI-Horn camera that can be used as diagnostic tool to ensure the right behavior of the camera in view of the ASTRI-MiniArray implementation.'

Collaborations
other (fill field below), ASTRI Project

Keywords and Comments
'IACT\r\nASTRI-Horn\r\nUVscope', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Measurement of the Proton-Air Cross Section with Telescope Ar-rays Black Rock, Long Ridge, and Surface Array in Hybrid Mode.

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Rasha Abbasi
Author and Co-Author
Rasha Abbasi | William Hanlon,

Abstract
'Ultra High Energy Cosmic Ray (UHECR) detectors have been reporting on the proton-air cross section measurement beyond the capability of particle accelerators since 1984. The knowledge of this fundamental particle property is vital for our understanding of high energy particle interactions and could possibly hold the key to new physics. The data used in this work was collected over eight years using the hybrid events of Black Rock (BR) and Long Ridge (LR) fluorescence detectors as well as the Telescope Array Surface array Detector (TASD). The proton-air cross section is determined at √s= 73 TeV by fitting the exponential tail of the Xmax distribution of these events. The proton-air cross section is then inferred from the exponential tail fit and from the most updated high energy interaction models. σ inel p−air is observed to be 520.1±35.8 [Stat.]+25.3−42.9[Sys.] mb. This is the second proton-air cross section work reported by the Telescope Array collaboration.'

Collaborations
Telescope Array,

Keywords and Comments
'Proton-air cross section; Ultra High Energy Cosmic Rays.', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Observation of Variations in Cosmic Ray Shower Rates During Thunderstorms and Implications for Large-Scale Electric Field Changes

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
Rasha Abbasi
Author and Co-Author
Rasha Abbasi | Joseph Mazich | Hans Jhonson | Kaleigh O'Brein | Pierce Myers,

Abstract
'This work presents the first observation by the Telescope Array Surface Detector (TASD) of the effect of thunderstorms on the development of the cosmic ray showers. Observations of variations in the cosmic ray showers, using the TASD, allows us to study the electric field inside thunderstorms on a large scale without dealing with all the limitation of narrow exposure in time and space using balloons and aircraft detectors. In this work, observations of changes in the cosmic ray shower intensity ΔN/N using the TASD, was studied and found to be on average at the 1−3% level. These observations were found to be both negative and positive in polarity. They were also found to be correlated with lightning but also with thunderstorms.The size of the footprint of these variations on the ground ranged from 4-24 km in diameter and lasted for 10s of minutes. The dependence of ΔN/N on the electric field inside thunderstorms, in this work, is derived from Monte Carlo CORSIKA simulations and will also be presented.'

Collaborations
Telescope Array,

Keywords and Comments
'EAS rate variation; Thunderstorms; Electric field.', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

A search for bursts at 0.1 PeV with a small air shower array.

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
Roger Clay
Author and Co-Author
Roger Clay | Jassimar Singh | For the CREDO Collaboration,

Abstract
'The Cosmic Ray Extremely Distributed Observatory (CREDO) pursues a global research strategy dedicated to the search for correlated cosmic rays, so-called Cosmic Ray Ensembles (CRE). Its general approach to CRE detection does not involve any a priori considerations and the search strategy encompasses both spatial and temporal correlations, on different scales. Here we search for time clustering of the cosmic ray events collected with a small sea-level air shower array at the University of Adelaide. The array consists of seven one square metre scintillators enclosing an area of 18.7 m x 9.7 m It has a threshold energy ~0.1 PeV, and records cosmic ray showers at a rate of ~6 mHz. We have examined event times over a period of almost two years (~294k events) to determine the event time spacing distributions between individual events and the distributions of time periods which contained specific numbers of multiple events. We find that the overall time distributions are as expected for random events. The distribution which was chosen a priori for particular study was for time periods covering four events. Overall, this fits closely with expectation but has two outliers of short 'burst' periods. One of these outliers contains eight events within 48 seconds. \r\n\r\nThe physical characteristics of the array will be discussed together with the analysis procedure, including a fit between the observed time distributions and expectation based on randomly arriving events.'

Collaborations
, CREDO

Keywords and Comments
'Arrival time distribution; bursts', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Mass composition anisotropy with the TA SD data

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Yana Zhezher
Author and Co-Author
Yana Zhezher,

Abstract
'Mass composition anisotropy is predicted by a number of theories describing sources of ultra-high-energy cosmic rays. \r\nEvent-by-event determination of a type of a primary cosmic-ray particle is impossible due to large shower-to-shower fluctuations, and the mass composition usually is obtained by averaging over some composition-sensitive observable determined independently for each extensive air shower (EAS) over a large number of events. \r\nIn the present study we propose to employ the observable $\\xi$ used in the mass composition analysis of the Telescope Array surface detector (TA SD) data for the mass composition anisotropy analysis. \r\nThe $\\xi$ variable is determined with the use of Boosted Decision Trees (BDT) technique trained with the Monte-Carlo sets, and the $\\xi$ value is assigned for each event, where $\\xi=1$ corresponds to an event initiated by the primary iron nuclei and $\\xi=-1$ corresponds to a proton event.\r\nUse of $\\xi$ distributions obtained for the Monte-Carlo sets allows us to separate proton and iron candidate events from a data set with some given accuracy and study its distributions over the observed part of the sky. \r\nResults for the TA SD 12-year data set mass composition anisotropy will be presented and possible applications for the cosmic-ray source models will be discussed. This presentation contains results we would like to include in a TA highlight talk.'

Collaborations
Telescope Array,

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Cosmic-ray mass composition with the TA SD 12-year data

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Yana Zhezher
Author and Co-Author
Yana Zhezher,

Abstract
'Telescope Array (TA) is the largest ultra-high-energy cosmic-ray (UHECR) observatory in the Northern Hemisphere. It is dedicated to detect extensive air showers (EAS) in hybrid mode, both by measuring the shower's longitudinal profile with fluorescence telescopes and their particle footprint on the ground from the surface detector (SD) array. While fluorescence telescopes are can measure the most composition-sensitive characteristic of EAS, the depth of the shower maximum (Xmax), they also have the drawback of small duty cycle. This work aims to study the UHECR composition based solely on the surface detector data. For this task, a set of composition-sensitive observables obtained from the SD data is used in a machine-learning method – the Boosted Decision Tree. We will present the results of the UHECR mass composition based on the 12-year data from the TA SD using this technique, and we will discuss of the possible systematics imposed by the hadronic interaction models.'

Collaborations
Telescope Array,

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Status and Prospects of the LHCf and RHICf experiments

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Hiroaki Menjo
Author and Co-Author
Hiroaki Menjo | For the LHCf and RHICf Collaborations,

Abstract
'Precise understanding of hadronic interactions at high energies is a key to improve chemical composition measurements of very high energy cosmic-rays and to solve the muon excess issue observed in high energy cosmic-ray experiments using air-shower technique. The LHCf and RHICf experiments measures the differential production cross sections of very forward neutral particle as photons, neutral pions and neutrons at LHC and RHIC, respectively. These data are critically important to test and tune hadronic interaction models used for air-shower simulations.\r\n\r\nIn this presentation, we introduce the recent results of both the experiments as well as our future operation plans. LHCf published an updated result of forward neutron measurement at pp, $\\sqrt{s}$ = 13 TeV. From the observed neutron energy spectra, we also obtained the average inelasticity, which is one of the key parameters for air shower development, as 0.536 +0.031-0.037. In addition, several analysis are on-going; neutral pion measurement at pp, $\\sqrt{s}$ = 13 TeV, central- forward correlation analysis with LHCf+ATLAS, photon measurement by RHICf.\r\n\r\nLHCf plans to have operations at pp and pO during the LHC-Run3 period. At pp collisions, a new silicon readout system will be introduced to improve the read-out speed, and 10 times more statistics of the previous operation in 2015 will be obtained. Thanks to high statistics, rare particles such as $\\eta$, K^0_s and $\\Lambda$ will be addressed also. We also plan another operation at RHIC in 2024 with a new detector. The detector, a calorimeter composed of tungsten, Si pad and pixel layers, will have a much wider acceptance and higher sensitivity of K^0_s measurement than the current detector.'

Collaborations
other (fill field below), LHCf and RHICf

Keywords and Comments
'Hadronic interaction; LHC; RHIC;', 'A joint contribution from two collaboration.'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The Results of 5 Years Study of Cosmic Rays Above 10 PeV with Differential Cherenkov Detectors

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
Valentina Mokhnachevskaya
Author and Co-Author
Valentina Mokhnachevskaya | Stanislav Knurenko,

Abstract
'This paper presents the results obtained with differential Cherenkov detectors consist of the Yakutsk array. Data on the energy spectrum and mass composition for 5 years are presented.'

Collaborations
other (fill field below), Yakutsk EAS Array

Keywords and Comments
'cosmic rays; cherenkov light; air shower', ''

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Subcategory Experimental Results

Fluctuations of the Xmax in Air Showers within 10 PeV-1 EeV Primary Energy Range

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Valentina Mokhnachevskaya
Author and Co-Author
Valentina Mokhnachevskaya | Stanislav Knurenko,

Abstract
'This paper presents a method for observing Cherenkov light from extensive air showers of ultrahigh energies generated by cosmic rays. Individual cascade curves for the development of extensive air showers were reconstructed, in particular, the depth of maximum (Xmax) for showers above 10 PeV. Experimental data indicate a change in mass composition in the energy range of 10 PeV - 1 EeV and are compared with the results of other air shower array.'

Collaborations
other (fill field below), Yakutsk EAS Array

Keywords and Comments
'cosmic rays; air shower', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Observations of the cosmic ray detector at the Argentine Marambio base in the Antarctic Peninsula

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 64

Presenter
Noelia Ayelén Santos
Author and Co-Author
Noelia Ayelén Santos, Sergio Dasso | Adriana Gulisano | Omar Areso | Matías Pereira | For the LAGO collaboration

Abstract
'On March 2019 a Space Weather Laboratory was deployed at Marambio base in the Antarctic Peninsula. The main instrument installed was a cosmic ray detector based on water Cherenkov radiation. This detector is the first permanent Antarctic node of LAGO (Latin American Giant Observatory) Collaboration and it has been working continously since its installation. LAGO Project is an extended Astroparticle Observatory and It is mainly oriented to basic research in three branches of Astroparticle physics: the Extreme Universe, Space Weather phenomena, and Atmospheric Radiation at ground level. The LAGO Space Weather program is directed towards the study of how the variations of the flux of secondary cosmic rays at ground level are linked with the heliospheric and geomagnetic modulations.\r\n\r\nObservations made during 2019 and 2020 will be presented here. The corrected count rate observed with our WCD is compared with observations of Oulu neutron monitor with similar rigidity cut off than the Marambio site (2,32 GV). During the summer Antarctic campaign of 2020 a new acquisition system was implemented. With this new system we are able to get a count rate related to the flux of secondary particles in a specific range of deposited energy into the detector. We analyze the effect of pressure and temperature in each of these count rates.'

Collaborations
, LAGO

Keywords and Comments
'Water Cherenkov detector; Space Weather; Antartctic Peninsula', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The measurements of the cosmic ray energy spectrum and the depth of maximum shower development of Telescope Array Hybrid trigger events

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Heungsu Shin
Author and Co-Author
Heungsu Shin, For the Telescope Array Collaboration

Abstract
'The Telescope Array experiment is an ultra-high energy cosmic ray observatory located in Millard County, Utah, USA. The observatory consists of 3 fluorescence detector (FD) stations and 507 surface detectors (SD) that cover an area of ~700 km². *Hybrid trigger* is an external trigger system for the SD arrays that prompts the SD to perform data acquisition when an FD detects a shower-like event. In comparison with the SD autonomous trigger, hybrid trigger allows the SD to collect the data of an air shower that has primary energy below 10^{18.5} eV, where the efficiency of SD autonomous trigger decreases rapidly. We present the measurements of the cosmic ray energy spectrum and the depth of maximum shower development of hybrid trigger events observed from October 2010 to June 2019.'

Collaborations
Telescope Array,

Keywords and Comments
'UHECR; Hybrid; Energy spectrum; Xmax; Telescope Array;', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Overview of the Mini-EUSO μs trigger logic performance

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Matteo Battisti
Author and Co-Author
Matteo Battisti, Mario Bertaina | Lech Wiktor Piotrowski | for the JEM-EUSO Collaboration | Hiroko Miyamoto | Francesca Capel | Alexander Belov | Marco Casolino | Marco Mignone

Abstract
'Mini-EUSO is the first detector of the JEM-EUSO program deployed on the International Space Station (ISS). It is a wide field of view telescope currently operating from a nadir-facing UV-transparent window in the Russian Zvezda module on the ISS. It is based on an array of Multi-Anode Photomultipliers Tubes (MAPMTs) working in photon counting mode with a microsecond time resolution. Among the different scientific objectives it searches for light signals with time durations compatible to those expected from Extensive Air Showers generated by Extreme Energy Cosmic Rays (EECRs) interacting in the atmosphere. Although the energy threshold for cosmic ray showers is above $E>10^{21}~eV$, due the constraints given by the size of the UV-transparent window, the dedicated trigger logic has been capable of the detection of other interesting classes of events, like elves, and ground flashers. An overview of the general performance of the trigger systems is provided, with a particular focus on the identification of classes of events responsible for the\r\ntriggers'

Collaborations
, JEM-EUSO

Keywords and Comments
'Mini-EUSO; JEM-EUSO; ISS; UHECR; EECR; trigger; elves; ground flasher', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The ultra-high-energy cosmic-ray sky above 32 EeV viewed from the Pierre Auger Observatory

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Jonathan Biteau
Author and Co-Author
Jonathan Biteau | Biteau, for the Pierre Auger Collaboration,

Abstract
'The region of the toe in the cosmic-ray spectrum, located at about 45 EeV by the Pierre Auger Collaboration, is of primary interest in the search for the origin of ultra-high energy cosmic rays (UHECRs). The suppression of the flux with increasing energy can be explained by the propagation of UHECRs in intergalactic photon fields, resulting in a shrinking of the observable universe, and/or by the reach of the maximum acceleration potential of astrophysical sources, yielding a sample of UHECRs at presumably high rigidities around the toe. The predominance of foreground sources combined with minimal magnetic bending of UHECR trajectories could thus offer a path towards localizing ultra-high energy accelerators, through the study of UHECR arrival directions.\r\nIn this contribution, we present the results of blind and astrophysically-motivated searches for anisotropies with data collected above 32 EeV during the first phase of the Pierre Auger Observatory, i.e. prior to the AugerPrime upgrade, for an exposure of over 100,000 km² yr sr. We have conducted model-independent searches for overdensities at small and intermediate angular scales, correlation studies with several astrophysical structures, and cross-correlation analyses with catalogs of candidate extragalactic sources. These analyses provide the most important evidence to date for an anisotropic distribution of UHECR arrival directions around the toe as measured from a single observatory.'

Collaborations
Auger,

Keywords and Comments
'Cosmic ray astronomy; Extragalactic astronomy; Ultra-high-energy cosmic radiation', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

UHECR arrival directions in the latest data from the original Auger and TA surface detectors and nearby galaxies

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Armando di Matteo
Author and Co-Author
Armando di Matteo | for the Pierre Auger and Telescope Array collaborations,

Abstract
'The distribution of ultra-high-energy cosmic-ray arrival directions appears to be nearly isotropic except for a dipole moment of order 6 × (*E*/10 EeV) per cent. Nonetheless, at the highest energies, as the number of possible candidate sources within the propagation horizon and the magnetic deflections both shrink, smaller-scale anisotropies might be expected to emerge. On the other hand, the flux suppression reduces the statistics available for searching for such anisotropies. In this work, we consider two different lists of candidate sources: a sample of nearby starburst galaxies and the 2MRS catalog tracing stellar mass within 250 Mpc.\r\nWe combine surface-detector data collected at the Pierre Auger Observatory and the Telescope Array until 2019, and use them to test models in which UHECRs comprise an isotropic background and a foreground originating from the candidate sources and randomly deflected by magnetic fields. The free parameters of these models are the energy threshold, the signal fraction, and the search angular scale. The results will be presented at the conference.'

Collaborations
Auger, Telescope Array

Keywords and Comments
'UHECR; arrival directions; anisotropies; starburst galaxies; galaxies', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Data-driven Scales of Depth of Shower Maximum and Signals at Ground Level using Hybrid Detection at the Pierre Auger Observatory

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Jakub Vícha
Author and Co-Author
Jakub Vícha,

Abstract
'Presently large systematic uncertainties still remain in the description of hadronic interactions at ultra-high energies and a fully consistent description of air-shower experimental data is yet to be reached. Specifically, the predictions of the depth of the shower maximum ($X_{\\rm max}$) by hadronic interaction models tuned to LHC data differ by around 30 g/cm^{2} at 10^{19} eV. This introduces a lower limit on the uncertainty in the average mass derived from the $X_{\\rm max}$ measurements at the level of one third of the difference between protons and iron nuclei. A deficit of the simulated signal with respect to the measured signal in ground detectors is another inconsistency that is usually interpreted as a deficit of the muon signal related to the hadronic component of a simulated shower.\r\n\r\nA new global method to simultaneously determine the mass composition of cosmic rays, modifications of the simulated $X_{\\rm max}$, and modifications of the hadronic and electromagnetic signals at ground level, is applied to the combined data of the surface and fluorescence detectors at the Pierre Auger Observatory. The data-driven results of the method prefer a deeper scale of simulated $X_{\\rm max}$ than predicted by hadronic interaction models EPOS-LHC, QGSJet II-04 and Sibyll 2.3d in the energy range $10^{18.5-19.0}$ eV. Consequently, the mass composition of the primary species was found to be heavier, and the deficit of the simulated hadronic signal at ground level, dominated by muons, is alleviated with respect to the unmodified hadronic interaction models. The standard models fail to describe the measured data without these modifications with a total significance of more than 5$\\sigma$.'

Collaborations
Auger,

Keywords and Comments
'Cosmic rays; mass composition; models of hadronic interactions; signal in surface detectors; depth of air-shower maximum', 'on behalf of the Pierre Auger Collaboration'

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Combined fit of the energy spectrum and mass composition across the ankle with the data measured at the Pierre Auger Observatory

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Eleonora Guido
Author and Co-Author
Eleonora Guido | For the Pierre Auger Collaboration,

Abstract
'The combined fit of the energy spectrum and mass composition data above $5\\cdot10^{18}\\:\\mathrm{eV}$ suggested the presence of extragalactic sources ejecting ultra-high-energy cosmic rays with relatively low maximum energies, hard spectral indices and mixed chemical compositions, dominated by the contribution of intermediate mass groups. Here we present an extension of the fit to lower energies, to include the feature observed near $5\\cdot10^{18}\\:\\mathrm{eV}$ in the all-particle energy spectrum, the so-called *ankle*. \r\nWe show that it is possible to generate such a change of slope assuming that the flux below the ankle is provided by the superposition of some additional contributions. The simplest extension of this sort consists of introducing a supplemental extragalactic component at low energy, characterised by different physical parameters with respect to the one contributing above the ankle: such a component may originate from a different population of sources or be provided by interactions occurring in the acceleration sites. In this framework we also explore the possibility of including the end of a Galactic contribution at low energies.\r\nThe fit suggests that these scenarios provide a reasonable description of the measurements across the ankle, without affecting the results obtained for the above-ankle region.\r\nIn order to evaluate our capability to constrain the source models, we finally discuss the impact of the main experimental systematic uncertainties and of the theoretical models choice on the fit results.'

Collaborations
Auger,

Keywords and Comments
'UHECR; ultra-high-energy cosmic rays; combined fit; energy spectrum; mass composition; ankle energy region; transition region; Auger; Pierre Auger Observatory; UHECR propagation; extragalactic sources', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Studies of a muon-based mass sensitive parameter for the IceTop surface array

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 66

Presenter
Donghwa Kang
Author and Co-Author
Donghwa Kang | Sally Browne | Andreas Haungs | for the IceCube collaboration,

Abstract
'IceTop is the surface instrumentation of the IceCube Neutrino Observatory at the South Pole. It is designed to measure extensive air showers of cosmic rays in the primary energy range from PeV to EeV. Air showers induced by heavier primary particles develop earlier in the atmosphere and produce more muons observable at ground level than lighter cosmic rays with the same primary energy. Therefore, the fraction of muons to all charged particles measured by IceTop characterizes the mass of primary particles. This analysis seeks a muon-based mass sensitive parameter by using the charge signal distribution for each individual cosmic ray event. In this contribution we present the analysis method for the mass-sensitive parameter and our studies of its possible application to the measurement of cosmic ray mass composition with the IceTop surface array.'

Collaborations
IceCube,

Keywords and Comments
'IceTop; cosmic ray mass composition', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Results from the KASCADE-Grande data analysis

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Donghwa Kang
Author and Co-Author
Donghwa Kang | for the KASCADE-Grande collaboration,

Abstract
'KASCADE-Grande and its original array of KASCADE were dedicated to measure individual air showers of cosmic rays with great detail in the primary energy range of 100 TeV up to 1 EeV. The experiment has significantly contributed to investigations of the energy spectrum and chemical composition of cosmic rays in the transition region from galactic to extragalactic origin of cosmic rays as well as to the further development of hadronic interaction models through validity tests using the multi-detector information from KASCADE-Grande. Though the data accumulation was completed in 2013, the data analysis is still continuing. Recently, we investigate the reliability of the new hadronic interactions model of the Sibyll version 2.3d with the combined data from KASCADE and KASCADE-Grande, and compare it to the predictions of different hadronic interaction models. In addition, we update the web-based platform of the KASCADE Cosmic Ray Data Centre (KCDC), where now full datasets from KASCADE and KASCADE-Grande and the corresponding Monte-Carlo simulated events are available.'

Collaborations
KASCADE-Grande,

Keywords and Comments
'KASCADE-Grande; energy spectrum; mass composition; hadronic interaction model; Sibyll 2.3d', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

First air-shower measurements with the prototype station of the IceCube surface enhancement

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Hrvoje Dujmovic
Author and Co-Author
Hrvoje Dujmovic | Alan Coleman | For the IceCube Collaboration,

Abstract
'IceTop, the surface array of the IceCube Neutrino Observatory, currently consists of 162 ice-Cherenkov tanks distributed over an area of 1km^2. Besides being used as a veto for the in-ice neutrino detector, IceTop is a powerful cosmic-ray detector, and analyses of IceTop data have led to advances in cosmic ray physics. In the upcoming years, the capabilities of the IceTop array will be further enhanced by augmenting the existing ice-Cherenkov tanks with an array of elevated scintillator panels and radio antennas. Combining the data obtained from the different detectors will improve the reconstruction of cosmic-ray energy and primary mass while reducing the energy threshold and increasing the aperture of the array. In January 2020, a prototype station consisting of 8 scintillation detectors and 3 antennas was deployed at the IceTop site. The prototype detectors are connected to the same data-acquisition system and the readout of the radio antennas is triggered using the signals from the scintillators. This allows us to regularly observe secondary air shower particles hitting the scintillators, as well as the radio emission of high-energy air showers. In this contribution, we will discuss the results obtained from the prototype station in the past year, present the first cosmic-ray air showers measured with this prototype station, and show how the observations with the different detector types complement each other.'

Collaborations
IceCube,

Keywords and Comments
'', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Relativistic dust grains: a new subject of research with orbital fluorescence detectors

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
Pavel Klimov
Author and Co-Author
Boris Khrenov | Pavel Klimov | Nikolai Kalmykov | Sergei Sharakin | Mikhail Zotov,

Abstract
"TUS (Tracking Ultraviolet Set-up) was the world's first orbital detector of ultra-high-energy cosmic rays (UHECRs), that was launched into orbit on 28th April 2016 as a part of the scientific payload of the Lomonosov satellite. During TUS operation for 1.5 years, its exposure reached ~1200-1400 km^{2}sr yr and the detector measured almost 80 thousands events with a few of them satisfying conditions anticipated for extensive air showers (EASs) initiated by UHECRs. A detailed analysis of these events, of event TUS161003 in particular, revealed certain specific features such as an extremely high energy (1 ZeV) and a small slant depth of the shower maximum. These parameters are not compatible with the UHECR spectrum and expected EAS parameters obtained by ground-based experiments, which presents a puzzle for their explanation. From the other hand, relativistic dust grains (RDGs) suggest an interesting explanation of an extreme-energy event developing high in the atmosphere. They were considered long ago by Spitzer and later by Hayakawa as possible sources of UHECRs of the highest energy. According to simulations, an EAS initiated by a massive RDG develops in the atmosphere at slant depths less than 400\xa0g/cm^2. We study if an EAS initiated by an RDG can explain TUS161003 and other similar events and discuss perspectives of their registration with the future orbital missions."

Collaborations

Keywords and Comments
'ultra-high-energy cosmic rays; relativistic dust grains', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Main results of the TUS experiment on board the Lomonosov satellite

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Pavel Klimov
Author and Co-Author
Pavel Klimov | Sergei Sharakin | Mikhail Zotov | Mario Bertaina,

Abstract
'The TUS detector was the first space-based mission aimed for ultra-high-energy cosmic ray (UHECR) measurements. The detector was designed to register the fluorescent signal of extensive air showers (EAS) developing in the night atmosphere of Earth in the UV range of 300-400 nm. TUS was launched on board the Lomonosov satellite in April, 2016 and operated till December, 2017. Almost 90 thousand events were recorded during the mission, among them lightning discharges, meteors, transient luminous events, polar lights and anthropogenic signals. Some puzzling bright UV flashes in a clear sky far from possible artificial sources were also registered. Besides this, a number of EAS candidates were found in the TUS database. The majority of candidates analysed so far were recorded above populated areas near airports or similar objects, and the energy of the signals corresponds to at least 1 ZeV if they were generated by an UHECR. This does not allow us to consider these events as UHECRs. We briefly present the main results of the TUS mission and discuss its importance for the development of the future orbital missions.'

Collaborations
, Lomonosov-UHECR/TLE

Keywords and Comments
'space-based telescope; ultra-high-energy cosmic rays', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Simulation Study of the Observed Radio Emission of Air Showers by the IceTop Surface Extension

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table 67

Presenter
Alan Coleman
Author and Co-Author
Alan Coleman | for the IceCube Collaboration,

Abstract
'Multi-detector observations of individual air showers are critical to make significant progress to precisely determine cosmic-ray quantities such as mass and energy of individual events and thus bring us a step forward in answering the open questions in cosmic-ray physics. An enhancement of IceTop, the surface array of the IceCube Neutrino Observatory, is currently underway and includes adding antennas and scintillators to the existing array of ice-Cherenkov tanks. The radio component will improve the characterization of the primary particles by providing an estimation of Xmax and a direct sampling of the electromagnetic cascade, both important for per-event mass classification. A prototype station has been operated at the South Pole and has observed showers, simultaneously, with the three detectors types. The observed radio signals of these events are unique as they are measured in the 100-350 MHz band, higher than many other cosmic-ray experiments. We present a comparison of the detected events with the waveforms from CoREAS simulations, convoluted with the end-to-end electronics response, as a verification of the analysis chain. Using the detector response and the measurements of the prototype station as input, we update a Monte-Carlo-based study on the potential of the enhanced surface array for the hybrid detection of air showers by scintillators and radio antennas.'

Collaborations
IceCube,

Keywords and Comments
'IceCube; IceTop; Radio;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The EUSO@TurLab project in view of Mini-EUSO and EUSO-SPB2 missions

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 68

Presenter
Mario Edoardo Bertaina
Author and Co-Author
Hiroko Miyamoto, Matteo Battisti | Alexander Belov | Mario Edoardo Bertaina | Francesca Bisconti | Francesca Capel | Giorgio Cotto | Renato Forza | Pavel Klimov | Massimiliano Manfrin | Marco Mignone | Lech Wiktor Piotrowski | for the JEM-EUSO collaboration

Abstract
'The TurLab facility is a laboratory, equipped with a 5 m diameter and 1 m depth rotating tank, located in the fourth basement level of the Physics Department of the University of Turin. \r\nIn the past years, we have used the facility to perform experiments related to the observations of Extreme Energy Cosmic Rays (EECRs) from space using the fluorescence technique for JEM-EUSO missions with the main objective to test the response of the trigger logic. In the missions, the diffuse night brightness and artificial and natural light sources can vary significantly in time and space in the Field of View (FoV) of the telescope. Therefore, it is essential to verify the detector performance and test the trigger logic under such an environment. By means of the tank rotation, a various terrestrial surface with the different optical characteristics such as ocean, land, forest, desert and clouds, as well as artificial and natural light sources such as city lights, lightnings and meteors passing by the detector FoV one after the other is reproduced. The fact that the tank located in a very dark place enables the tests under an optically controlled environment.\r\nThanks to the Mini-EUSO data taken since 2019 onboard the ISS, it was possible to verify the reliability of the light conditions reproduced at TurLab. This contribution will report on the comparison between TurLab and ISS measurements in view of future experiments at TurLab. Moreover, in the forthcoming months we will start testing the trigger logic of the EUSO-SPB2 mission. We will report also on the plans and first measurements for this purpose.'

Collaborations
other (fill field below), JEM-EUSO

Keywords and Comments
'Mini-EUSO; photodetection; UHECR; EECR; trigger; ISS', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

New insights from old cosmic rays: A novel analysis of archival KASCADE data

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Dmitriy Kostiunin
Author and Co-Author
Dmitriy Kostiunin | Plokhikh Ivan | Markus Ahlers | Victoria Tokareva | Pavel Bezyazeekov | Rustam Mullyadzhanov | Ev Sotnikova,

Abstract
'Cosmic ray data collected by the KASCADE air shower experiment are competitive in terms of quality and statistics with those of modern observatories. We present a novel mass composition analysis based on archival data acquired from 1998 to 2013 provided by the KASCADE Cosmic ray Data Center (KCDC). The analysis is based on modern machine learning techniques trained on simulation data provided by KCDC. We present spectra for individual groups of primary nuclei, the results of a search for anisotropies in the event arrival directions taking mass composition into account, and search for gamma-ray candidates in the PeV energy domain'

Collaborations

Keywords and Comments
'cosmic rays; machine learning; open data; anisotropy; pev gamma', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Observation of Cosmic Ray Anisotropy with Nine Years of IceCube Data

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Frank McNally
Author and Co-Author
IceCube Collaboration, Rasha Abbasi | Paolo Desiati | Juan Carlos Díaz Vélez | Frank McNally | Tim Aguado | Katherine Gruchot | Andrew Moy | Alexander Simmons | Andrew Thorpe | Hannah Woodward

Abstract
'The complete IceCube Observatory has collected over 700 billion cosmic-ray induced muon events from May 2011 to May 2020. We used this data set to provide an unprecedented statistically accurate map of the cosmic ray arrival direction distribution in the TeV-PeV energy range scale in the southern hemisphere. Such an increase in event statistics makes it possible to extend the sensitivity to higher cosmic ray energies and smaller angular scales. It will also facilitate a more detailed assessment of the observatory stability over both short- and long-time scales. This will enable us to study the time variability of the cosmic ray anisotropy on a yearly-base and over the entire data sample period covering most of the solar cycle 24. We present the preliminary results from the study with the extended event sample.'

Collaborations
IceCube,

Keywords and Comments
'anisotropy; time variability', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Indication of a mass-dependent anisotropy above $10^{18.7}\,$eV in the hybrid data of the Pierre Auger Observatory

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Eric Mayotte
Author and Co-Author
Eric Mayotte | For the Pierre Auger Collaboration,

Abstract
'We test the hypothesis of an anisotropy in the mass of cosmic-ray primaries as a function of galactic latitude. The mass estimate is made using the depth of shower maximum, $X_{\\text{max}}$, from hybrid events measured at the Pierre Auger Observatory. The 14 years of available data are split into on- and off-plane regions using the galactic latitude of each event to form two distributions in $X_{\\text{max}}$, which are compared using the Anderson-Darling 2-samples test. A scan over a subset of the data is used to select an optimal threshold energy of $10^{18.7}\\,$eV and an angular split of the data into equally sized on- and off-plane subsamples. Applied to all events, the distribution from the on-plane region is found to have a mean $X_{\\text{max}}$ which is $9.3 \\pm 1.7^{+2.6}_{-2.2}\\,\\text{g}\\,\\text{cm}^{-2}$ shallower and a width which is $6.3\\pm2.9^{+3.8}_{-2.8}\\,\\text{g}\\,\\text{cm}^{-2}$ narrower than that of the off-plane region. These differences are such as to indicate that the mean mass of the primary particles arriving from the on-plane region is higher than the mean mass of those coming from the off-plane region.\r\nMonte-Carlo studies yield a preliminary $5.0^{+1.4}_{-1.5}\\,\\sigma$ post-trial statistical significance, where the uncertainties are of systematic origin. Penalizing for systematic uncertainties leads to an indication for anisotropy in mass composition above $10^{18.7}\\,$eV at a preliminary confidence level of $3.5\\,\\sigma$. The anisotropy is observed independently at each of the four fluorescence telescope sites. Interpretations of possible causes of the observed effect will be discussed.'

Collaborations
Auger,

Keywords and Comments
'UHECR; Mass Composition; Anisotropy; Galactic Plane; Xmax; Hybrid', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Results on mass composition of cosmic rays as measured with LOFAR

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Arthur Corstanje
Author and Co-Author
Arthur Corstanje | For the LOFAR CR-KSP,

Abstract
'We present an updated analysis of the mass composition of cosmic rays in the 10^{17} to 10^{18} eV energy range. It is based on measurements with the LOFAR telescope of the depth of shower maximum, $X_{\\mathrm{max}}$.\r\nWe review the improvements to the simulation-based reconstruction setup, as well as the selection method to obtain a minimally biased $X_\\mathrm{max}$-dataset. Systematic uncertainties on $X_\\mathrm{max}$ have been lowered to an estimated 7 to 9 $\\mathrm{g/cm^2}$, at a resolution of about 20 $\\mathrm{g/cm^2}$ per shower.\r\nResults include estimates of the mean and standard deviation of the $X_\\mathrm{max}$-distribution. A statistical analysis at distribution level has been done as well, using a 4-component model of light to heavy nuclei. \r\nIt confirms our previous results showing a significant low-mass fraction in this energy range.\r\nWe discuss consistency with existing results on Xmax and mass composition.'

Collaborations
LOFAR,

Keywords and Comments
'air showers; cosmic rays; mass composition; shower maximum; Xmax', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Study of mass composition of cosmic rays with IceTop and IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 69

Presenter
Paras Koundal
Author and Co-Author
Paras Koundal | Matthias Plum | Julian Saffer | For the IceCube Collaboration,

Abstract
'The IceCube Neutrino Observatory is a multi-component detector at the South Pole which detects high-energy particles emerging from astrophysical events. These particles provide us with insights into the fundamental properties and behaviour of their sources. Besides its principal usage and merits in neutrino astronomy, using IceCube in conjunction with its surface array, IceTop, also makes it a unique three-dimensional cosmic-ray detector. This distinctive feature helps facilitate detailed cosmic-ray analysis in the transition region from galactic to extragalactic sources. We will present the progress made on multiple fronts to establish a framework for mass-estimation of primary cosmic rays. The first technique uses advanced methods in Graph Neural Networks to use the full in-ice shower footprint, in addition to global shower-footprint features from IceTop. The second technique relies on a likelihood-based analysis of the surface signal distribution and improves upon the standard reconstruction technique. A comparison between the two methods for composition analysis as well as a possible extension of the analysis techniques for sub-PeV cosmic-ray air-showers will also be discussed.'

Collaborations
IceCube,

Keywords and Comments
'Cosmic Rays; Cosmic Ray Composition; Deep Learning; Graph Neural Network; Machine Learning; IceCube Observatory;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Energy spectrum of cosmic rays measured using the Pierre Auger Observatory

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
Vladimír Novotný
Author and Co-Author
Vladimír Novotný | for the Pierre Auger Collaboration,

Abstract
'We present the energy spectrum of cosmic rays measured at the Pierre Auger Observatory from $6 \\times 10^{15}$ eV up to the most extreme energies where the accumulated exposure reaches about 80 000 km^2 sr yr. The wide energy range is covered with five different measurements, namely using the events detected by the surface detector with zenith angles below 60 degrees and applying different reconstruction method also above 60 degrees, those collected by a denser array, the hybrid events simultaneously recorded by the surface and fluorescence detectors, and using those events in which the signal is dominated by Cherenkov light registered by the high-elevation telescopes. In this contribution, we report updates of the analysis techniques and present the spectrum obtained by combining the five different measurements. Spectral features occurring in the wide energy range covered by the Observatory are discussed.'

Collaborations
Auger,

Keywords and Comments
'cosmic rays; energy spectrum; Pierre Auger Observatory', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Cosmic Ray Detection at the Murchison Radio-astronomy Observatory – a pathfinder for SKA-Low

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 70

Presenter
Alexander Williamson
Author and Co-Author
Clancy James | Tim Huege | Justin Bray | Steven Tingay | Alexander Williamson,

Abstract
'We present the status of cosmic-ray detection activities at the Murchison Radio-astronomy Observatory. Using 128 antennas of the Murchison Widefield Array radio telescope in its extended configuration, we detect the radio emission from extensive air showers in the 122-154 MHz range at a rate of slightly less than once per hour, each with an approximate energy of 10^17 eV. We have developed a bespoke filter inversion to obtain high-time-resolution data from this general-purpose astronomy instrument, and trigger data capture directly from the radio signal. Our future plans include the implementation of a particle-triggered mode, and expanded operations with the low-frequency component of the Square Kilometre Array, which will have ~100,000 antennas deployed on the same site.'

Collaborations

Keywords and Comments
", "

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Subcategory Experimental Results

Muon deficit in simulations of air showers inferred from AGASA data

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Flavia Gesualdi
Author and Co-Author
Flavia Gesualdi, A. Daniel Supanitsky | Alberto Etchegoyen

Abstract
'Multiple experiments reported evidences of a muon deficit in air-shower simulations with respect to data, which increases with the primary energy. In this work, we study the muon deficit using measurements of the muon density at $1000\\,$m from the shower axis obtained by the Akeno Giant Air Shower Array (AGASA). The selected events have reconstructed energies in the range $18.83\\,\\leq\\,\\log_{10}(E_{R}/\\textrm{eV})\\,\\leq\\,19.46$ and zenith angles $\\theta\\leq 36^\\circ$. We compare these muon density measurements to proton, iron, and mixed composition scenarios, obtained by using the high-energy hadronic interaction models EPOS-LHC, QGSJetII-04, and Sibyll2.3c. We find that AGASA data are compatible with a heavier composition, lying above the predictions of the mixed composition scenarios. The average muon density divided by the energy in AGASA data is greater than in the mixed composition scenarios by a factor of $1.49\\pm0.11\\,\\textrm{(stat)}\\pm0.18\\,\\textrm{(syst)}$, $1.54\\pm0.12\\,\\textrm{(stat)}\\pm0.18\\,\\textrm{(syst)}$, and $1.66\\pm0.13\\,\\textrm{(stat)}\\pm0.20\\,\\textrm{(syst)}$ for EPOS-LHC, Sibyll2.3c, and QGSJetII-04, respectively. We interpret this as further evidence of a muon deficit in air-shower simulations at the highest energies.'

Collaborations
Auger,

Keywords and Comments
'Muon deficit; AGASA; Air showers', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Study on multi-ELVES in the Pierre Auger Observatory

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
Adriana Vásquez Ramírez
Author and Co-Author
Adriana Vásquez Ramírez,

Abstract
'Since 2013, the four sites of the Fluorescence Detector (FD) of the Pierre Auger Observatory record ELVES with a dedicated trigger. These UV light emissions are correlated to distant lightning strikes. The length of recorded traces has been increased from 100 $\\mu$s (2013), to 300 $\\mu$s (2014-16), to 900 $\\mu$s (2017-present), to progressively extend the observation of the light emission towards the vertical of the causative lightning and beyond. A large fraction of the observed events shows double ELVES within the time window, and, in some cases, even more complex structures are observed. The nature of the multi-ELVES is not completely understood but may be related to the different types of lightning in which they are originated. For example, it is known that Narrow Bipolar Events can produce double elves, and Energetic In-cloud Pulses, occurring between the main negative and upper positive charge layer of clouds, can induce double and even quadruple ELVES in the ionosphere. This report shows the seasonal and daily dependence of the time gap, amplitude ratio, and correlation between the pulse widths of the peaks in a sample of 1000+ multi-ELVES events recorded during the period 2014-20. The events have been compared with data from other satellite and ground-based sensing devices to study the correlation of their properties with lightning observables such as altitude and polarity.'

Collaborations
Auger,

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Hotspot Update, and a new Excess of Events on the Sky Seen by the Telescope Array Experiment

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Jihyun Kim
Author and Co-Author
Jihyun Kim | Dmitri Ivanov | Kazumasa Kawata | Hiroyuki Sagawa | Gordon Thomson, For the Telescope Array Collaboration

Abstract
'The Telescope Array (TA) experiment, the largest studying ultrahigh energy cosmic rays in the northern hemisphere, has reported an excess in the arrival direction distribution for events with energies above $5.7\\times10^{19}$ eV, called the hotspot. We report here the latest results of the TA hotspot using the most recent data measured by the TA surface detector array, which is more than doubled exposure since the first publication; the hotspot still exists with 3 sigma post-trial significance. By using an oversampling search with a $20^\\circ$-circle, similar to the study of the hotspot, we find that an additional excess of events at slightly lower energies. The Perseus-Pisces supercluster lies at the location of the new excess. Assuming this structure is responsible for the excess, we conducted a statistical analysis to verify the correlation between observed events and the members of the Perseus-Pisces supercluster. The analysis results will be presented at the conference.'

Collaborations
Telescope Array,

Keywords and Comments
'', 'This presentation contains results we would like to include in a TA highlight talk'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Energy spectrum and the shower maxima of cosmic rays above the knee region measured with the NICHE detectors at the TA site

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
Yugo Omura
Author and Co-Author
Yugo Omura, Douglas Bergman | Yoshiki Tsunesada | Ryosuke Tsuda | John Krizmanic

Abstract
'The Non-Imaging CHErenkov Array (NICHE) is a low energy extension to Telescope Array (TA) using an array of closely spaced (~100 m) light collectors covering an area of ~2 square km. It is being deployed in the field-of-view of the FD for the TA Low Energy Extension (TALE) and overlaps with the TALE FD in the energy range above 2 PeV. Cosmic ray air showers with energies 1-100 PeV will be reconstructed using the Lateral Distribution of Cherenkov light from the air showers. This method allows shower energy and the maximum of shower depth (Xmax) to be determined. A prototype of the array, j-NICHE, has been making routine observations with 14 detectors since May, 2019. We will present the latest results of NICHE including the energy spectrum and the shower maximum distribution around the cosmic ray knee.'

Collaborations
Telescope Array,

Keywords and Comments
", "

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The all-particle cosmic ray energy spectrum measured with HAWC

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
Jorge Antonio Morales-Soto
Author and Co-Author
Jorge Antonio Morales-Soto | Juan Carlos Arteaga-Velázquez | for the HAWC Collaboration,

Abstract
"Thanks to recent technological development, a new generation of experiments have been developed with more sensitivity in the energy interval from 10 TeV to 1 PeV, such as HAWC. Due to its designs and high altitude, the HAWC air shower observatory can provide a bridge between the data from direct and indirect cosmic ray detectors. In 2017 the HAWC collaboration published their first results on the energy spectrum of cosmic rays, in the range from 10 to 500 TeV. This work updates these results by extending the energy interval of the measured all-particle cosmic-ray energy spectrum up to 1 PeV. The energy spectrum was obtained from the analysis of two years of HAWC's data using an unfolding method. We employed the QGSJET-II-04 model for the energy calibration and the spectrum reconstruction. The results confirm the presence of a knee like feature around 45 TeV, which was reported by the HAWC collaboration in 2017."

Collaborations
HAWC,

Keywords and Comments
'all-particle energy spectrum; extensive air showers; TeV cosmic rays; HAWC', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Reconstruction of air shower events measured by the surface detectors of the TAx4 experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 71

Presenter
Hyomin Jeong
Author and Co-Author
Hyomin Jeong, Telescope Array collaboration

Abstract
'The source, propagation and acceleration mechanism of Ultra High Energy Cosmic Rays (UHECRs) has been investigated since the first discovery of UHECRs to solve the mystery about the extremely-high energy universe. The Telescope Array times 4 (TAx4) experiment, which currently consists of 257 Surface Detectors (SDs) and 2 Fluorescence Detector (FD) stations, had been built in Utah, USA in 2019. The TAx4 SDs are detecting secondary particles in an extensive air shower induced by UHECRs, and we reconstructed arrival directions and energies of UHECR using the signals measured by SDs. We present the reconstruction procedure and preliminary results of the reconstructed energies and arrival directions of UHECRs detected by the TAx4 SDs.'

Collaborations
Telescope Array,

Keywords and Comments
'TA; UHECR; SD', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Analysis of TAx4 hybrid trigger and events

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 72

Presenter
Sangwoo Kim
Author and Co-Author
Sangwoo Kim | Telescope Array Collaboration,

Abstract
'The Telescope Array is the largest ultra-high energy cosmic ray hybrid detector in the Northern hemisphere. While the TAx4 Surface Detector (TAx4 SD) has a duty cycle of ~ 100%, it should be noted that the TAx4 Fluorescence Detector (TAx4 FD) observes the full longitudinal profile of the cosmic ray air showers and therefore is able to determine their energies more accurately than TAx4 SD. In addition, observing cosmic rays in hybrid mode ("hybrid events") has several advantages. Events seen in hybrid mode by the TAx4 FD and SD are used to establish the energy scale of the TAx4 SD. Moreover, the FD longitudinal profile is used to determine the mass composition of the primary comic ray particles, when the event geometries are well constrained by FD and SD measurements simultaneously. Despite large differences in the TAx4 SD/FD stand-alone performances, both detector types complement each other in measuring important physical quantities. Since August 2019, direction, energy, and Xmax can be obtained from reconstructing hybrid events. In this poster, preliminary analysis of TAx4 hybrid trigger and TAx4 hybrid events will be presented with focus on energy and Xmax observations.'

Collaborations
Telescope Array,

Keywords and Comments
'Cosmic-Ray; Ultra-High-Energy-Cosmic-Ray(UHECR); Telescope Array(TA)', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Estimation of the exposure of the TUS space based cosmic ray observatory

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 73

Presenter
Francesco Fenu
Author and Co-Author
Francesco Fenu, Mikhail Zotov | Kenji Shinozaki | Mario Bertaina | Pavel Klimov | for the JEM-EUSO collaboration

Abstract
'The TUS observatory, as a part of the JEM-EUSO program, aimed at the detection of Ultra High Energy Cosmic Rays (UHECR). TUS was the first UHECR detector to operate in space and was launched on April 28th 2016 from the Vostochny cosmodrome in Russia. It operated until December 2017 and collected ~80000 events with a time resolution of 0.8 μs. A fundamental parameter to be determined for the measurement of cosmic rays properties is the exposure. Such a parameter is important to estimate the average expected event rate as a function of energy and to calculate the absolute flux in case of event detection. We present here a study for the determination of the exposure that TUS accumulated during its flight. The role of clouds, detector dead time, man made sources, storms, lightning discharges, airglow and moon phases is studied in detail. An exposure estimate with its dependence on the energy and with its geographical distribution is presented. We report on the applied technique and on the perspectives of this study in view of future missions of the JEM-EUSO program.'

Collaborations
other (fill field below), JEM-EUSO

Keywords and Comments
'TUS; exposure; JEM-EUSO', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Simulations studies for the Mini-EUSO detector

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 74

Presenter
Francesco Fenu
Author and Co-Author
Francesco Fenu, Hiroko Miyamoto | Mario Bertaina | Marco Casolino | Antonio Montanaro

Abstract
'Mini-EUSO is a mission of the JEM-EUSO program flying onboard the International Space Station since August 2019. Since the first data acquisition in October 2019, more than 35 sessions have been performed for a total of 52 hours of observations. The detector has been observing Earth at night-time in the UV range and detected a wide variety of transient sources all of which have been modeled through Monte Carlo simulations. Mini-EUSO is also capable of detecting space debris and meteors and we performed simulations for such events to estimate their impact on future missions for cosmic ray science from space.\r\nWe show here examples of the simulation work done in this framework to analyze the Mini-EUSO data. The expected response of Mini-EUSO with respect to ultra high energy cosmic ray showers has been studied. The efficiency curve of Mini-EUSO as a function of primary energy has been estimated and the energy threshold for Cosmic Rays has been confirmed to be above 10^{21} eV. We compared the morphology of several transient events detected during the mission with cosmic ray simulations and excluded that they can be due to cosmic ray showers. To validate the energy threshold of the detector, a system of ground based flashers is being used for end-to-end calibration purposes. We therefore implemented a parameterization of such flashers into the JEM-EUSO simulation framework and studied the response of the detector with respect to such sources.'

Collaborations
other (fill field below), JEM-EUSO

Keywords and Comments
'MIni-EUSO; simulations; data analysis; JEM-EUSO', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Large-scale and multipolar anisotropies of cosmic rays detected at the Pierre Auger Observatory with energies above 4 EeV

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Rogerio de Almeida
Author and Co-Author
Rogerio de Almeida,

Abstract
'More than half a century after the discovery of ultra-high energy cosmic rays (UHECRs), their origin is still an open question. The study of anisotropies in the arrival directions of such particles is an essential ingredient to solve this puzzle. We update our previous analysis of large-scale anisotropies observed by the Pierre Auger Observatory using the latest data collected before the AugerPrime upgrade. By selecting events with zenith angles up to 80$^{\\circ}$, implying a sky coverage of 85%, and energies above 4 EeV, for which the surface detector of the Observatory is fully efficient, we evaluate the dipolar and quadrupolar amplitudes through a combined Fourier analysis of the event count rate in right ascension and azimuth. The analysis is performed in three energy bins with boundaries at 4, 8, 16 and 32 EeV and two additional cumulative bins with energies above 8 and 32 EeV. The most significant signal is a dipolar modulation in right ascension for energies above 8 EeV, as previously reported, with statistical significance above 5$\\sigma$. Additionally, we report the measurements of the angular power spectrum for the same energy bins. The updated results with the latest data will be presented at the conference.'

Collaborations
Auger,

Keywords and Comments
'Large scale anisotropies; angular power spectrum', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Cosmic-Ray Studies with the Surface Instrumentation of IceCube

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Andreas Haungs
Author and Co-Author
Andreas Haungs | For the IceCube Collaboration,

Abstract
"IceCube is a cubic-kilometer Cherenkov detector installed in deep ice at the geographic South Pole. IceCube's surface array, IceTop, measures the electromagnetic signal and mainly low-energy muons from extensive air showers above several 100 TeV primary energy, with shower bundles and high-energy muons detected by the in-ice detectors. In combination, IceCube and IceTop provide unique opportunities to study cosmic rays in detail with large statistics. This contribution summarizes recent results from these studies. In addition, the IceCube-Upgrade will include a considerable enhancement of the surface detector through the installation of scintillation detectors and radio antennas and possibly small air-Cherenkov telescopes. We will discuss the results of the prototype detectors installed at the South Pole and the prospects of this enhancement as well as the surface array planned for IceCube-Gen2."

Collaborations
IceCube,

Keywords and Comments
'Cosmic Rays; Energy Spectrum; Composition; Hadronic Interaction Model; Transition Region', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Joint analysis of the energy spectrum of ultra-high-energy cosmic rays as measured at the Pierre Auger Observatory and the Telescope Array

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
Yoshiki Tsunesada
Author and Co-Author
Yoshiki Tsunesada, Valerio Verzi | Toshihiro Fujii | Douglas Bergman | Oliver Deligny | Francesco Salamida | Ioana Maris | Isabelle Lhenry-Yvon | Markus Roth | Ines Valino | Alexander Schulz | Dmitri Ivanov

Abstract
'The measurement of the energy spectrum of ultra-high-energy cosmic rays (UHECRs) is of crucial importance to clarify their origin and acceleration mechanisms. The Pierre Auger Observatory in Argentina and the Telescope Array (TA) in the US reported their measurements of UHECR energy spectra observed in the southern and northern hemisphere, respectively. The region of the sky accessible to both Observatories ([-15,+24] degrees in declination) can be used to cross-calibrate the two spectra.\r\nThe Auger-TA energy spectrum working group was organized in 2012 and has been working to understand the uncertainties in energy scale in both experiments, their systematic differences, and differences in the shape of the spectra. In previous works, we reported that there was an overall agreement of the energy spectra measured by the two observatories below 10 EeV while at higher energies, a remaining significant difference was observed in the common declination band. We revisit this issue to understand its origin by examining the systematic uncertainties, statistical effects, and other possibilities. We will also discuss the differences in the spectra in different declination bands and a new feature in the spectrum recently reported by the Auger Collaboration.'

Collaborations
other (fill field below), Pierre Auger Observatory, Telescope Array

Keywords and Comments
'ultra-high energy cosmic rays; energy spectrum', 'Auger-TA working group report'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Telescope Array Combined Fit to Cosmic Ray Spectrum and Composition

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Douglas Bergman
Author and Co-Author
Douglas Bergman | For the Telescope Array Collaboration,

Abstract
'The cosmic rays observed at Earth have propagated through the universe over cosmological distances. The propagation should effect both the observed spectrum of cosmic rays and the abundance of different nuclear species that are observed at each energy. By performing a combined fit of Telescope Array spectrum and composition measurements to a simple source model consisting of a universal power-law with a rigidity dependent cutoff and variable, five-component composition fractions, one can constrain the possible sources of cosmic rays. We will present the results of such a fit using the Telescope Array surface array spectral measurements and the Telescope Array hybrid and stereo composition measurements.'

Collaborations
Telescope Array,

Keywords and Comments
'CR composition; CR spectrum; CR source model; CR propagation model', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

TA Monocular Spectrum Measurement

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
Douglas Bergman
Author and Co-Author
Douglas Bergman | Greg Furlich | For the Telescope Array Collaboration,

Abstract
'The Telescope Array (TA) Cosmic Ray Observatory is the largest cosmic ray detector in the northern hemisphere. TA was built to study ultra-high-energy cosmic rays (UHECRs), cosmic rays with energies above 1 EeV. TA is a hybrid detector, employing both a surface detector array and fluorescence telescopes. We present a measurement of the cosmic ray energy spectrum for energies above $10^{17.5}$ eV using only the fluorescence telescopes. A new, machine-learning based, weather classification scheme was used to select data parts with good weather and ensure the quality of the fluorescence data. The data from the Black Rock Mesa (BR) and Long Ridge (LR) fluorescence telescope stations were analyzed separately in monocular mode, with the calculated fluxes combined into a single spectrum. We present fits of the combined spectrum to a series of broken power law models. A three-times-broken power law gives the best fit. The three breaks suggest an additional feature of the spectrum between the previously observed Ankle and the GZK suppression.'

Collaborations
Telescope Array,

Keywords and Comments
'CR Spectrum; Monocular', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Constraining Lorentz Invariance Violation using the muon content of extensive air showers measured at the Pierre Auger Observatory

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 57 New Physics | CRD-CRI-DM-GAD-GAI-NU-MM-SH
Presenter Forum Table

Presenter
Caterina Trimarelli
Author and Co-Author
Caterina Trimarelli | For the Pierre Auger Collaboration,

Abstract
'Lorentz symmetry requires the space-time structure to be the same for all observers, but, on the other hand, various quantum gravity theories suggest that it may be violated when approaching the Planck scale. Even a small violation of Lorentz Invariance (LI) could easily affect the Ultra High Energy Cosmic Rays (UHECRs) propagation on a cosmological scale. Moreover, at the extreme energies, like those available in the collision of UHECRs with atmosphere, one should also expect a change in the interactions and, therefore, in the development of extensive air showers. For the first time, this effect has been studied using the muon content of air showers measured at the Pierre Auger Observatory. After having introduced Lorentz Invariance Violation (LIV) as a perturbation term in the single particle dispersion relation, a library of simulated showers with different energies, primary particles and LIV strengths has been produced. Leading to a change in the energy threshold of particle decays, the modification of the energy-momentum relation allows hadronic interactions of neutral pions that contribute to the growth of the hadronic cascade. As a consequence, an increase in the number of muons and a decrease in their intrinsic fluctuations are expected. Comparing the Monte Carlo expectations with the muon fluctuation measurements from the Pierre Auger Observatory, limits on LIV parameters have been derived and presented in this contribution.'

Collaborations
Auger,

Keywords and Comments
'Extensive Air Showers; Muon content; Lorentz Invariance Violation; etc.', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Recent measurement of the Telescope Array energy spectrum and observation of the shoulder feature in the Northern Hemisphere

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
Dmitri Ivanov
Author and Co-Author
Dmitri Ivanov, Douglas Bergman | Greg Furlich | Ricardo Gonzalez | Gordon Thomson | Yoshiki Tsunesada

Abstract
"The Telescope Array (TA) is a hybrid cosmic ray detector deployed in 2007 in Millard County, Utah, USA, which consists of a surface detector of 507 plastic scintillation counters spanning a 700 km^2 area on the ground that is overlooked by three fluorescence detector stations. The High Resolution Fly's Eye (HiRes) experiment is a predecessor of TA, which consisted of two fluorescence detector stations operating from 1997 until 2006 from Dugway Proving Ground, Utah, USA, and which was the the first cosmic ray experiment with sufficient resolution and exposure to successfully observe the Greisen–Zatsepin–Kuzmin (GZK) suppression at 10$^{19.75}$ eV. In this work, we present an updated TA energy spectrum result and a joint fit of independent spectrum measurements by the TA surface detector, TA fluorescence detector, and HiRes fluorescence detector to a broken power law function, which exhibits the ankle, GZK suppression, and the new shoulder feature initially seen by the Pierre Auger Observatory in the Southern Hemisphere. HiRes and TA observe the shoulder feature in the Northern Hemisphere at 10$^{19.25}$ eV, with a statistical significance of 5.3 standard deviations."

Collaborations
Telescope Array,

Keywords and Comments
"cosmic rays; energy spectrum; UHECR; ultrahigh energy;surface detector;telescope array;TA;high resolution fly's eye;HiRes;fluorescence detector; surface detector;", 'This presentation contains results we would like to include in a TA highlight talk'

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Density of GeV Muons Measured with IceTop

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Dennis Soldin
Author and Co-Author
Dennis Soldin | for the IceCube Collaboration,

Abstract
'We present a measurement of the density of GeV muons in near-vertical air showers using three years of data recorded by the IceTop array at the South Pole. We derive the muon densities as functions of energy at reference distances of 600 m and 800 m for primary energies between 2.5 PeV and 40 PeV and between 9 PeV and 120 PeV, respectively. The measurements are consistent with the predicted muon densities obtained from Sibyll 2.1 assuming any physically reasonable cosmic ray flux model. However, comparison to the post-LHC models QGSJet-II.04 and EPOS-LHC shows that the post-LHC predict a higher muon density than Sibyll 2.1. Therefore, based on these models, the measured data yield lower average masses which are in tension with flux models obtained by fitting experimental data.'

Collaborations
IceCube,

Keywords and Comments
'', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Update on the TAx4 Fluorescence Detectors

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Mathew Potts
Author and Co-Author
Mathew Potts | Collaboration TA,

Abstract
'Following the evidence for a hotspot in the arrival directions of the highest energy cosmic rays, the Telescope Array (TA) Experiment undertook the TAx4 upgrade to expand the area of our Surface Detectors (SD) by a factor of 4 and have added new Fluorescence Detector (FD) stations to view over the new SD arrays. Currently, TAx4 consists of 12 FDs and 257 SDs, of a planned 500, at a spacing of 2.08 km spread over two sites. TAx4 MD (4 FDs), completed in 2018, views over the northern wing of the new SD, and TAx4 BR (8 FDs), completed in 2019, views over the southern wing. Both FD sites are in routine observation, with data being taken remotely at the TAx4 BR site. In this presentation, we will report on the performance of the TAx4 FD, showing data/MC comparisons. We will present a preliminary monocular energy spectrum and the progress of hybrid analysis.'

Collaborations
Telescope Array,

Keywords and Comments
'Telescope Array; TAx4; Energy Spectrum; Cosmic Rays;', 'This presentation contains results we would like to include in a TA highlight talk. \r\nCould you please change the author from "TA, Collaboration" to just "the TA Collaboration."'

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Anisotropy search in the Ultra High Energy Cosmic Ray Spectrum in the Northern Hemisphere using latest data obtained with Telescope Array surface detector

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Toshiyuki Nonaka
Author and Co-Author
Toshiyuki Nonaka, for the Telescope Array Collaboration

Abstract
'The Telescope Array (TA) experiment is located in the western desert of Utah, USA and observes ultra-high energy cosmic rays in the northern hemisphere. At the energies, the shape of the cosmic ray energy spectrum carries information of the source distribution. We present the search for differences in spectrum shape in different parts of the sky using latest data of TA surface detector (SD) data. From this study, we observe an apparent enhancement in the region of the northern sky that contain nearby objects, such as the super-galactic plane. Details of this analysis will be presented.'

Collaborations
Telescope Array,

Keywords and Comments
'Ultra high energy cosmic ray; cosmic ray propagation', 'The result will be refereed in highlight talk of Telescope Array experiment also.'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Insight Into Lightning Initiation via Downward Terrestrial Gamma-ray Flash Observations at Telescope Array

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
Jackson Remington
Author and Co-Author
Jackson Remington, John Belz | Paul Krehbiel | Mark Stanley | Rasha Abbasi | Ryan LeVon | William Rison | Daniel Rodeheffer

Abstract
'Due to the difficulty of direct measurement of the thunderstorm environment, in particular the electric field strengths, the initial stages of lightning breakdown remain mysterious. The 1994 discovery of Terrestrial Gamma-ray Flashes (TGFs) and their implications for megavolt potentials within thunderclouds has proved to be a valuable source of information about the breakdown process.\r\n\r\nThe Telescope Array Surface Detector (TASD) --- a 700 km^2 scintillator array in Western Utah, U.S.A --- coupled with a lightning mapping array, fast sferic (field change) sensor and broadband interferometer, has provided unique insight into the properties of this energetic radiation and of lightning initiation in general. In particular, microsecond-scale timing comparisons have clearly established that downward TGFs occur during strong initial breakdown pulses (IBPs) of downward negative cloud-to-ground and intracloud flashes. In turn, the IBPs are produced by streamer-based fast negative breakdown.\r\n\r\nInvestigations into downward TGFs with the TASD have significantly evolved with recent upgrades to lightning instrumentation. A second state-of-the-art broadband interferometer allows high-resolution stereo observation of lightning development. A high-speed optical video camera, set to be deployed in Spring 2021, will allow simultaneous observation of the visual component of lightning responsible for TGF production. Finally, a suite of ground based static electric field mills will provide new information on the large-scale properties of the thunderstorms in which downward TGFs arise.\r\n\r\nIn this talk, we present the most recent TGF observations from the Telescope Array.'

Collaborations
Telescope Array,

Keywords and Comments
'TA;TASD;LMA;lightning;terrestrial gamma-ray flash;TGF;streamer;leader;gamma', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Cosmic Ray Composition between 2 PeV and 2 EeV measured by the TALE Fluorescence Detector

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Tareq AbuZayyad
Author and Co-Author
Tareq AbuZayyad | For the Telescope Array Collaboration,

Abstract
'The Telescope Array (TA) cosmic rays detector located in the State of Utah in the United States is the largest ultra high energy cosmic rays detector in the northern hemisphere. The Telescope Array Low Energy Extension (TALE) fluorescence detector (FD) was added to TA in order to lower the detector\'s energy threshold, and has succeeded in measuring the cosmic rays energy spectrum down to PeV energies, by making use of the direct Cherenkov light produced by air showers. In this contribution we present the results of a measurement of the cosmic-ray composition using TALE FD data collected over a period of ~4 years. TALE FD data is used to measure the X_{max} distributions of showers seen in the energy range of $10^{15.3}$ - $10^{18.3}$ eV. The data distributions are fit to Monte Carlo distributions of {H, He, N, Fe} cosmic-ray primaries for energies up to 10^{18} eV. Mean X_{max} values are measured for the full energy range. TALE observes a light composition at the "Knee", that gets gradually heavier as energy increases toward the "Second-Knee". An increase in the X_{max} elongation rate is observed at energies just above $10^{17.3}$ eV indicating a change in the cosmic rays composition from a heavier to a lighter mix of primaries.'

Collaborations
Telescope Array,

Keywords and Comments
'Cosmic Rays; Composition; Cherenkov; Galactic Cosmic Rays; Knee', 'This presentation contains results we would like to include in a TA highlight talk.'

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Cosmic Ray Energy Spectrum measured by the TALE Fluorescence Detector

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
Tareq AbuZayyad
Author and Co-Author
Tareq AbuZayyad | For the Telescope Array Collaboration,

Abstract
'The Telescope Array (TA) cosmic rays detector located in the State of Utah in the United States is the largest ultra high energy cosmic rays detector in the northern hemisphere. The Telescope Array Low Energy Extension (TALE) fluorescence detector (FD) was added to TA in order to lower the detector\'s energy threshold, and has succeeded in measuring the cosmic rays energy spectrum and mass composition down to PeV energies. In this contribution we describe the measurement of the cosmic ray energy spectrum using $\\sim4$ years of TALE FD data. The energy spectrum shows features consistent with the "knee" and the "second knee".'

Collaborations
Telescope Array,

Keywords and Comments
'Cosmic Rays; Galactic Extra-Galactic Transition; Knee', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

LHCf plan for proton-oxygen collisions at LHC

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Eugenio Berti
Author and Co-Author
Eugenio Berti | Lorenzo Bonechi,

Abstract
'During LHC runs 1-2 the LHCf experiment measured neutral particles in the forward region of proton+proton and proton+lead ion collisions. These measurements allow the testing and fine tuning of hadronic interaction models in a phase space region relevant for studying the development of cosmic-ray air showers. One of the limitations in using the results obtained so far by LHCf is linked to the fact that the interactions of cosmic rays in the atmosphere involve low mass nuclei, mainly nitrogen and oxygen. Expectations for proton+nitrogen or proton+oxygen collisions can be obtained interpolating the results obtained with proton+proton and proton+lead collisions, but large uncertainties arise due to Ultra Peripheral Collisions occurring frequently in heavy ion interactions.\r\nA new opportunity is under evaluation at the LHC, concerning the injection of oxygen ions in the LHC collider, as suggested in the past by the LHCf collaboration. Proton+oxygen collisions at the LHC energy scale would allow a direct study of atmospheric showers under controlled conditions. LHCf need a 2 nb^-1 integrated luminosity at low pile-up (mu<0.02) to complete a measurement at pseudorapidity larger than 8.4, for a total acquisition time of less than two days.\r\nAt the end of 2020 the cosmic-ray community has supported the LHCf proposal signing a letter to the LHC Committee to express the interest in the implementation of proton-oxygen collisions in the LHC run 3 and in the LHCf data taking.\r\nWe will present the LHCf plan and point of view in connection with this important opportunity at the LHC.'

Collaborations
other (fill field below), LHCf

Keywords and Comments
'Forward physics at LHC; particle accelerator; calibration of hadronic interaction models', 'on behalf of the LHCf collaboration'

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Update on the Combined Analysis of Muon Measurements from Nine Air Shower Experiments

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Dennis Soldin
Author and Co-Author
Dennis Soldin | for the EAS-MSU | IceCube | KASCADE-Grande | NEVOD-DECOR | Pierre Auger | SUGAR | Telescope Array | Yakutsk EAS Array Collaborations,

Abstract
'Over the last two decades, various experiments have measured muon densities in extensive air showers over several orders of magnitude in primary energy. While some experiments observed differences in the muon densities between simulated and experimentally measured air showers, others reported no discrepancies. We will present an update of the meta-analysis of muon measurements from nine air shower experiments, covering shower energies between a few PeV and tens of EeV and muon threshold energies from a few 100 MeV to about 10 GeV. In order to compare measurements from different experiments, their energy scale was cross-calibrated and the experimental data has been compared using a universal reference scale based on air shower simulations. Above 10 PeV, we find a muon excess with respect to simulations for all hadronic interaction models considered. This excess is increasing with shower energy, and for the models EPOS-LHC and QGSJet-II.04 the slope of the increase is found to be significant with more than 8 sigma.'

Collaborations
, Working Group on Hadronic Interactions and Shower Physics (WHISP)

Keywords and Comments
'WHISP; Extensive Air Showers; Atmospheric Muons', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The performances of the LHAASO-KM2A tested by the observation of cosmic-ray Moon shadow.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 75

Presenter
Yuncheng Nan
Author and Co-Author
Yuncheng Nan | Songzhan Chen | Zhe Li | Sha Wu | Yizhuo Li | Cunfeng Feng | for the LHAASO Collaboration,

Abstract
"The half array of the KM2A in LHAASO has been operated since the end of 2019. It is a major ground-based array for the researches on cosmic rays around knees and the gamma-ray astronomy at ultra-high energy, which depends heavily on its performances. The cosmic-ray Moon shadow, which is observed by KM2A with monthly significance of 25 standard deviation, is used as an unique and powerful source to test the array's performances. Through the observation of the characteristics of the Moon shadow, including the displacement from the centre, the shape, the deficit, and their variation with the time and energy, we discuss the pointing error, the angular resolution, the long-term stability of the KM2A and the absolute energy scale of the primary cosmic-ray particles. In particular, the position of Moon varies within a declination band of about ±25°, the pointing errors of KM2A to observe sources at different declinations are thoroughly tested in this work."

Collaborations
Lhaaso,

Keywords and Comments
'Moon Shadow；performance of LHAASO-KM2A', 'I submitted two substracts. If the other substract is determined to be oral, I will change the type of this to poster. If not, I will still keep the oral form of this report.'

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Observation of large-scale anisotropy in the arrival directions of cosmic rays with LHAASO

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Wei Gao
Author and Co-Author
Wei Gao, Qing Cao | Hengying Zhang | Huihai He | Songzhan Chen | Shuwang Cui | Sha Wu | Wenlong Li | Chengguang Zhu | for the LHAASO Collaboration

Abstract
'A global large-scale anisotropy in the arrival directions of cosmic rays were observed both in the Northern and Southern Hemisphere. Above 100 TeV, change in the morphology of the arrival direction distribution is appeared. However, most reports of anisotropy are from TeV to hundred TeV and only a few experiments can up to PeV with long term data accumulation. The measurement of anisotropy at high energies are need to enrich and provide more clues to the origin and propagation of cosmic rays. The Large High Altitude Air Shower Observatory (LHAASO), covering an area of 1.36 sq.km., could detect cosmic rays from hundred GeV up to 100 PeV with good element discrimination ability. In this paper, data collected by WCDA during 2019 and KM2A during 2020 are used to analyze the large-scale anisotropy. The anisoptropies in a very wide energy range from TeV up to PeV are reported and the results are compared with others. With the operation of LHAASO, more accurate observation for the cosmic-ray anisotropy at higher energy will be made.'

Collaborations
Lhaaso,

Keywords and Comments
'large-scale anisotropy; LHAASO; cosmic ray', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Measurement of muon contents in cosmic ray shower with LHAASO-KM2A around knee region

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Hengying Zhang
Author and Co-Author
Hengying Zhang | Liping Wang | Xiaoting Feng, Songzhan Chen | Cunfeng Feng | Huihai He | Cong Li | Lingling Ma | for the LHAASO Collaboration

Abstract
'The number of muons observed at the ground from air showers is sensitive to the mass composition of cosmic ray. Large High Altitude Air Shower Observatory is a hybrid extensive air shower array and the KM2A is a sub-array covering an area of 1 km^2, consisting of electromagnetic detectors and muon detectors, can measure the muon content and shower size of the air shower simultaneously with high precision for cosmic rays in the knee region. The muon detector of the KM2A is the most powerful muon detector in the current cosmic ray observatory on the ground. In this paper, the experimental data is recorded by the KM2A in 2020. The mean number of muons in air shower is measured by analyzing the signal of muon detectors for the cosmic ray from hundreds of TeV to tens of PeV, where the energy is reconstructed with the shower size and muon number which is weakly dependent on the components of cosmic ray. We investigate the ability to identify cosmic ray components using muon content. Based on the constant intensity cut method, the muon attenuation length is derived by fitting the muon number with same flux in different zenith angle. The relation between attenuation length and muon number in the shower is studied also. In addition, the experiment data in muon abundance is compared with the simulation results of proton and iron. The mean logarithmic mass of the cosmic ray derived from the mean number of muons in same energy interval, together with the mean mass of supposed spectra, are presented with systematic errors from the energy scale and hadronic model.'

Collaborations
Lhaaso,

Keywords and Comments
'LHAASO-KM2A; cosmic ray; muon content; mean mass; knee region', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Cosmic Ray Composition in the Second Knee Region as Measured by the TALE Hybrid Detector

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Keitaro Fujita
Author and Co-Author
Keitaro Fujita, for the Telescope Array Collaboration

Abstract
'The Telescope Array Low-energy Extension (TALE) experiment is a hybrid air shower detector for the observation of air showers induced by cosmic rays with energy above 10^{16} eV. The TALE detector consists of a Fluorescence Detector (FD) station with 10 FD telescopes located at the TA Middle Drum FD Station (itself made up of 14 FD telescopes), and a Surface Detector (SD) array made up of 80 scintillation counters, including 40 with 400 m spacing and 40 with 600 m spacing. A triggering system for the TALE-SD using an external trigger from the TALE-FD, a so-called hybrid trigger, allows for a lower energy threshold. The TALE hybrid trigger system has been working since 2018. Here we present an estimate of the performance of hybrid detection using a Monte Carlo simulation, and a first measurement of the cosmic ray composition using the TALE-Hybrid detector.'

Collaborations
Telescope Array,

Keywords and Comments
'', 'This presentation contains results we would like to include in a TA highlight talk.'

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The Mini-EUSO telescope on board the International Space Station: Launch and first results

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Marco Casolino
Author and Co-Author
Marco Casolino | Pavel Klimov,

Abstract
'Mini-EUSO is a detector observing the Earth in the ultraviolet band from the International Space Station. It was launched in 2019 in the framework of the "Beyond" mission and as part of an agreement between Russian and Italian space agencies.\r\nThe main camera has an optical system with two double-sided Fresnel lenses and a focal surface with 2304 channels and a field of view of 44^o. The observed bandwidth is in the range 290-430 nm, where emissions from Nitrogen de-excitation of Ultra-High Energy cosmic rays Extensive Air showers are located. The telescope observes the Earth with a pixel size of 6.3 km, sampling of 2.5μs, through a nadir-facing UV-transparent window in the Russian Zvezda module. It also has two cameras in the near infrared and visible ranges and Silicon Photomultipliers. Mini-EUSO is capable of observing Extensive Air Showers generated by Cosmic Rays with energy above 10^21 eV and detect artificial showers generated from the ground with LED flashers and lasers. Among the scientific objectives are the search for nuclearites and Strange Quark Matter, the study of atmospheric phenomena such as Transient luminous events, meteors and meteoroids, the observation of artificial satellites and man-made space debris.\r\nIn this talk we will present the launch, the first results and the perspectives for observations in light of the flight of EUSO-SPB2 and future missions such as K-EUSO and Poemma.'

Collaborations
other (fill field below), JEM-EUSO

Keywords and Comments
'International Space Station; UHECR; Fluorescence detectors; Strange Quark Matter;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Performance and simulation of the surface detector array of the TAx4 experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 76

Presenter
Kozo Fujisue
Author and Co-Author
Kozo Fujisue | For the Telescope Array Collaboration,

Abstract
'The TAx4 experiment is a project to observe highest energy cosmic rays by expanding the detection area of the Telescope Array (TA) experiment with newly constructed surface detectors (SDs) and fluorescence detectors (FDs). New SDs are arranged in a square grid with 2.08 km spacing at the north east and south east of the TA SD array. We use CORSIKA simulations and implement the calibration data of the new SDs to calculate the performance of the new SDs. We compare the data with the simulation and validate the performance of the SDs. The comparison and the performance will be shown in the presentation.'

Collaborations
Telescope Array,

Keywords and Comments
'Ultra high energy cosmic rays; simulation; etc.', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The Energy Scale Calibration using the Moon Shadow of LHAASO-WCDA Detector

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 10 EAS reconstruction and analyses | CRI
Presenter Forum Table

Presenter
Yanjin Wang
Author and Co-Author
Yanjin Wang, Min Zha | Zhen Cao | Xin Zhang

Abstract
'The shadow of the moon observed with cosmic rays offers a good ability to\r\ndo Energy scale calibration below a few TeV. Water Cherenkov Detector Array\r\n(WCDA), one of components of Large High Altitude Air Shower Observation\r\n(LHAASO), has lower threshold, and high duty cycle, which make itself a very good\r\nfacility in this particular aspect. In this presentation, a work to study the energy scale calibration will be presented, some related works are also going to be shown.'

Collaborations
Lhaaso,

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Testing Hadronic Interaction Models with Cosmic Ray Measurements at the IceCube Neutrino Observatory

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Stef Verpoest
Author and Co-Author
Stef Verpoest | Dennis Soldin | Sam De Ridder | For the IceCube collaboration,

Abstract
'The IceCube Neutrino Observatory, with its deep in-ice detector IceCube and surface array IceTop, provides the unique possibility to measure the low-energy (~1 GeV) and high-energy (>500 GeV) muon component as well as the electromagnetic component of cosmic-ray air showers simultaneously. For events coincident between the two detectors, IceTop provides an estimate of the primary cosmic-ray energy and a sensitivity to the density of low-energy surface muons. In IceCube, the energy loss of the associated high-energy muon bundle is reconstructed. The muon energy spectra predicted by air shower simulations are strongly dependent on which hadronic interaction model is used. Therefore, in this work, we present an analysis of air shower data between 2.5 and 100 PeV, comparing the surface muon density measurement with the energy loss of the high-energy muon bundle and the reconstructed lateral distribution function's slope under different composition assumptions to test the internal consistency of several hadronic interaction models.'

Collaborations
IceCube,

Keywords and Comments
'Cosmic Rays; Air showers; Hadronic interaction models; Muons', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Effects of Galactic magnetic field on the UHECR anisotropy studies

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Ryo Higuchi
Author and Co-Author
Ryo Higuchi, Takashi Sako | Kazumasa Kawata | Toshihiro Fujii | Eiji Kido

Abstract
'Telescope Array (TA) and Auger experiments reported anisotropies in the arrival direction of ultra-high-energy cosmic rays (UHECRs). In particular, Auger reported a correlation between UHECR events and the flux model of assumed sources, and suggested a contribution of starburst galaxies (SBGs) to the anisotropy of UHECRs. However, they did not take into account the effect of coherent deflections by the galactic magnetic field (GMF) and the consequent effects of the energy spectrum and mass composition. In this study, we investigated the effect of the GMF on the arrival directions of UHECRs using the cosmic ray propagation code CRPropa3. We used a backtracking technique which consists in propagating antiparticles from the Earth. We analyzed the reported anisotropies, namely, the hot spot by TA and the SBG correlation by Auger, and found that the effect of GMF is small with pure proton assumption. By building a forward-tracking-function based on the backtracking calculation, we constructed a new method of calculating the flux model of sources with a convolution of GMF, energy spectrum and mass composition. We studied the source models of UHECRs that can be verified at high significance with the upcoming TAx4 data.'

Collaborations
Telescope Array,

Keywords and Comments
'"Cosmic Ray";"Galactic Magnetic Field"', "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Event-by-event reconstruction of the shower maximum X_max with the Surface Detector of the Pierre Auger Observatory using deep learning

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 77

Presenter
Jonas Glombitza
Author and Co-Author
Jonas Glombitza | For the Pierre Auger Collaboration,

Abstract
'The measurement of the mass composition of ultra-high energy cosmic rays constitutes one of the\r\nbiggest challenges in astroparticle physics. Most detailed information on the composition\r\ncan be obtained from measurements of the depth of maximum of air showers, $X_\\mathrm{max}$, with the use of fluorescence telescopes, which can be operated only during clear and moonless nights.\r\n\r\nUsing deep neural networks, it is now possible for the first time to perform an event-by-event\r\nreconstruction of $X_\\mathrm{max}$ with the Surface Detector (SD) of the Pierre Auger Observatory. Therefore, previously recorded data can be analyzed for information on $X_\\mathrm{max}$, and thus the cosmic-ray composition. Since the SD operates with a duty cycle of almost 100% and its event selection is less strict than for the Fluorescence Detector (FD), the gain in statistics with respect to the FD is almost a factor of 15 for energies above $10^{19.5}$ eV.\r\n\r\nIn this contribution, we introduce the neural network particularly designed for the SD of the Pierre Auger Observatory. We evaluate its performance using three different hadronic interaction models and verify its functionality using Auger hybrid measurements. \r\nFinally, we quantify the expected systematic uncertainties and show that the method permits to determine the first two moments of the $X_\\mathrm{max}$ distributions up to the highest energies.'

Collaborations
Auger,

Keywords and Comments
'machine learning; mass composition;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Measurements of the charge ratio and polarization of cosmic ray muons with the Super-Kamiokande detector

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Hussain Kitagawa
Author and Co-Author
Hussain Kitagawa, Yuuki Nakano | Yusuke Koshio

Abstract
'Cosmic ray muons arise from the showers of secondary particles produced in the interactions of primary cosmic particles with air nuclei at the top of the atmosphere. The interaction products, pions and kaons composing showers mostly decay to muons reflect the details of the hadronic interactions depending on their energy. Measurements of the charge ratio and polarization of cosmic ray muons can be used to constrain high energy hadronic interaction models in the atmosphere. Previous measurements have been performed in various experiments. Kamiokande measured the charge ratio and polarization as 1.37+/-0.06(stat)+/-0.01(syst) and 0.26+/-0.04(stat)+/-0.05(syst), respectively, at the sea level momentum of 1.2 TeV/c. In this presentation, we will report the current status of the measurement of the charge ratio and polarization using data collected by the Super-Kamiokande detector located at a depth of 2700 m of water equivalent.'

Collaborations
other (fill field below), Super-Kamiokande

Keywords and Comments
'Cosmic ray muons; Charge ratio; Polarization', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Tunka-Grande array for high-energy gamma-ray astronomy and cosmic-ray physics: preliminary results.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 78

Presenter
Anna Ivanova
Author and Co-Author
Anna Ivanova | Roman Monkhoev | for TAIGA Collaboration,

Abstract
'The Tunka-Grande scintillation array is a part of the TAIGA experimental complex designed for high-energy gamma-ray astronomy and cosmic-ray physics.\r\nIn this work methods of reconstruction of primary particles parameters are presented, as well as the accuracy of reconstruction of the EAS core position, energy, and arrival direction, obtained by comparing the reconstruction results with the data of the Tunka-133 and TAIGA-HiSCORE Cherenkov arrays. The preliminary all-particle energy spectrum based on 3 operation seasons of the installation is presented.'

Collaborations
TAIGA,

Keywords and Comments
'High energy cosmic rays; air shower; scintillation detectors; energy spectrum.', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Cosmic ray energy spectrum in the 2nd knee region measured by the TALE-SD array

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
Koki Sato
Author and Co-Author
Koki Sato | For the Telescope Array collaboration,

Abstract
'The Telescope Array Low energy Extension (TALE) experiment in Utah, U.S.A., consists of 10 atmospheric fluorescence telescopes and 80 Surface Detectors (SDs) spread over an area of 21 km^2. The SD array consists of 40 SDs at 400 m spacing and 40 SDs at 600 m spacing. The TALE-SD was completed in February 2018 and has been in steady operation since then, triggering at a rate of about 30 air shower events in 10 minutes. We have developed the software to measure the energy spectrum of cosmic rays from the data obtained by TALE-SD. The performance of the software was evaluated by using air shower events generated by Monte Carlo simulation. We estimate that when the energy of the primary cosmic ray is $10^{18.0}$eV, the accuracy of energy determination is 15%, the accuracy of arrival direction determination is 1.5°, and the aperture is 15 km^2 sr. Furthermore, we obtained the energy spectrum of cosmic rays from the actual data obtained by the TALE-SD array from October to the end of November 2019. In this presentation, I will report these results.'

Collaborations
Telescope Array,

Keywords and Comments
'', 'This presentation contains results we would like to include in a TA highlight talk.'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Features of a single source describing the very end of the energy spectrum of cosmic rays

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 02 Constraining UHECR sources | CRI
Presenter Forum Table

Presenter
Alena Bakalova
Author and Co-Author
Alena Bakalova, Jakub Vícha | Petr Travnicek

Abstract
'The energy spectrum of cosmic rays extends over many orders of magnitude with a steep suppression of the flux at the highest energies. The energy spectrum of ultra-high energy cosmic rays (UHECR) is measured with great precision by the Pierre Auger Observatory (Auger) and Telescope Array. However, the two measured spectra show different slopes of the decrease at the highest energies. This disagreement can be caused by the ability of these two experiments to see different parts of the night sky and, therefore, in principle, different sources of UHECR as well. In our study, we investigate the possibility that the energy spectrum measured by Auger at energies above $log(E/eV)\\geq19.5$ could be explained by a dominant single strong source. We explore the space of possible features of such a source including its distance, spectral index and mass composition, and compare the resulting flux after propagation using simulations within CRPropa 3 with the data measured by Auger. No restrictions are made on the measurement of shower maximum tightly connected with the mass composition due to large uncertainties at the highest energies. We show the possible parameters of such a source and explore possible mass composition mixes that could explain the data well.'

Collaborations
Auger,

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Study horizontal air showers with LHAASO-KM2A

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 79

Presenter
Quanbu Gou
Author and Co-Author
Quanbu Gou | Zhuo Li | Giuseppe Di Sciascio | Chao Hou | Jiangtao Liu | Xiaochuan Chang | Hongkui Lv | Lili Yang | Sujie Lin | Andrea Addazi | Xuewen Liu | Mingming Kang | Antonino Marciano | Jinsheng Gou | Shiyu Yin | Yaping Wang | Zihan Yang | Xishui T,

Abstract
'LHAASO-KM2A is a sub-array of the Large High Altitude Air Shower Observatory (LHAASO) with an area of 1.3 km2. It consists of 5195 electromagnetic detectors (EDs, 1 m2 each) and 1171 muon detectors (MDs, 36 m2 each). Horizontal Air Showers (HAS) are a fundamental tool to detect penetrating particles like neutrinos and to study hadronic interactions. HAS detected at ground are mainly constituted by secondary muons. In this contribution first observations of HAS with EDs of LHAASO-KM2A are reported. We discuss the zenith angle distribution of EAS and the transition from electromagnetic-dominated showers to muon-dominated ones above a zenith angle of 60 degree. Muon contents together with hadronic interaction models will also be discussed.'

Collaborations
Lhaaso,

Keywords and Comments
'horizontal air showers;muon contents; hadronic interaction models', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Simulation Study on Scaler Mode in LHAASO-KM2A

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 80

Presenter
Daihui Huang
Author and Co-Author
Zhicheng Huang | Daihui Huang | Xunxiu Zhou | Jing Zhao | Huihai He | songzhan Chen | Xinhua Ma | Dong Liu | Kegu Axi | Bing Zhao,

Abstract
'LHAASO, located at Daocheng in Sichuan province of China with an altitude up to 4410 m above the sea level, takes the function of hybrid technology to detect cosmic rays. As the major array of LHAASO, KM2A is composed of 5195 electromagnetic particle detectors (EDs) and 1188 muon detectors (MDs). In the ground-based experiments, there are two common independent data acquisition systems, corresponding to the scaler and shower operation modes. In order to learn more about the scaler mode in LHAASO-KM2A, we adopt the CORSIKA to study the shower development and employ the G4KM2A (based on Geant4) to simulate the detector responses. For one cluster (composed of 64 EDs) in the array of KM2A-ED, the event rates of showers having a number of fired EDs ≥1, 2, 3 and 4 (in a time coincidence of 100 ns) are recorded. The average rates of the four multiplicities are ~88 kHz, ~1.4 kHz, ~210 Hz, ~110 Hz, respectively. For the array of KM2A-MD, there are 16 MDs in one cluster. The average rates with multiplicities ≥1 and ≥2 are ~84 kHz and ~890 Hz, respectively. The corresponding primary energies are also given. According to our simulations, the energy threshold of the scaler mode can be lowered to ~ 100 GeV. At the same time, the energy threshold of LHAASO-KM2A in shower mode is presented for comparison. The simulation results in this work are beneficial for the online trigger with scaler mode, and also be useful in understanding the experiment results in LHAASO-KM2A.'

Collaborations
Lhaaso,

Keywords and Comments
'Scaler mode; Shower mode; LHAASO-KM2A; Monte Carlo simulations; Cosmic rays', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The progress of High-Energy Physics in Atmosphere achieved with the implementation of particle physics and nuclear spectroscopy methods

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
Ashot Chilingarian
Author and Co-Author
Ashot Chilingarian,

Abstract
'At Aragats research station we are consistently applying methods of particle physics and nuclear spectroscopy for revealing details of the operation of electron accelerators emerging just above our heads in the thunderclouds. The newly emerging field of high-energy physics in the atmosphere needs successive application of experimentation paired with the simulation of physical processes with CORSIKA and GEANT4 packages well established in the high-energy physics community. In addition to the minute-long fluxes of high-energy electrons and gamma rays from relativistic runaway electron avalanches (RREA), we discover also the origin of hour-long isotropic fluxes of low-energy gamma rays from the 222Rn progeny. During 12 years of 24/7 monitoring of cosmic ray fluxes, we observe more than half-of-thousand thunderstorm ground enhancements (TGEs). Each od cosmic-ray species brings its own special evidence on the structure and strength of the atmospheric electric field. The depletion of muon flux (muon stopping effect) observed simultaneously with the world's largest-ever enhancement of electron and gamma rays at Mt. Lomnicky Stit allows us to estimate the maximum value of the atmospheric electric field. Using a high-precision spectrometer for the measurement of the energy spectra of the natural gamma radiation we discovered a new effect of circulation of radon progeny during thunderstorms. The comparison of electron and gamma ray energy spectra allows us to localize the emerging electrical structures in the atmosphere which makes it possible to accelerate seed electrons up to ≈100 MeV. Measuring simultaneously neutron and gamma ray fluxes by a neutron monitor and SEVAN hybrid particle detector we prove the photonuclear origin of the atmospheric neutrons.'

Collaborations

Keywords and Comments
'Electron accelerator in the atmosphere; energy spectra of electrons; and gamma rays of the atmospheric origin; Atmospheric electricity; TGE; RREA; LPCR', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Observation of Transient Luminous Events with the Mini-EUSO telescope on board the ISS

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
laura marcelli
Author and Co-Author
laura marcelli | Marco Casolino | Enrico Arnone | Matteo Battisti | Mario Bertaina | Pavel Klimov | Lech Wiktor Piotrowski, for the JEM-EUSO Collaboration

Abstract
'Mini-EUSO is a detector observing the Earth in the ultraviolet band from the International Space Station,from a nadir-facing window, transparent to the UV radiation in the Russian Zvezda module.\r\nThe instrument, launched in 2019 as part of the Italian Beyond mission, has a field of view of 44◦, a spatial resolution on the ionosphere of 4.7 km and a sampling rate of 2.5 microseconds.\r\nMini-EUSO main detector consists in an optical system with two Fresnel lenses and a focal surface composed of an array of 36 Hamamatsu multi-anode photo-multiplier tubes, for a total of 2304 pixels. The telescope also contains two ancillary cameras, in the near infrared and visible ranges, to complement measurements in these bandwidths.\r\nThe telescope detects UV emissions of cosmic, atmospheric and terrestrial origin on different time scales, from a few microseconds upwards. On the fastest timescale of 2.5 microseconds, Mini-EUSO is able to observe atmospheric phenomena as Transient Luminous Events and in particular the ELVES, apparently superluminal rings produced by the interaction with the ionosphere of spherical electromagnetic waves generated by lightning. These highly energetic fast events has been observed to be produced in conjunction with Terrestrial Gamma-Ray Flashes and therefore a detailed study of their characteristics (speed, radius, energy ...) is of crucial importance for the understanding of these phenomena.\r\nIn this work we will present the measurements of Transient Luminous Events and specifically the reconstruction and study of ELVE characteristics with Mini-EUSO.'

Collaborations

Keywords and Comments
'', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

A combined fit of energy spectrum, shower depth distribution and arrival directions to constrain astrophysical models of UHECR sources

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 02 Constraining UHECR sources | CRI
Presenter Forum Table

Presenter
Teresa Bister
Author and Co-Author
Teresa Bister, for the Pierre Auger Collaboration

Abstract
'The combined fit of the measured energy spectrum and shower depth distribution of ultra-high-energy cosmic rays is known to constrain the parameters of astrophysical scenarios with homogeneous source distributions. Further measurements show that the cosmic-ray arrival directions agree better with the directions and fluxes of catalogs of starburst galaxies and active galactic nuclei than with isotropy.\r\nHere, we present a novel combination of both analyses. For that, a three-dimensional universe model containing a nearby source population and a homogeneous background source distribution is built, and its parameters are adapted using a combined fit of energy spectrum, shower depth distribution and energy-dependent arrival directions. The model takes into account a symmetric magnetic field blurring, source evolution and interactions during propagation.\r\nWe use simulated data, which resemble measurements of the Pierre Auger Observatory, to evaluate the method’s sensitivity. By that, we are able to verify that the source parameters as well as the fraction of events from the nearby source population and the size of the magnetic field blurring are determined correctly, and that the data is described by the fitted model including the catalog sources with their respective fluxes and three-dimensional positions. We demonstrate that by combining all three measurements we reach the sensitivity necessary to discriminate between the catalogs of starburst galaxies and active galactic nuclei.'

Collaborations
Auger,

Keywords and Comments
'UHECR sources; SBG; AGN; combined fit', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Latest results from the PolarquEEEst missions

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 81

Presenter
Marcello Abbrescia
Author and Co-Author
Marcello Abbrescia | for the EEE collaboration,

Abstract
'The PolarquEEEst scientific programme consists in a series of measurements of the cosmic ray flux up to the highest latitudes, well beyond the Polar Article Circle. It started in Summer 2018, when one telescope for cosmic rays was installed on a sailboat leaving from North Iceland, to circumnavigate the Svalbard archipelago and land in Tromsø. It collected data up to 82N, measuring with unprecedented precision the charged particle rate at sea level in these regions.\r\n\r\nDuring Fall of the same year and Spring 2019 the PolarquEEEst programme continued with a series of measurements performed using the same detector, which took place first in Italy, with the southernmost point reached at Lampedusa, and then in Germany, with the goal to measure the dependence of cosmic charged particle rate with latitude.\r\n\r\nThen, in May 2019, the PolarquEEEst collaboration accomplished another important result, installing a cosmic ray observatory for the detection of secondary cosmic muons at Ny Alesund, at 79N, made of three independent identical detectors positioned a few hundred meters from each other, and synchronized in order to operate together as a network. This configuration allows high precision measurements never performed before at these latitudes on a long term, also interesting for their connection with environmental phenomena.\r\n\r\nHere the various missions will be presented, and the latest results from the measurements performed will be shown.'

Collaborations
other (fill field below), Extreme Energy Events (EEE)

Keywords and Comments
'secondary cosmic rays; latitude dependance', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Integration and qualification of the Mini-EUSO telescope on board the ISS

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Giorgio Cambiè
Author and Co-Author
Giorgio Cambiè | Laura Marcelli | Marco Casolino,

Abstract
'Mini-EUSO is a new space-based experiment designed primarily to observe showers that develop in atmosphere due to the interaction between molecular nitrogen and Ultra High Energy Cosmic particles (above 10 ZeV) crossing by. It belongs to the JEM-EUSO program, which includes\r\nseveral past experiments all devoted to develop new larger size satellite detectors like K-EUSO and POEMMA for future UHEC Rays study from space. Mini-EUSO is a multiwavelenght telescope launched on August 2019 with the unmanned Soyuz MS-14 rocket to the International Space Station and currently operating on board the Russian Zvezda module, facing a UV-transparent window watching Earth in Nadir direction. The telescope optics comprise a main detection system employing two double-sided Fresnel lenses focusing UV (300–400 nm) light onto an array of 36 Hamamatsu Multi-Anode PhotoMultiplier Tubes, each of 64 channels for a total of 2304 pixels working in single photon counting mode, providing a wide field of view (44°) correpsonding to a ground area of 263 km x 263 km with a time resolution up to few microseconds.\r\nMini-EUSO includes also multiple ancillary sensors such as visible (400–780 nm) and NIR (1500– 1600 nm) cameras as well as a 64 channels Multi- Pixel Photon Counter Silicon PhotoMultiplier array which will increase the Technology Readiness Level of this ultrafast imaging sensor. Beside the primary objective, the mission aims to study different event such as meteoroids, Transient Luminous Event, search for Strange Quark matter and is capable to provide UV Earth maps over the surface covered during ISS orbits. In this work we will present the detector integration, qualification measurements on ground and some preliminary data.'

Collaborations
other (fill field below), on behalf of the JEM-EUSO Collaboration

Keywords and Comments
'', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

On the cosmic-ray energy scale of the LOFAR radio telescope

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 82

Presenter
Katharine Mulrey
Author and Co-Author
Katharine Mulrey, For the LOFAR CR-KSP

Abstract
'Cosmic rays are measured at LOFAR simultaneously with a dense array of antennas and with the LOFAR Radboud air shower Array (LORA) which consists of 20 scintillators. In this contribution we present cosmic-ray energy reconstruction using radio and particle techniques and discuss the event-by-event and absolute scale uncertainties. The energies reconstructed with each method are shown to be in good agreement. The radio-based reconstruction has smaller uncertainty on an event-to event basis, so LOFAR analyses will use that technique in the future. We also present the radiation energy of air showers measured at LOFAR. Radiation energy scales quadratically with the electromagnetic energy in an air shower, which can be related to the energy of the primary cosmic ray. Once the local magnetic field is accounted for, the radiation energy can be used to compare the energy measured at different locations using different techniques. We compare the LORA particle-based energy scale to that of the Pierre Auger Observatory and find that they agree to within (6 $\\pm$ 20)% for a radiation energy of 1 MeV. The uncertainty on the comparison is dominated by the antenna calibration of each experiment. We plan to reduce this uncertainty in the future using a portable radio array to cross-calibrate the energy scales of different experiments using radiation energy and the same antennas.'

Collaborations
LOFAR,

Keywords and Comments
'energy scale; radiation energy', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Lateral density distributions of muons and electrons in EAS from the KASCADE-Grande data for different zenith angle intervals.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 83

Presenter
David Rivera-Rangel
Author and Co-Author
David Rivera-Rangel, Juan Carlos Arteaga Velazquez | Andreas Haungs | for the KASCADE-Grande Collaboration

Abstract
'KASCADE-Grande was a cosmic ray experiment located at the Karlsruhe Institute of technology (110 m a.s.l., 49°N, 8°E), Germany, and it was designed to study extended air showers (EAS) initiated by primary nuclei in the energy range between 10 PeV and 1 EeV. KASCADE-Grande was capable of measuring the local density of charged particles, muons and of electrons of the EAS at ground level using different types of particle detectors. Using such data, we have estimated the mean radial density distributions of muon and electrons in EAS. The study was done in the radial range from 150 m to 650 m and zenith angles from 0 to 40 degrees. The zenith angle interval was divided in three bins with the same acceptance: [0°, 21.78°], [21.78°, 31.66°] and [31.66°, 40°]. Moreover, the data was further subdivided into distinct intervals in the total number of charged particles. The measurements were confronted against expectations of Monte Carlo shower simulations with iron nuclei and protons as primaries. The simulations were performed using the hadronic interaction models SIBYLL 2.3, QGSJET-II-04, SIBYLL 2.3 c and EPOS-LHC.'

Collaborations
KASCADE-Grande,

Keywords and Comments
'', ''

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Subcategory Experimental Results

A search for ultra-high-energy photons at the Pierre Auger Observatory exploiting air-shower universality

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 84

Presenter
Pierpaolo Savina
Author and Co-Author
Pierpaolo Savina, For the Pierre Auger Collaboration

Abstract
'The Pierre Auger Observatory is the most sensitive detector to primary photons with energies\r\nabove ~ 0.2 EeV. It measures extensive air-showers using a hybrid technique that combines\r\na fluorescence detector (FD) with a ground array of particle detectors (SD). The signatures\r\nof a photon-induced air-shower are a larger atmospheric depth at the shower maximum\r\n(Xmax) and a steeper lateral distribution function, along with a lower number of muons with\r\nrespect to the bulk of hadron-induced background. Using observables measured by the\r\nFD and SD, three photon searches in different energy bands are performed. In particular,\r\nbetween 1 and 10 EeV, a new analysis technique has been developed by combining the FD\r\nbased measurement of Xmax with the SD signal through a parameter related to its muon\r\ncontent, derived from the universality of the air-showers. This technique has led to a better\r\nphoton/hadron separation and, consequently, to a higher search sensitivity, resulting in a\r\ntighter upper limit than before. The outcome of this new analysis is presented here, along\r\nwith previous results below 1 EeV and above 10 EeV. From the data collected by the Pierre\r\nAuger Observatory in about 15 years of operation, the most stringent constraints on the\r\nfraction of photons in the cosmic flux are set over about three decades in energy.'

Collaborations
Auger,

Keywords and Comments
'UHE-photons; universality; photons; gamma-rays; Pierre Auger Observatory; extensive air showers; shower depth; muonic content; Fisher test;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

HAWC measurements of the energy spectra of cosmic ray protons, helium and heavy nuclei in the TeV range

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Juan Carlos Arteaga Velazquez
Author and Co-Author
Juan Carlos Arteaga Velazquez, For the HAWC Collaboration

Abstract
'Current knowledge of the relative abundances and the energy spectra of the elemental mass groups of cosmic rays in the 10 TeV - 1 PeV interval are uncertain. This situation prevents carrying out precision tests that may lead to distinguish among the existing hypotheses on the origin and propagation of TeV cosmic rays in the galaxy. In order to learn more about the mass composition of these particles, we have employed HAWC data from hadron induced air showers in order to determine the spectra of three mass groups of cosmic rays: protons, helium and heavy nuclei with Z > 2. The energy spectra were estimated by using the Gold unfolding technique on the 2D distribution of the lateral shower age against the estimated primary energy of events with arrival zenith angles smaller than 45 degrees. The study was carried out based on simulations using the QGSJET-II-04 model. Results are presented for primary cosmic-ray energies from 8 TeV to 400 TeV. They reveal that the aforementioned cosmic ray spectra exhibit fine structures within the above primary energy range.'

Collaborations
HAWC,

Keywords and Comments
'TeV cosmic rays; energy spectrum; cosmic ray composition; HAWC; extensive air showers', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The UHECR dipole and quadrupole in the latest data from the original Auger and TA surface detectors

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Peter Tinyakov
Author and Co-Author
Peter Tinyakov | For the Telescope Array and Pierre Auger collaborations,

Abstract
'The sources of ultra-high-energy cosmic rays are still unknown, but assuming standard physics, they are expected to lie within a few hundred megaparsecs from us. Indeed, over cosmological distances cosmic rays lose energy to interactions with background photons, at a rate depending on their mass number and energy and properties of photonuclear interactions and photon backgrounds. The universe is not homogeneous at such scales, hence the distribution of cosmic-ray arrival directions is expected to reflect the inhomogeneities in the distribution of galaxies; the shorter the energy loss lengths, the stronger the expected anisotropies. Galactic and intergalactic magnetic fields can blur and distort the picture, but the magnitudes of the largest-scale anisotropies, namely the dipole and quadrupole moments, are the most robust to their effects. Measuring them with no bias regardless of any higher-order multipoles is not possible except with full-sky coverage. In this work, we achieve this in three energy ranges (approximately 8–16 EeV, 16–32 EeV, and 32– EeV) by combining surface-detector data collected at the Pierre Auger Observatory and the Telescope Array until 2019, before the completion of the upgrades of the arrays with new scintillation detectors. The results will be presented at the conference.'

Collaborations
Telescope Array, Auger

Keywords and Comments
'ultra-high energy cosmic rays; dipole and quadrupole anisotropy', 'This is joint Auger and Telescope Array presentation'

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Subcategory Experimental Results

Estimations of the muon content of cosmic ray air showers between 10 PeV and 1 EeV from KASCADE-Grande data

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Juan Carlos Arteaga Velazquez
Author and Co-Author
Juan Carlos Arteaga Velazquez, Andreas Haungs | for the KASCADE-Grande Collaboration

Abstract
'Measurements of KASCADE-Grande on the muon size in high energy extensive air showers (EAS) have provided evidence that the actual attenuation length of shower muons in the atmosphere is larger than the expectations from the hadronic interaction models QGSJET-II-04, EPOS-LHC and SIBYLL 2.3. This discrepancy is related to a deficient description of the shower muon content with atmospheric depth by MC models. To further explore the origin of the above anomaly, we have investigated the muon size as a function of the primary energy at different zenith angles using data from the KASCADE-Grande experiment. The procedure consisted in comparing the measured muon number flux against the predictions of a reference cosmic ray energy spectrum and from the observed difference to estimate the data/MC muon ratio that best describe the measurements. The ratio is then applied to the MC simulations and from here, we estimate the muon content versus the primary energy. As a reference model, we employed the energy spectrum measured from the Pierre Auger observatory, while, for the different cosmic ray abundances, the GSF model. Results are presented using the QGSJET-II-04, EPOS-LHC, SIBYLL 2.3 and SIBYLL 2.3c models in the analysis procedure.'

Collaborations
KASCADE-Grande,

Keywords and Comments
'Extensive air showers; muons; KASCADE-Grande; hadronic interaction models', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The Energy Spectrum of Cosmic Ray Proton and Helium above 100TeV Measured by LHAASO Experiment

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
Zhiyong You
Author and Co-Author
Li.Qiao Yin | Lingling Ma | Zhiyong You | Shoushan Zhang,

Abstract
'The determination of energy spectrum of different species above 100 TeV is still one of the main challenges in cosmic ray physics. The energy spectrum of the individual component is an important tool to investigate the cosmic ray production and propagation mechanisms. A preliminary results of mixed proton and helium energy spectrum, obtained with the combined data of six Cherenkov telescopes, one 150m×150m water Cherenkov detector (WCDA-1) and half muon detector and scintillator detector array in LHAASO experiment will be reported. The preliminary results will be analyzed by using the combined data obtained between October 2020 and February 2021. By means of a multiparameter technique, the resolution of reconstructed energy, shower direction, shower core location and composition identification are improved.'

Collaborations
Lhaaso,

Keywords and Comments
'LHAASO', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The azimuthal distribution of thunderstorm events recorded by the GRAPES-3 experiment

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
Balakrishnan Hariharan
Author and Co-Author
Balakrishnan Hariharan,

Abstract
'The GRAPES-3 experiment reported the measurement of 1.3 GV potential across one of the massive thunderclouds recorded on 1 December 2014 by making use of the muon imaging technique. This measurement is ten times larger than the maximum potential reported previously by balloon and rocket sounding measurements, verifying the almost a century old prediction by C.T.R. Wilson. These measurements rely on the precise estimate of the change in the angular muon flux caused by the acceleration of muons during their passage through the charged layers of thunderstorms. The electric potential is estimated with the help of Monte Carlo simulations by using CORSIKA and other in-house tools. A study of the thunderstorms events recorded since April 2011 displays an asymmetry in their azimuthal distribution which can be understood to be caused by the ratio of $\\mu^+$/$\\mu^-$.'

Collaborations
other (fill field below), GRAPES-3

Keywords and Comments
'GRAPES-3; Thunderstorm; Muon; Monte Carlo', 'for the GRAPES-3 collaboration'

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Measurement of large angle muon flux in GRAPES-3 experiment using triggerless DAQ system

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 85

Presenter
Balakrishnan Hariharan
Author and Co-Author
Balakrishnan Hariharan,

Abstract
'The large area muon telescope of GRAPES-3 has been operating continuously for more than two decades with a DAQ which has several limitations. At present, this DAQ is in the process of being upgraded with a FPGA based system. The new DAQ system is designed to be triggerless and capable of recording every hit from the 3712 proportional counters along with a time-stamp (10 ns accuracy) which has significantly expanded the physics horizon of the experiment. This triggerless feature allows the detection of muons beyond the nominal zenith range of the current system (0<45$^\\circ$). The upgraded DAQ system has been deployed for 25% of the telescope. An offline software trigger has been developed for the reconstruction of muon tracks by using the timing and pulse height information of each hit in the raw data. For the first time the muons are reconstructed in the entire zenith angle range. The extensive air showers (EAS) at large angles can be studied through the muon component. We present measurements of the flux of the large angle muons and their correlation with EAS triggers.'

Collaborations
other (fill field below), GRAPES-3

Keywords and Comments
'GRAPES-3; Muons', 'for the GRAPES-3 collaboration'

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Status of simulation and data comparison of wcda-1

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
hanrong wu
Author and Co-Author
hanrong wu | Sujie Lin | Wei Liu | yiqing Guo | Hongbo Hu,

Abstract
'In the high-energy physics experiment, the simulation research of the detector is very important. In the early stage of the experiment construction, the performance of the detector can be understood through simulation. After the experiment is completed, the simulation and the physical results of the experimental observation like energy spectrum measurement are directly related, so the consistency check between the simulation results of the detector and the experimental data is very important. In this work, the comparison between the simulation results of LHAASO-WCDA and the experimental data is described in detail, such as the comparison of the important parameters such as multiplicity, triggering rate, and g / P discrimination factor, etc.'

Collaborations

Keywords and Comments
'', ''

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Subcategory Experimental Results

Muon excess in ultra-high energy inclined EAS according to the NEVOD-DECOR data

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
R.P. Kokoulin
Author and Co-Author
R.P. Kokoulin | N.S. Barbashina | A.G. Bogdanov | S.S. Khokhlov | V.V. Kindin | K.G. Kompaniets | G. Mannocchi | A.A. Petrukhin | V.V. Shutenko | G. Trinchero | I.I. Yashin | E.A. Yurina | E.A. Zadeba,

Abstract
'Data of the NEVOD-DECOR experiment on investigations of inclined cosmic ray muon bundles for a long time period (May 2012 – March 2021) are presented. Their comparison with the results of calculations based on simulations of EAS hadron and muon components allows one to study the behavior of the energy spectrum and mass composition of primary cosmic rays and/or to check the validity of hadron interaction models in a wide energy range from about 10^16 to more than 10^18 eV. The analysis showed that the observed intensity of muon bundles at primary particle energies of about 10^18 eV and higher can be compatible with the expectation only under the assumption of an extremely heavy mass composition of cosmic rays. This conclusion is consistent with data of a number of other experiments investigating the muon component of air showers at ultra-high energies. On the contrary, measurements of the depth of the shower maximum in the atmosphere (Xmax) in the experiments using air fluorescence technique favor a light mass composition of primary cosmic rays at these energies. This contradiction (so-called "muon puzzle") cannot be resolved without serious changes of the existing hadron interaction models.'

Collaborations

Keywords and Comments
'Inclined muon bundles; 10 - 1000 PeV primary energies', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

A Review of Cosmic Rays of LHAASO

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 86

Presenter
Shoushan Zhang
Author and Co-Author
Shoushan Zhang | Lingling Ma | Liping Wang | Feng Xiaoting | Liqiao Yin | Zhiyong You | Hengying Zhang,

Abstract
'Large High-Altitude Air Shower Observatory (LHAASO) has one square kilometer array of scintillator detectors and muon detectors, 18 Imaging Atmospheric Cherenkov telescopes and a 78,000 square meter Water Cherenkov Detector Array. LHAASO located at very high altitude (around 4410 m a.s.l.) in China. Multi-parameter observation of showers allows to measurement the energy spectrum, elemental composition and anisotropy with high resolution, which give us an excellent opportunity to understand the origin, acceleration and propagation of ultra-high energy cosmic rays. The 1/4, the 1/2, the 3/4 LHAASO array have started running in September 2019, in January 2020, in December 2020 respectively. Preliminary results and the prospect of the energy spectrum, elemental composition and anisotropy measured by LHAASO experiment will be presented in the paper.'

Collaborations
Lhaaso,

Keywords and Comments
'LHAASO, Elemental composition; Energy spectrum; Anisotropy', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Measurements of the average muon energy in inclined muon bundles in the NEVOD-DECOR experiment

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
E.A. Yurina
Author and Co-Author
E.A. Yurina | N.S. Barbashina | A.G. Bogdanov | S.S. Khokhlov | V.V. Kindin | R.P. Kokoulin | K.G. Kompaniets | G. Mannocchi | A.A. Petrukhin | V.V. Shutenko | G. Trinchero | I.I. Yashin,

Abstract
'One of the first setups at which an excess of muons in comparison with the expectation (“muon puzzle”) was detected and its dependence on the primary energy was measured, was the NEVOD-DECOR complex. Since various mechanisms for the appearance of an excess of multi-muon events (of cosmophysical or nuclear-physical nature) should have different effects on the muon energy, one of the possible approaches to solving the problem is the studying of the energy characteristics of EAS muon component and their changes with the energy of particles of primary cosmic rays. The average energy loss of muons in matter almost linearly depends on the muon energy. If an excess of high energy muons appears, then this should be reflected in the dependence of the muon energy deposit on the primary energy. At present, such an experiment is being carried out at the NEVOD-DECOR setup. The installation includes a Cherenkov water calorimeter and a precise coordinate-tracking detector. The energy deposit of muon bundles is measured from the response of the NEVOD calorimeter, and the coordinate-tracking detector DECOR allows one to determine the number of muons in the bundles. For the first time, experimental estimates of the average muon energy in the bundles and its dependence on zenith angle and primary energy in the range from 10 PeV to 1000 PeV have been obtained and compared with the results of calculations performed using the CORSIKA-based simulation using modern models of hadronic interactions.'

Collaborations

Keywords and Comments
'Cherenkov water calorimeter; coordinate-tracking detector; muon bundle energy deposit; 10-1000 PeV primary energies', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Mass composition of Telescope Array's surface detectors events using deep learning

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 87

Presenter
Ivan Kharuk
Author and Co-Author
Ivan Kharuk | Mikhail Kuznetsov | Yana Zhezher | Grigory Rubtsov | Oleg Kalashev | For the Telescope Array Collaboration,

Abstract
"The mass composition of ultra-high-energy cosmic rays can be analyzed by employing deep neural networks. We present an improved version of such analysis for Telescope Array's surface detectors data. Our neural network was trained on a large Monte-Carlo dataset simulating the expected experimental data distribution, and then was applied to the actual experimental data. Systematic and model errors are discussed."

Collaborations
Telescope Array,

Keywords and Comments
'machine learning; neural networks; mass composition; ultra-high-energy cosmic rays', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Measurement of UV light emission of the nighttime Earth by Mini-EUSO for space-based UHECR observations

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 88

Presenter
Kenji Shinozaki
Author and Co-Author
Kenji Shinozaki | Dario Barghini | Matteo Battisti | Alexandar Belov | Mario Bertaina | Francesca Bisconti | Karl Bolmgren: | Giorgio Cambie | Francesca Capel | Marco Casolino | Alessio Giolzio | Pavel Klimov | Viktoria Kungel | Laura Marcelli | Hiroko Mi,

Abstract
'The JEM-EUSO Program aims at the realization of the ultra-high energy cosmic ray (UHECR) observation in the satellite orbit by the air fluorescence technique. The Mini-EUSO mission is the first space-based pathfinder mission of the program that has been conducted on the International Space Station since 2019. The Mini-EUSO detector consists of a 25 cm refractive optics that focuses the UV light on the 2304-pixel array of the multi-anode photomultiplier tubes with ultra-fast readout electronics. In the mission, Mini-EUSO is operated by cosmonauts a few days per month. From the nadir-looking window of the Russian Module Zvezda, the detector is capable of continuously monitoring a ~300 km x 300 km area at night. The objectives of the mission include to understand the properties of the diffuse UV light emission from the earth and atmosphere. Such light originates from the airglow emission, back-scattered light of astronomical origin as well as the artificial light. The intensity of this light varies over the time, geographic location, atmospheric conditions. It is a key factor that determines the performance for the scientific objectives, i.e., the search for strange quark matter, observation of meteors, study of the transient luminous events etc. The data also allows for the study of the role of such light as the main background for the future UHECR space-based observation missions. In this contribution, we report the result of Mini-EUSO as well as the discussion with those of the past balloon-borne and ground-based pathfinders and perspectives for the future missions.'

Collaborations
other (fill field below), JEM-EUSO

Keywords and Comments
'Mini-EUSO; International Space Station; ultra-high energy cosmic rays; fluorescence technique; airglow', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Very-forward neutral pion production cross section in proton-proton collisions at $\sqrt{s}$ = 13 TeV measured with the LHCf experiment

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Alessio Tiberio
Author and Co-Author
Alessio Tiberio, For the LHCf Collaboration

Abstract
'The LHCf experiment, situated at the LHC accelerator, is composed of two independent detectors located at 140 metres from the ATLAS interaction point (IP1) on opposite sides along the beam axis. LHCf covers the pseudorapidity region above 8.4, with the capability to measure zero-degree neutral particles. The physics motivation of the experiment is to test the hadronic interaction models commonly used in ground-based cosmic rays experiments to simulate air-showers induced by ultra-high-energy cosmic rays (UHECR) in the Earth atmosphere. The data from accelerator experiments are very important for the tuning of these phenomenological models in order to reduce the systematic uncertainty of UHECR measurements.\r\nA precise measurement of the $\\pi^{0}$s produced in the very-forward region in high energy collisions provides the possibility to study the electromagnetic component of secondary particles produced in the first interaction of a UHECR with the atmosphere. In this contribution the results from the $\\pi^{0}$ analysis of the data acquired in proton-proton collisions at $\\sqrt{s}$ = 13 TeV will be presented. The Feynman-x and transverse momentum spectra will be shown and they will be compared with the predictions of several hadronic interaction models. The comparison with the results obtained at lower collision energies, which allows to test scaling laws (such as Feynman scaling), will be also discussed.'

Collaborations
, LHCf

Keywords and Comments
'LHCf; neutral pion; π0; LHC; UHECR; cosmic rays; hadronic interaction models; forward; zero degree; Feynman scaling; 13 TeV', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The depth of the shower maximum of air showers measured with AERA

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Bjarni Pont
Author and Co-Author
Bjarni Pont | For the Pierre Auger Collaboration,

Abstract
'The *Auger Engineering Radio Array* (AERA) is currently the largest array of radio antennas for the detection of cosmic rays, spanning an area of 17 km^2 with 153 radio antennas, measuring in the energy range around the transition from galactic to extra-galactic origin. It measures the radio emission of extensive air showers produced by cosmic rays, in the $30-80$ MHz band. The cosmic-ray mass composition is a crucial piece of information in determining the sources of cosmic rays and their acceleration mechanisms. The composition can be determined with a likelihood analysis that compares the measured radio-emission footprint on the ground to an ensemble of footprints from CORSIKA/CoREAS Monte-Carlo air shower simulations. These simulations are also used to determine the resolution of the method and to validate the reconstruction by identifying and correcting for systematics. We will present the method for the reconstruction of the depth of the shower maximum, compare our results to the independent fluorescence detector reconstruction measured on an event-by-event basis, and show the results of the cosmic-ray mass composition reconstruction with AERA in the energy range from $10^{17.5}$ to 10^{19} eV for data taken over the past seven years.'

Collaborations
Auger,

Keywords and Comments
'Radio; AERA; Pierre Auger; Xmax; mass composition; cosmic rays; depth of shower; composition;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Recent measurements of the cosmic ray energy spectrum and composition from the GRAPES-3 experiment

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 05 CR Mass composition | CRI
Presenter Forum Table

Presenter
Fahim Varsi
Author and Co-Author
Fahim Varsi, For the GRAPES-3 Collaboration

Abstract
'The GRAPES-3 experiment is located at Ooty in India. It consists of a densely packed array of 400 plastic scintillator detectors (1 m^{2} area each) with 8 m inter-detector separation and a large area (560 m^{2}) muon telescope. It measures the cosmic rays from a few TeV to over 10 PeV, thereby providing a substantial overlap with direct experiments as well as covering the knee region. The shower parameters are reconstructed by fitting the observed particle densities with the NKG lateral distribution function. The relation between the shower size and energy of primary cosmic rays is derived by using simulations with the SIBYLL-2.3c and QGSJET-II-04 hadronic interaction models. The Bayesian unfolding method is used for obtaining the energy spectrum. Measurements of nuclear composition are obtained by comparing muon multiplicity distributions (MMDs) for proton, helium, nitrogen, aluminium, and iron primaries obtained from the simulations against the MMDs measured by the muon telescope. The details of the analysis method and the extracted energy spectrum and composition from a few TeV to 10 PeV will be presented.'

Collaborations
other (fill field below), GRAPES-3

Keywords and Comments
'GRAPES-3; Energy spectrum; Composition;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

A study of the Moon shadow by using GRAPES-3 muon telescope

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 10 EAS reconstruction and analyses | CRI
Presenter Forum Table

Presenter
Meeran Zuberi
Author and Co-Author
Meeran Zuberi | for the GRAPES-3 Collaboration,

Abstract
'The GRAPES-3 experiment is designed to perform precision studies of gamma-ray sources in the TeV-PeV energy region. It consists of 400 plastic scintillator detectors spanning an effective area of 25000 m^2 and a large area (560 m^2) muon telescope which records 4x10^9 muons every day. With the recent installation of an improved triggerless data acquisition (DAQ) system, the information related to every muon is recorded with a timing resolution of 10 ns. The angular resolution and pointing accuracy of the upgraded muon telescope has been validated by characterizing the shadow of the moon among recorded muons. Here, the details of the analysis and results, as well as the simulation studies to account for the deflection of the particles in the Earth’s magnetic field will be presented.'

Collaborations
other (fill field below), GRAPES-3

Keywords and Comments
'', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Zenith angle dependence of pressure effect in GRAPES-3 muon telescope

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 89

Presenter
Meeran Zuberi
Author and Co-Author
Meeran Zuberi | for the GRAPES-3 Collaboration,

Abstract
'A large area (560 m^2) muon telescope in the GRAPES-3 experiment at Ooty, India records muon intensity at high cutoff rigidities (15–24 GV) along 169 independent directions spanning a field of view of 2.3 sr. The threshold energy of the recorded muons is sec(θ) GeV along a direction with a zenith angle (θ) and with the average angular accuracy of ~4°. The directional capabilities of the muon telescope are exploited for studying the effect of atmospheric pressure on the muon flux as a function of θ. The analysis details and results will be presented.'

Collaborations
, GRAPES-3

Keywords and Comments
", "

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Measurement of the improved angular resolution of GRAPES-3 EAS array by the observation of the Moon shadow

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 90

Presenter
Diptiranjan Pattanaik
Author and Co-Author
Diptiranjan Pattanaik, for the GRAPES-3 Collaboration

Abstract
'The Moon prevents cosmic rays along its direction from reaching Earth, giving rise to a deficit in the flux of cosmic rays. The observed deficit can be used for obtaining the absolute calibration of the angular resolution and to verify the pointing accuracy of the array. GRAPES-3 is an extensive air shower experiment located at Ooty, India consisting of a dense array of scintillator detectors. It records $\\sim10^9$ showers per year with a median energy of 10 TeV. With the precise determination of the arrival time of shower particles and an accurate correction for the shower front curvature, a major improvement in the angular resolution of the array has been achieved. We present a verification of the angular resolution estimated using the division of the array into left-right and even-odd sub-arrays as well as the pointing accuracy by observing the shadow of the Moon.'

Collaborations
other (fill field below), GRAPES-3

Keywords and Comments
'Angular resolution; Moon shadow; EAS; cosmic rays; gamma rays; GRAPES-3;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

TA anisotropy summary

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Igor Tkachev
Author and Co-Author
Igor Tkachev | For the Telescope Array collaboration,

Abstract
'The Telescope Array has collected 12 years of data and accumulated the largest to date UHECR data set in the Northern hemisphere. We make use of these data to search for large- and small-scale anisotropy of UHECR. At small angular scales we examine the data for clustering of events and correlations with several classes of putative sources. At intermediate scales we will present a blind search for localized excesses of events anywhere on the sky -- "hot spots" -- and give an update on the excess in the direction of Ursa Major previously found in the TA data. We will also discuss a related anisotropy of the UHECR spectrum. At largest scales we will test the TA data for the presence of a dipole. Finally, we will examine the data for correlations with the large-scale structures in the nearby Universe.'

Collaborations
Telescope Array,

Keywords and Comments
'ultra high energy cosmic rays; anisotropy', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Large-scale cosmic ray anisotropy measured by the GRAPES-3 experiment

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Medha Chakraborty
Author and Co-Author
Medha Chakraborty | for the GRAPES-3 collaboration,

Abstract
'The deflection of cosmic rays (CRs) in the interstellar magnetic field results in an almost isotropic flux as observed on Earth. However, an anisotropy has been observed at the level of $\\sim 10^{−4} − 10^{−3}$. The GRAPES-3 experiment located at Ooty, India consists of an array of 400 plastic scintillator detectors. It measures the particle densities and their relative arrival times in extensive air showers produced by the CRs. This information collected is then reconstructed to obtain the energy and direction of the primary CRs. The near-equatorial location of GRAPES-3 provides an opportunity to study this anisotropy in both hemispheres of the celestial sphere in the TeV-PeV energy range. However, detector and atmospheric effects that induce a few percent change in the primary CR flux are challenges to be addressed. The techniques developed to address the systematic effects along with the results of anisotropy studies will be presented.'

Collaborations
other (fill field below), GRAPES-3

Keywords and Comments
'Anisotropy; GRAPES;', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Vetoing the high energy showers in the GRAPES-3 experiment whose cores lie outside the array

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 91

Presenter
Medha Chakraborty
Author and Co-Author
Medha Chakraborty | for the GRAPES-3 collaboration,

Abstract
'The GRAPES-3 experiment located at Ooty, India, consists of an array of 400 plastic scintillators which records the particle densities and relative arrival times of secondaries in an air shower. The particle densities recorded in individual detectors are then fitted by the well known NKG function to obtain the shower parameters, namely the shower core, age and size. High energy showers with cores simulated using CORSIKA with true cores far away from the array center are also capable of triggering the array. Some of those showers are mis-reconstructed such that the cores appear to lie within the array, leading to contamination which can affect the measurement of the energy spectrum of cosmic rays. To reduce this contamination, we have devised a selection technique employing several shower properties, the details of which will be presented here.'

Collaborations
other (fill field below), GRAPES-3

Keywords and Comments
'Shower core; GRAPES; EAS;', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Downward Terrestrial Gamma-ray Flashes in Auger?

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 09 Atmospheric and geophysical phenomena | CRI
Presenter Forum Table

Presenter
Roberta Colalillo
Author and Co-Author
Roberta Colalillo | for the Pierre Auger Collaboration,

Abstract
'At the Pierre Auger Observatory, designed primarily to study ultra-high-energy cosmic rays, phenomena related to atmospheric electricity are also observed. Particularly peculiar events have been detected with the Surface Detector (SD), characterized by long-lasting signals (tens of microseconds) and event footprints much larger (up to 200 km^2) than those produced by the highest energy cosmic rays. Moreover, some of them appear to be accompanied by smaller events occurring in the same area within about 1 ms and probably produced by the same phenomenon. A previously reported correlation with the World Wide Lightning Location Network, as well as the observation of very low-altitude clouds confirm that such events are related to thunderstorms. An ad-hoc reconstruction points to high-energy particles being produced very close to the ground, suggesting that they originate from electrons accelerated to relativistic energies in strong electric fields inside low clouds, as is the case for Terrestrial Gamma-ray Flashes above thunderstorms.\r\n\r\nA definitive explanation of the observed phenomenon is hindered by two facts.\r\nOne is that the rate of such events, serendipitously detected, is very small (less than 2 events/year) and decreased even further after an optimization of the SD trigger for low-energy shower-events. The second is that most events show a puzzling lack of signals in the central part of the footprint.\r\nWe have studied in detail both effects and will present such studies here.\r\nWe developed a strategy for a dedicated trigger to enhance the detection efficiency for such atmospheric-electricity events.'

Collaborations
Auger,

Keywords and Comments
'atmospheric electricity; TGF; lightning', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

An extensive study for correcting the nonlinear particle density measured by GRAPES-3 scintillator detectors

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 92

Presenter
Anuj Chandra
Author and Co-Author
Anuj Chandra | For the GRAPES-3 Collaboration,

Abstract
'The GRAPES-3 extensive air shower (EAS) array located at Ooty is equipped with 400 plastic scintillator detectors spread over an area of 25000 m^2 and a muon telescope of area 560 m^2 built with 3,712 proportional counters. One of its principal objectives is to measure the primary cosmic ray energy spectrum in the TeV-PeV energy region. The response of the photo-multiplier tubes (PMTs) used in the plastic scintillator detectors becomes nonlinear at densities >50 particles per m^2 in large EAS. We describe a technique to correct for the nonlinearity of these PMTs, thereby extending the dynamic range of the detector for observed particle densities up to 1000 particles per m^2. The details of the technique will be presented.'

Collaborations
other (fill field below), GRAPES-3

Keywords and Comments
'Primary Cosmic Rays; PMT; Non-Linearity; Particle density; Scintillator detector; Proportional counter',
''

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Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Preliminary Cosmic Ray Results from the HAWC's Eye Telescopes

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 04 CR Energy Spectrum | CRI
Presenter Forum Table

Presenter
Florian Rehbein
Author and Co-Author
Florian Rehbein, Giang Do | Maria Magdalena Gonzalez | Ruben Alfaro | Thomas Bretz | Arturo Iriarte | Yunior Perez | Francisco Javier Gonzalez | Frank Maslowski | Merlin Schaufel | José Serna-Franco | Franziska Tischbein | Ibrahim Torres | Jesus Martinez-Castro | Oscar Ch

Abstract
"The compact imaging air-Cherenkov telescope HAWC’s Eye was developed to operate together with the High-Altitude Water Cherenkov Gamma-Ray Observatory (HAWC). The combination of both detection techniques in a hybrid setup provides a significant improvement in energy and angular resolution, aiming for improved measurements of the cosmic ray composition above 10 TeV and contributing to the physics program of the observatory. Preliminary results of the first hybrid measurements of the cosmic ray spectrum are presented. A second HAWC's Eye telescope was successfully commissioned at the HAWC site in 2019. Two measurement nights since then recorded the data used in this analysis. The HAWC's Eye events were successfully synchronized with HAWC and further used to characterize the hybrid system. A complete simulation of the hybrid configuration was used to develop algorithms to reconstruct the energy and arrival direction of proton-induced air showers. Those algorithms were successfully applied to the measured cosmic ray events to analyze the improved performance of the hybrid detection. The spectrum reconstructed with HAWC's Eye is compatible with the spectrum reconstructed solely from the coincident HAWC data."

Collaborations
HAWC, HAWC's Eye Project

Keywords and Comments
'EAS Array; IACT; hybrid', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Atmospheric Electric Field Effects on Cosmic Rays detected at Sierra Negra, Mexico

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 93

Presenter
Bertha Jania Newton Bosch
Author and Co-Author
Bertha Jania Newton Bosch | Luis Xavier González Méndez, José Francisco Valdés Galicia | Oscar Gustavo Morales Olivares | Yasushi Muraki | Yutaka Matsubara | Takashi Sako | Kyoko Watanabe | Fernando Monterde Andrade

Abstract
'The effect of thunderstorms' atmospheric electric field on secondary cosmic rays (CR) detected at high altitude was studied. We analyzed the data obtained during the period of October 2019 to March 2020 by the Solar Neutron Telescope (SNT) and a Boltek EFM-100 electric field monitor installed in the Sierra Negra Cosmic Ray Observatory (SNCRO) located at 4580 m a.s.l. in Puebla, Mexico. Based on the measurements of the Boltek EFM-100, 15 thunderstorms were identified in the established period. When the majority of thunderstorms occurred, fluctuations in the average counting rate of 2 SNT channels were observed. On the basis of the general theory of atmospheric electric field effects in the secondary CR components proposed by Dorman, we calculated as a first approximation the effect on the total charged component and the neutron component at the observation level of SNCRO. Simulations of air showers in the presence of a simplified electric field were performed with the CORSIKA code to complete the calculations. The observations were consistent with the calculated intensity variations.'

Collaborations

Keywords and Comments
'Secondary cosmic rays; atmospheric electric field', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

The TRISTAN detector. Cosmic ray survey between latitudes 38ºN and 53ºS along the Atlantic Ocean

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 94

Presenter
Damián Garcia-Castro
Author and Co-Author
Hector Alvarez-Pol | Marwan Ajoor | Alberto Blanco | Pablo Cabanelas | Miguel Cruces | Jose Cuenca | Paulo Fonte | Yanis Fontenla | Damián Garcia-Castro | Juan A. Garzon | Georgy Kornakov | Teresa Kurtukian | Luis Lopes | João Saraiva | Marcos Seco | Vict,

Abstract
'TRISTAN (TRasgo para InveSTigaciones ANtarticas) is a high granularity tracking detector of the Trasgo family. It was developed to complement the other detectors of the ORCA observatory that have been installed in one of the Spanish bases in Antarctica. TRISTAN is composed of three RPC planes (Resistive Plate Chambers) and offers, (i) a surface of 1.8 m2, (ii) a high multiplicity tracking capability of charged particles, (iii) a position of resolution of around 30 cm2, and (iv) an angular resolution near 0.2 sr. The detector was equipped with a 1cm lead (Pb) plate in order to separate muons from the low energy electromagnetic radiation background.\r\n\r\nBefore being installed in the definitive location, we used the TRISTAN detector to collect data \r\nduring three journeys through the Atlantic Ocean between latitudes 36ºN and 52ºS on board of the Sarmiento de Gamboa and BIO Hesperides oceanographic vessels. The trips took place between Nov. 2018 and Dec. 2019 with the main purpose of analysing the capability of a Trasgo detector to explore the geomagnetic field variations and the different atmospheric behaviours at both hemispheres and in the Equator region.\r\n\r\nThe main technical aspects of the detector and its performance (efficiency, resolutions, and acceptances) will be discussed and the preliminary results on the analysis of the correlations between the measured cosmic ray rates at different arrival angles with the geomagnetic field will be presented.'

Collaborations

Keywords and Comments
'Tracking detector; Resistive Plate Chambers; Secondary Cosmic Rays. Ground detector; Geomagnetic field; muons; electrons', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Experimental Results

Muography background sources: simulation, characterization, and machine-learning rejection

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 95

Presenter
Jesús Peña-Rodríguez
Author and Co-Author
Jesús Peña-Rodríguez | Mauricio Suárez-Durán | Adriana Vásquez Ramírez | Hernán Asorey | Luis A. Núñez | Ricardo deLeón-Barrios | David Villabona-Ardila | Alejandro Ramírez-Muñóz,

Abstract
'Muography scans large-size objects, natural or anthropic, by detecting atmospheric muon flux after crossing these buildings. Muography suffers an overwhelming background noise because of the weakness of the emerging muon flux from scanned objects. The background noise sources are scattered muons, electromagnetic particles of Extensive Air Showers (EAS), backward particles, and particles arriving simultaneously. We carried out a muography background analysis using Monte Carlo simulations (CORSIKA-GEANT4) and data recorded by MuTe (a hybrid Muon Telescope composed of a scintillator hodoscope and a water Cherenkov detector).\r\n\r\nWe estimated the scattered muon energy-angular spectra and the EAS components impinging the MuTe. We quantified the muography background using measurements of the Time-of-Flight and deposited energy of particles. We found that the spectrum of particles impinging on MuTe is mainly composed of muons (~3 GeV/c average) and electromagnetic particles (~20 MeV/c average). The scattering probability of muons increases inversely with the energy and relative incidence angle concerning the object surface. For muons with momentum < 1 GeV/c, the scattering angle is above 1 degree. Backward impinging particles represent up to 22% of the flux and depend on their elevation angle. Two processes cause multiple particle backgrounds. Independent particles from the atmospheric radiation background and correlated particles (mainly a muon pair) originated in the same EAS, with relative arriving times > 300 ns and < 100 ns, respectively. This study offers a better understanding of background sources in muography and proposes machine learning methods to filter them.'

Collaborations
, Muon Telescope (MuTe)

Keywords and Comments
'muography; background noise; muon scattering; machine learning', ''

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Branch	CRI | Cosmic Ray Indirect
Subcategory	Experimental Results

New coordinate-tracking detector on drift chambers for registration of muons in near-vertical EAS

Time	21 July 2021 | 12:00 - 13:30 | Berlin Time
Session	Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table	

Presenter
Vladislav Vorobev
Author and Co-Author
Vladislav Vorobev,

Abstract
'The new coordinate-tracking detector was developed in the Experimental complex NEVOD, MEPhI for the study of near-vertical extensive air showers. The installation consists of two planes of drift chambers, 7 chambers in each, and has an effective area of 13 m^2. The registration system of the new detector gets trigger from scintillator counters and uses the TDC that has been specially designed for this detector. It is based on FPGA Altera Cyclone V and has GPS synchronization with the joint triggering system of the experimental complex. Time synchronization allows to investigate extensive air showers in joint operation with a classical EAS setup of 10000 m^2 area and Cherenkov water detector of 2000 m^3 volume. A deep learning approach is used to reconstruct multi-muon events. The poster presents the design of the detector and first experimental results including joint events with the NEVOD-EAS setup.'

Collaborations

Keywords and Comments
'', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

Latest results of ultra-high-energy cosmic ray measurements with prototypes of the Fluorescence detector Array of Single-pixel Telescopes (FAST)

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Toshihiro Fujii
Author and Co-Author
Toshihiro Fujii | Justin Albury | Jose Bellido | Ladislav Chytka | John Farmer | Petr Hamal | Pavel Horvath | Miroslav Hrabovsky | Hidetoshi Kubo | Jiri Kvita | Max Malacari | Dusan Mandat | Massimo Mastrodicasa | John Matthews | Stanislav Michal | Xiaoch,

Abstract
'Clarifying the origin and nature of ultra-high-energy cosmic rays (UHECRs) is of the uppermost importance in the astroparticle physics. The Fluorescence detector Array of Single-pixel Telescopes (FAST) is a design for a next-generation ground-based UHECR observatory, addressing the requirements for a large-area, low-cost detector suitable for detecting the properties of UHECRs with an unprecedented aperture. The full-scale FAST prototype consists of four 200 mm photomultiplier tubes at the focus of a segmented mirror of 1.6 m in diameter. Over the last five years, three prototypes have been installed at the Telescope Array Experiment in Utah, USA, and one prototype at the Pierre Auger Observatory in Mendoza, Argentina, for remote observation of UHECRs in both hemispheres.We report on the latest results of these FAST prototypes including telescope calibrations, atmospheric monitoring by distant ultra-violet laser and all-sky astronomical camera, ongoing electronics upgrade, development of sophisticated reconstruction methods and UHECR detections. We also discuss possible benefits to the Telescope Array Experiment and the Pierre Auger Observatory, such as comparing the transparency of the atmosphere above both experiments, a study of the systematic uncertainty associated with their existing fluorescence detectors, and a cross-calibration of their energy and $X_{\\rm{max}}$ scales.'

Collaborations
other (fill field below), FAST

Keywords and Comments
'Ultra-high-energy cosmic ray; extensive air shower; energy spectrum; mass composition; anisotropy; fluorescence technique', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

The Zettavolt Askaryan Polarimeter (ZAP) mission concept: radio detection of ultra-high energy cosmic rays in low lunar orbit.

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table 96

Presenter
Andres Romero-Wolf
Author and Co-Author
Andres Romero-Wolf | Jaime Alvarez-Muñiz | Luis A. Anchordoqui | Douglas Bergman | Washington Rodrigues de Carvalho | Austin Cummings | Peter Gorham | Casey Handmer | Nate Harvey | John Krizmanic | Kurtis Nishimura | Eric Oberla | Mary Hall Reno | Harm Sc,

Abstract
'Probing the ultra-high energy cosmic ray (UHECR) spectrum beyond the cutoff at ~40 EeV requires an observatory with an acceptance that is impractical to achieve with ground arrays. We present a concept, designated the Zettavolt Askaryan Polarimeter (ZAP), for radio detection of UHECRs impacting the Moon's regolith from low-lunar orbit. ZAP would observe several thousands of events above the cutoff (~40 EeV) with a full-sky field of view to test whether UHECRs originate from Starburst Galaxies, Active Galactic Nuclei, or other sources associated with the matter distribution of the local universe at a distance > 1 MPc. The unprecedented sensitivity of ZAP to energies beyond 100 EeV would enable a test of source acceleration mechanisms. At higher energies, ZAP would produce the most stringent limits on super heavy dark matter (SHDM) via limits on neutrinos and gamma rays resulting from self-annihilation or decay.'

Collaborations

Keywords and Comments
'radio detection; ultra-high energy cosmic rays; space-based', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

Science and mission status of EUSO-SPB2

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Johannes Eser
Author and Co-Author
Johannes Eser | Angela Olinto | Lawrence Wiencke | For the JEM-EUSO collaboration,

Abstract
"The Extreme Universe Space Observatory on a Super Pressure Balloon II (EUSO-SPB2) is a second generation stratospheric balloon instrument for the detection of Ultra High Energy Cosmic Rays (UHECRs, E > 1EeV) via the fluorescence technique and of Very High Energy (VHE, E > 10PeV) neutrinos via Cherenkov emission. EUSO-SPB2 is a pathfinder mission for instruments like the proposed Probe Of Extreme Multi-Messenger Astrophysics (POEMMA). The purpose of such a space-based observatory is to measure UHECRs and UHE neutrinos with high statistics and uniform exposure.\r\n\t\tEUSO-SPB2 is designed with two Schmidt telescopes, each optimized for their respective observational goals. The Fluorescence Telescope looks at the nadir to measure the fluorescence emission from UHECR-induced extensive air shower (EAS), while the Cherenkov Telescope is optimized for fast signals ($\\sim$10ns) and points near the Earth's limb. This allows for the measurement of Cherenkov light from EAS caused by Earth skimming VHE neutrinos if pointed slightly below the limb or from UHECRs if observing slightly above.\r\n\t\tThe expected launch date of EUSO-SPB2 is Spring 2023 from Wanaka, NZ with target duration of up to 100 days. Such a flight would provide hundreds of UHECR Cherenkov signals in addition to tens of UHECR fluorescence tracks. Neither of these kinds of events have been observed from either orbital or suborbital altitudes before, making EUSO-SPB2 crucial to move forward towards a space based instrument. It will also enhance the understanding of potential background signals for both detection techniques.\r\n\t\tThis contribution will provide a short overview of the detector and the current status of the mission as well as its scientific goals."

Collaborations
, JEM-EUSO

Keywords and Comments
'UHECR; VHE neutrinos; stratospheric balloon', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

Expected Performance of the EUSO-SPB2 Fluorescence Telescope

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 97

Presenter
George Filippatos
Author and Co-Author
George Filippatos | Matteo Battisti | Mario Bertaina | Francesca Bisconti | Johannes Eser | Fred Sarazin | Lawrence Wiencke | for the JEM-EUSO Collaboration,

Abstract
'The Extreme Universe Space Observatory Super Pressure Balloon 2 (EUSO-SPB2) is under development, and will prototype instrumentation for future satellite-based missions, including the Probe of Extreme Multi-Messenger Astrophysics (POEMMA). EUSO-SPB2 will consist of two telescopes. The first is a Cherenkov telescope (CT) being developed to identify and estimate the background sources for future (below-the-limb) very high energy (E>10 PeV) astrophysical neutrino observations, as well as above the limb cosmic ray induced signals. The second is a fluorescence telescope (FT) being developed for detection of Ultra High Energy Cosmic Rays (UHECRs). In preparation for the expected launch in 2023, extensive simulations, tuned by preliminary laboratory measurements have been performed to understand the capabilities of the FT. The energy threshold has been estimated at 10$^{18.2}$eV, and results in a maximum detection rate at 10$^{18.5}$eV, taking into account the shape of the UHECR spectrum. EUSO-SPB2 will be the first opportunity to perform a shower reconstruction from near-space. Using the JEM-EUSO OffLine framework, the reconstruction capabilities of the instrument have been estimated. In addition, online software has been developed based on the simulations as well as experience with previous EUSO missions. This includes a level 1 trigger to be run on the limited flight hardware, as well as a deep learning based prioritization algorithm in order to accommodate the balloon's telemetry budget. These techniques could be used for future, space-based missions.'

Collaborations
, JEM-EUSO

Keywords and Comments
'UHECR;Balloon based;Fluorescence;Simulation', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

An overview of the JEM-EUSO program and results

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Mario Edoardo Bertaina
Author and Co-Author
Mario Edoardo Bertaina | for the JEM-EUSO Collaboration,

Abstract
'The objective of the JEM-EUSO program, is the realisation of a space mission devoted to Ultra-High Energy Cosmic Ray (UHECR) science. A super-wide-field telescope will look down from space onto the night sky to detect UV photons emitted from Extensive Air Showers (EAS) generated by UHECRs in the atmosphere. The JEM-EUSO program includes different missions from ground (EUSO-TA), from stratospheric balloons (EUSO-Balloon,EUSO-SPB1,EUSO-SPB2) and from space (TUS, Mini-EUSO) employing fluorescence detectors, and more recently Cherenkov detectors, to demonstrate the UHECR observation from space and prepare large-size missions such as K-EUSO and POEMMA.\r\nIn this contribution we will review the current status of the program, the key results obtained so far by the different projects, and the perspectives for the near future.'

Collaborations
other (fill field below), JEM-EUSO Collaboration

Keywords and Comments
'UHECR; EAS; space-based observation', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

The Surface Array planned for IceCube-Gen2

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Frank Schröder
Author and Co-Author
Frank Schröder | for the IceCube-Gen2 Collaboration,

Abstract
'IceCube-Gen2, the extension of the IceCube Neutrino Observatory, will feature three main components: a $10\\,$km^3 optical array in the deep ice, a large-scale radio array in the shallow ice and firn, and a surface detector above the optical array. Thus, IceCube-Gen2 will not only be an excellent detector for PeV neutrinos, but also constitutes a unique setup for the measurement of cosmic-ray air showers, where the electromagnetic component and low-energy muons are measured at the surface and high-energy muons are measured in the ice. As for ongoing enhancement of IceCube's current surface array, IceTop, we foresee a combination of elevated scintillation and radio detectors for the Gen2 surface array, aiming at high measurement accuracy for air showers. The science goals are manifold: The in-situ measurement of the cosmic-ray flux and mass composition, as well as more thorough tests of hadronic interaction models, will improve the understanding of muons and atmospheric neutrinos detected in the ice. Moreover, the surface array provides a cosmic-ray veto for the in-ice detector and contributes to the calibration of the optical and radio arrays. Last but not least, the surface array will make major contributions to cosmic-ray science in the energy range of the transition from Galactic to extragalactic sources. The increased sensitivities for photons and for cosmic-ray anisotropies at multi-PeV energies provide a chance to solve the puzzle of the origin of the most energetic Galactic cosmic rays and will serve IceCube's multimessenger mission.'

Collaborations
IceCube-Gen2,

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

Progress and future prospect of the CRAFFT project for the next generation UHECR observation

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Yuichiro Tameda
Author and Co-Author
Yuichiro Tameda, Takayuki Tomida | Daisuke Ikeda | Katsuya Yamazaki | Takashi Kagitani | Norimichi Shibata | Eiji Nishio | Hirokazu Iwakura | Yuya Nakamura | Yuto Kubota | Shinnosuke Kurisu | Ryosuke Saito

Abstract
'Signs of anisotropy of the ultra-high-energy cosmic ray (UHECR) arrival direction have been reported by The Telescope Array and The Pierre Auger Observatory. Then, it is expected that source of UHECRs will be clarified. However, because of the quite low flux of UHECR, it is inevitable to extend observatory to much larger than existing ones. Cosmic Ray Fluorescence Fresnel lens Telescope (CRAFFT) project has been developed a low cost fluorescence detector to realize the huge observatory for UHECR observation. CRAFFT project reduced the cost to 1/10 agains fluorescence detectors now in use, and succeeded to observe UHECR air showers by the prototype of CRAFFT telescope. In this presentation, we report the progress of CRAFFT project such as the result of the test observation and data analysis and discuss the future prospect.'

Collaborations
, CRAFFT

Keywords and Comments
'UHECR; fluorescence detector', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

A performance study of the K-EUSO space based observatory

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 98

Presenter
Francesco Fenu
Author and Co-Author
Francesco Fenu, Sergei Sharakin | Mikhail Zotov | Mario Bertaina | Yoshiyuki Takizawa | Naoto Sakaki | Pavel Klimov | Marco Casolino | for the JEM-EUSO collaboration

Abstract
'K-EUSO is a planned mission of the JEM-EUSO program for the study of Ultra High Energy Cosmic Rays (UHECR) from space. The K-EUSO observatory consists of a UV telescope, to be deployed on the International Space Station, with a wide field of view, that aims at the detection of the fluorescence light emitted by Extensive Air Showers (EAS) in the atmosphere. The EAS events will be sampled with a time resolution of 1μs to reconstruct the entire shower profile with high precision. The detector, consisting of ~ \$10^{5}\$ independent pixels, will allow a spatial resolution of ~500 m on ground. From 400 km altitude, K-EUSO will achieve an enormous exposure to sample the highest energy range of the UHECR spectrum. In this contribution, we present the performance of the observatory. We will first of all, present an estimation of the expected exposure and triggered event rate as a function of energy. The event reconstruction technique will be then described in detail. The triggered events will be reconstructed and we will present a summary of the event reconstruction performance. The resolution of the arrival direction and of the energy reconstruction, as well as the reconstruction efficiency as a function of the true shower parameters will be presented.'

Collaborations
other (fill field below), JEM-EUSO

Keywords and Comments
'K-EUSO; Simulations; JEM-EUSO', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

Study of the potential of MATHUSLA as a cosmic ray detector

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 99

Presenter
Arturo Fernandez Tellez
Author and Co-Author
Arturo Fernandez Tellez | Cristiano Alpigiani | Juan Carlos Arteaga-Velazquez | Davide Boscherini | Karen Salome Caballero-Mora | Paolo Camarri | Roberto Cardarelli | Dennis Cazar Ramirez | Giuseppe Di Sciascio | Henry Lubatti | Oscar Morales-Olivares,

Abstract
'MATHUSLA is a proposal to build a hodoscope of large dimensions at ground level, close to the interaction point of the CMS detector at CERN, to search for displaced vertices from the decay of neutral long-lived particles (LLP) during the High Luminosity LHC runs in an environment with low background. LLPs are predicted by different models, which try to solve open problems in fundamental particle physics. The idea behind MATHUSLA is to monitor a large volume of air (100 m x 100 m x 25 m) with a series of layers of tracking detectors to look for displayed vertices produced by the LLPs. MATHUSLA design considers 9 m x 9 m units of extruded scintillators bars (4.6 m x 4.5 cm x 2 cm) in each detector plane, which will provide spatial and timing information of impinging charged particles. Due to its configuration, MATHUSLA could be also sensitive to air showers induced by cosmic rays. However, it would be limited as an air shower detector due to hit saturation. To enhance the capabilities of MATHUSLA to the detection of extensive air showers above 100 TeV, it was proposed to add an extra layer of RPCs. We present the results of a MC study to analyze the sensitivity of MATHUSLA to cosmic ray detection. We will show that MATHUSLA could offer different advantages for cosmic ray research: it could provide unique spatial and temporal measurements of an EAS for studies of the energy spectrum, composition and arrival distribution of cosmic rays, as well as for tests of hadronic interaction models. In addition, it offers potential tracking capabilities particularly for inclined events.'

Collaborations
other (fill field below), MATHUSLA

Keywords and Comments
'"LLP";"secondary cosmic rays"; "CERN"; "MATHUSLA"', '

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Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

Simulation study for the future IceCube-Gen2 surface array

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 10 EAS reconstruction and analyses | CRI
Presenter Forum Table

Presenter
Agnieszka Leszczyńska
Author and Co-Author
Agnieszka Leszczyńska | Mark Weyrauch | Alan Coleman | For the IceCube-Gen2 Collaboration,

Abstract
'The next generation of the IceCube Neutrino Observatory, IceCube-Gen2, will constitute a much larger detector, increasing the rate of high-energy neutrinos. IceCube-Gen2 will address the long-standing questions about astrophysical accelerators. The experiment will also include a surface air-shower detector which will allow for measurements of cosmic rays in the energy region where a transition between Galactic and extragalactic accelerators is expected. As a baseline design for the surface detector, we consider a surface array above the optical in-ice array consisting of the same type of stations used for the IceTop enhancement, i.e., scintillation detectors and radio antennas. In order to better understand the capabilities of such an array, we performed simulations of its response to air showers, including both detector types. We will show the results of this simulation study and discuss the prospects for the surface array of IceCube-Gen2.'

Collaborations
IceCube-Gen2,

Keywords and Comments
", "

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Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

EUSO-SPB2 Telescope Optics and Testing

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Viktoria Kungel
Author and Co-Author
Viktoria Kungel, Randy Bachman | Jerod Brewster | Madeline Dawes | Julianna Desiato | Johannes Eser | William Finch | Lindsey Huelett | Justin Pace | Patrick Reardon | Chantal Wang | Lawrence Wiencke | for the JEM-EUSO Collaboration

Abstract
'The Extreme Universe Space Observatory - Super Pressure Balloon (EUSO-SPB2) mission will fly two custom telescopes that feature Schmidt optics to measure Cherenkov- and fluorescence-emission from extensive air-showers at the PeV and EeV-scale. Both telescopes have 1-meter diameter apertures and UV/UV-visible sensitivity. The Cherenkov telescope uses a bifocal mirror segment alignment, to distinguish between a direct cosmic ray that hits the camera versus the Cherenkov light from outside the telescope. Telescope integration and laboratory calibration will be performed in Colorado. To estimate the point spread function and efficiency of the integrated telescopes, a test beam system that delivers a 1-meter diameter parallel beam of light is being fabricated.\r\nEnd-to-end tests of the fully integrated instruments will be carried out in a field campaign at dark sites in the Utah desert using cosmic rays, stars, and artificial light sources. Laser tracks have long been used to characterize the performance of fluorescence detectors in the field. For EUSO-SPB2 an improvement in the method that includes a correction for aerosol attenuation is anticipated by using a bi-dynamic Lidar configuration in which both the laser and the telescope are steerable. We plan to conduct these field tests in Fall 2021 and Spring 2022 to accommodate the scheduled launch of EUSO-SPB2 in 2023 from Wanaka, New Zealand.'

Collaborations
other (fill field below), JEM-EUSO

Keywords and Comments
'UHECR; fluorescence detector; Cerenkov detector; telescope calibration; Lidar', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

Particle detector development for the Square Kilometre Array

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Justin Bray
Author and Co-Author
Justin Bray, Han Nan Chen | Ben Cropper | David Emrich | Kate Gould | Andreas Haungs | Tom Howland | Tim Huege | Clancy James | David Kenney | Iuliana-Camelia Nitu | Paul Roberts | Jesse Schelfhout | Ralph Spencer | Rosemary Tawn | Jonathan Tickner | Steven Tingay | B

Abstract
'We describe the development of particle detectors for operation at the Murchison Radio-astronomy Observatory. These detectors are intended as a trigger for the capture of radio data from extensive air showers with radio telescopes, first with 128 antennas of the Murchison Widefield Array, and later with ~100,000 antennas of the low-frequency component of the Square Kilometre Array which is being constructed at the same site. The detector design is driven by a stringent requirement to minimise inadvertent radio emission which can interfere with the operation of the co-located radio telescopes. We present the key features of the resulting design, and a characterisation of its particle-detection efficiency measured using the muon tower test facility at Karlsruhe Institute of Technology.'

Collaborations

Keywords and Comments
'extensive air showers; particle detectors; radio', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

Cross-calibrating the energy scales of cosmic-ray experiments using a portable radio array

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table 100

Presenter
Katharine Mulrey
Author and Co-Author
Katharine Mulrey, S. Buitink | A. Corstanje | H. Falcke | B. M. Hare | J. R. Hörandel | T. Huege | G. K. Krampah | P. Mitra | A. Nelles | H. Pandya | J. P. Rachen | O. Scholten | S. ter Veen | S. Thoudam | T. N. G. Trinh | T. Winchen | K. De Vries | R. Stanley | E. Santiag

Abstract
'Different experiments use different techniques to detect and reconstruct cosmic-ray events, yielding different energy scales. Having a method to compare the energy scales of different experiments with minimal uncertainty is necessary in order to make meaningful comparisons of their spectra and composition measurements, which are used to create global models of cosmic-ray sources, acceleration and propagation. Comparing energy scales has proven to be difficult, given that uncertainties on energy measurements depend on the location, technique and equipment used. In this contribution we introduce a new radio-based technique which will be used to build a universal cosmic-ray energy scale. Radio detection provides a measure of the radiation energy in air showers, which scales quadratically with the electromagnetic energy. Once the local magnetic field strength is taken into account, radiation energy can be directly compared at different locations. A portable array of antennas will be built and deployed at various experiments, measuring radiation energy in conjunction with the host experiment's traditional air shower measurements. The energy measured at each location can then be directly compared via the contemporaneous radiation energy measurements. Using radiation energy to compare the energy scales eliminates uncertainties due to measurements being made at different locations, and using the same array at each site eliminates the uncertainties associated with the equipment and calibration. This will allow for a cross-calibration of the energy scales of different experiments with minimal uncertainty. Here we present the technique and report on the status of a prototype array that began taking data in January 2021.'

Collaborations
LOFAR,

Keywords and Comments
'energy scale; cross-calibration; radiation energy', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

Performance of SKA as an air shower observatory

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table 101

Presenter
Stijn Buitink
Author and Co-Author
Stijn Buitink,

Abstract
'The low frequency segment of SKA in Australia will have an extremely dense antenna array spanning an area of roughly 0.5 km^2. It offers unique possibilities for high-resolution observations of air showers. Compared to LOFAR, it will have a much more homogeneous ground coverage, an increased frequency bandwidth (50-350 MHz), and the possibility to continuously observe with nearly 100% duty cycle.\r\n\r\nSKA will observe air showers in the range 10^{16} eV - 10^{18} eV with a reconstruction resolution on Xmax of around 10 g/cm^2. This allows for a high-precision study of mass composition in the energy regime where a transition is expected from Galactic to extragalactic origin. In addition, SKA will be able to put constraints on hadronic interaction models, which is crucial for interpreting the data in this complex energy range.\r\n\r\nIn this talk, we will show the results of a full detector simulation and demonstrate the capabilities of SKA, including energy and Xmax reconstruction, as well as more advanced methods to constrain the shape of the longitudinal development of air showers.'

Collaborations
LOFAR, SKA HECP focus group

Keywords and Comments
'SKA; radio detection of air showers', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

Simulation and Optimisation for the Radar Echo Telescope for Cosmic Rays

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table 102

Presenter
Rose Stanley
Author and Co-Author
Rose Stanley | Simon De Kockere | on behalf of the Radar Echo Telescope Collaboration,

Abstract
'The Radar Echo Telescope for Cosmic Rays (RET-CR) will use the radar echo technique to detect the in-ice continuation of an ultra high energy cosmic ray (UHECR) air shower. When a UHECR particle cascade propagates into a high-elevation ice sheet, it produces a dense in-ice cascade of charged particles which can reflect incoming radio waves. Through the detection of transmitted radio waves, the energy and direction of the UHECR can be reconstructed. RET-CR will consist of a transmitter array, receiver antennas and a surface scintillator plate array.\r\n\r\nIn this poster we present the simulation efforts for RET-CR performed to optimise the surface array layout and triggering system, which finally leads to the prediction of the expected event rate. Showers are generated using the CORSIKA Monte Carlo code. The energy deposits in the scintillators are then found by propagating the particle output from CORSIKA through the scintillating material in Geant4. Thresholds are applied to the energy deposits to determine which showers trigger providing the surface detector efficiency. Additionally, CoREAS is used to generate radio emission which will be used to reconstruct events with the surface array. For the prediction of the event rate seen by the in-ice radar system, we use a simulation chain of existing and new tools. UHECR showers are generated using the CORSIKA Monte Carlo code, which are then propagated through a realistic ice layer using Geant4. The energy depositions from the Geant4 simulations were subsequently used in RadioScatter to calculate the radar scatter amplitude to trigger the in-ice system leading to a prediction of the expected event rates for the RET-CR detector.'

Collaborations
other (fill field below), Radar Echo Telescope Collaboration

Keywords and Comments
'cosmic ray; radio; radar; air showers;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

Classification and Denoising of Cosmic-Ray Radio Signals using Deep Learning

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table 103

Presenter
Abdul Rehman
Author and Co-Author
Abdul Rehman, Alan Coleman | Frank G. Schröder | Dmitriy Kostiunin

Abstract
'The radio detection technique with advantages like inexpensive detector hardware and full year duty cycle can prove to be a vital player in cosmic-ray detection at the highest energies and can lead us to the discovery of high energy particle accelerators in the universe. However, radio detection has to deal with continuous irreducible background. The Galactic and thermal backgrounds, which contaminate the radio signal from air showers, lead to a relatively high detection threshold compared to other techniques. For the purpose of reducing the background, we employ a deep learning technique namely, convolutional neural networks (CNN). This technique has already proven to be efficient for radio pulse recognition e.g., in the Tunka-Rex experiment. We train CNNs on the radio signal and background to separate both from each other. The goal is to improve the radio detection threshold on the one hand, and on the other hand, increase the accuracy of the arrival time and amplitude of the radio pulses and consequently improve the reconstruction of the primary cosmic-ray properties. Here we present two different networks: a Classifier, which can be used to distinguish the radio signals from the pure background waveforms, and a Denoiser, which allows us to mitigate the background from the noisy traces and hence recover the underlying radio signal.'

Collaborations

Keywords and Comments
'Deep Leaning; Radio Signals;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

GCOS - The Global Cosmic Ray Observatory

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Jörg Hörandel
Author and Co-Author
Jörg Hörandel,

Abstract
'Nature is providing particles with energies exceeding 100 EeV. Their existence imposes immediate questions: Are they ordinary particles, accelerated in extreme astrophysical environments, or are they annihilation or decay products of super-heavy dark matter or other exotic objects? \r\nIf the particles are accelerated in extreme astrophysical environments, are their sources related to those of high-energy neutrinos, gamma rays, and/or gravitational waves, such as the recently observed mergers of compact objects? The particles can also be used to study physics processes at extreme energies; is Lorentz invariance still valid? Are the particles interacting according to the Standard Model or are there new physics processes? The particles can be used to study hadronic interactions (QCD) in the kinematic forward direction; what is the cross section of protons at sqrt(s) > 100 TeV?\r\n\r\nThese questions are addressed at present by installations like the Telescope Array or the Pierre Auger Observatory. After the year 2030, a next-generation observatory will be needed to study the physics and properties of the highest-energy particles in Nature, building on the knowledge, harvested from the existing observatories. It should have an aperture at least an order of magnitude bigger than the existing observatories. We aim for a detector system with an area of 40000 square kilometers or more and all-sky coverage. \r\n\r\nThe physics case and possible scenarios for technical implementation of the Global Cosmic Ray Observatory - GCOS will be presented.'

Collaborations
other (fill field below), GCOS

Keywords and Comments
'cosmic rays; air showers; detector; future observatory; gamma-ray detector; neutrino detector; multi-messenger astroparticle physics', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Future projects

Prospects for Cross-correlations of UHECR Events with Astrophysical Sources with Upcoming Space-based Experiments

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Tonia Venters
Author and Co-Author
Tonia Venters | Andres Romero-Wolf | for the POEMMA and ZAP Collaborations,

Abstract
'Ultra-high energy cosmic rays (UHECRs) are the messengers of the most extreme physics in the cosmos; however, efforts to identify their origins have thus far been thwarted by the fact that they don't point back to their sources. Using statistical studies cross-correlating UHECR arrival directions with astrophysical catalogs, the ground-based Pierre Auger Observatory has reported hints of a correlation (at energies ~ 40 EeV) with nearby starburst galaxies, as well as lower-significance correlations with other classes of astrophysical sources. Space-based UHECR experiments, such as POEMMA and ZAP, will monitor large interaction volumes on the Earth or the Moon, achieving unprecedented exposures at the highest energies and full sky coverage within a few years of mission operation time. We discuss the prospects for a significant detection of a correlation between UHECRs and astrophysical sources with POEMMA and ZAP.'

Collaborations
other (fill field below), POEMMA; ZAP

Keywords and Comments
'UHECRs; Intermediate-scale Anisotropy; Astrophysical Cross-Correlations', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Outreach and Education

CORSIKA below the knee

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Tadeusz Wibig
Author and Co-Author
Tadeusz Wibig,

Abstract
'Recently, there has been an increased interest in small-scale EAS experiments designed to satisfy young people\'s scientific curiosity and develop their interest in science. It is worth noting that networking these arrays creates opportunities to pose and solve serious physical problems.\r\nThe particle flux on the ground, due to the steep cosmic ray spectrum, is dominated by particles from small and very small showers. Quantitative interpretation of showers recorded by small local arrays requires different methodology than that used by ordinary big EAS arrays operating in the \'knee\' region and above. Showers observed by several small detectors placed closely together and operating in coincidence cannot be effectively localized, their arrival directions cannot be reliably determined and their sizes cannot be estimated with reasonable accuracy. To draw physical conclusions from such events, a proper simulation tool is needed to determine, in a reasonable time, the registration rates of particular configurations triggered mostly by secondary particles created in interactions of primary cosmic rays with very low energies. The CORSIKA program was created (~30 years ago) for the KASCADE experiment for ~PeV energies. Since then, the program has been greatly expanded and enhanced and becomes one of the primary tools for shower simulations up to the highest observed energies. It can be used for calculations in TeV region, but its suitability here is debatable, mostly because of computational time required. \r\nWe present "small EAS generator", semi-analytical method for integrating cosmic ray spectra over energies and angles of interest and summing over mass spectra of primary nuclei in arbitrary detector configurations. Results on the single muon flux and particle density spectra will be given.'

Collaborations

Keywords and Comments
'EAS; simulations; muons; education; small array; CORSIKA', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Outreach and Education

Tunka-Rex Virtual Observatory

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Vladimir Lenok
Author and Co-Author
Dmitriy Kostiunin | Vladimir Lenok | Olga Kopylova | Doris Wochele | Frank Polgart | Sergey Golovachev | Ev Sotnikova | for the Tunka-Rex Collaboration,

Abstract
'Tunka-Rex (Tunka Radio Extension) was a detector for ultra-high energy cosmic rays measuring radio emission for air showers in the frequency band of 30-80 MHz, operating in 2010s. It provided an experimental proof that sparse radio arrays can be a cost-effective technique to measure the depth of shower maximum with resolutions competitive to optical detectors. After the decommissioning of Tunka-Rex, as last phase of its lifecycle and following the FAIR (Findability – Accessibility – Interoperability – Reuse) principles, we publish the data and software under free licenses in the frame of the TRVO (Tunka-Rex Virtual Observatory), which is hosted at KIT under the partnership with the KCDC and GRADLCI projects. We present the main features of TRVO, its interface and give an overview of projects, which benefit from its open software and data.'

Collaborations
other (fill field below), Tunka-Rex

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Outreach and Education

Status and Future Prospects of the KASCADE Cosmic-ray Data Centre KCDC

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 104

Presenter
Andreas Haungs
Author and Co-Author
Andreas Haungs | Donghwa Kang | Katrin Link | Frank Polgart | Victoria Tokareva | Doris Wochele | Jürgen Wochele,

Abstract
"KCDC, the 'KASCADE Cosmic-ray Data Centre', is a web-based interface where initially the scientific data from the completed air-shower experiment KASCADE-Grande was made available for the astroparticle community as well as for the interested public. Over the past 7 years, we have continuously extended the data shop with various releases and increased both the number of detector components from the KASCADE-Grande experiment and the data sets and corresponding simulations. With the latest releases we added a new and independent data shop for a specific KASCADE-Grande event selection and by that created the technology for integrating further data shops and data of other experiments, like the data of the air-shower experiment MAKET-ANI in Armenia. In addition, we made available educational examples how to use the data, more than 100 cosmic ray energy spectra from various experiments, and recently attached a public server with access to Jupyter notebooks. In this paper we present a brief history of KCDC, the main features of the recent release as well as will discuss future development plans.\r\n."

Collaborations

Keywords and Comments
'Open Data Plattform', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Acceleration of ultrahigh-energy cosmic rays in the early afterglows of gamma-ray bursts: concurrence of jet’s dynamics and wave-particle interactions

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 11 UHECR Acceleration | CRI
Presenter Forum Table

Presenter
Zhang Ze-Lin
Author and Co-Author
Zhang Ze-Lin | Liu Ruo-Yu | Wang Xiang-Yu,

Abstract
'The origin of ultrahigh-energy cosmic rays (UHECRs) still remains mystery. It has been suggested that UHECRs can be produced by the stochastic acceleration in relativistic jets of gamma-ray bursts (GRBs) at the early afterglow phase. Here, we propose a time-dependent model for proton energization by cascading compressible waves in GRB jets with concurrence of the jet’s dynamics and the mutual interactions between turbulent waves and particles. With the assumption of an initial turbulent injection spectrum W(k) ∝ k^(−3/2) and interstellar medium (ISM) for circumburst environment, our numerical results suggest that protons can be accelerated up to 10^19 eV at the early afterglow. An estimation shows UHE nuclei can easily survive photodisintegration in the external shocks in most cases, thus allowing the acceleration of 10^20 eV cosmic rays in the proposed frame. The spectral slope can be as hard as dN/dE ∝ E^0, which is consistent with the requirement for the interpretation of intermediate-mass composition of UHECR as measured by the Pierre Auger Observatory.'

Collaborations
other (fill field below), Nanjing University

Keywords and Comments
'particle acceleration; ultrahigh-energy cosmic rays; gamma-ray bursts; turbulence', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

On the possible method of identification of two probably cognate extensive air showers

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 105

Presenter
Dmitriy Beznosko
Author and Co-Author
Manana Svanidze | Yuri Verbetsky | Piotr Homola | Dmitriy Beznosko | for the CREDO Collaboration,

Abstract
'The persistent attempts are undertaken to show existence and investigate the special pairs of Extensive Air Showers (EAS) that can be suspected in common origin in the near space, i.e. to observe some consequence of existence of Cosmic Ray Ensembles (CRE). The remote cosmic ray stations observing EAS events are useful for this investigation. Such stations are operating within the GELATICA net (GEorgian Large-area Angle and TIme Coincidence Array) and are planed within the CREDO Collaboration (Cosmic Ray Extremely Distributed Observatory) as the CREDO-Maze project. The possible criteria are developed in the paper for detecting of two specific showers which ancestors have probable mutual proximity in their past.'

Collaborations
, Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'cosmic ray ensembles; large scale cosmic ray correlations; extensive air showers; pair of showers; relativistic invariant parameters; proximity definition;', 'The main results covered by this article will be summarised in a highlight talk to be presented by a representative\xa0speaker of the CREDO Collaboration, if only the Conference Organizers agree that such a talk is given (an appropriate\xa0request will b

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Cosmic ray acceleration and transport

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Christoph Pfrommer
Author and Co-Author
Christoph Pfrommer, Timon Thomas | Georg Winner | Matteo Pais | Maria Werhahn | Philipp Girichidis

Abstract
'Supernova remnants are believed to be the source of galactic cosmic rays, which are then propagating in the Galaxy to generate radio and gamma-ray emission and to finally reach us. Recent particle-in-cell simulations and gamma-ray observations revealed spectacular insight into the particle acceleration process. However, these simulations are subject to fundamental limitations so that it is unclear whether we can extrapolate and apply these results to observations of supernova remnants. In this talk, I will present three-dimensional magnetohydrodynamics simulations where we self-consistently include cosmic ray protons and follow the time evolution of the cosmic ray electron spectrum. By matching the observed morphology and non-thermal spectra of shell-type supernova remnants (SN 1006, RXJ 1713, and Vela Jr.) in radio, X-rays and gamma-rays, I demonstrate how we gain insight into the following topics: 1) leptonic vs. hadronic model of the gamma-ray emission, 2) origin of patchiness of TeV gamma-ray maps and how this relates to interstellar magnetic turbulence, 3) quasi-parallel vs. quasi-perpendicular acceleration of cosmic ray electrons, 4) nature of magnetic field amplification and damping in supernova remnants (turbulently vs. Bell-amplified magnetic field). In the second part of this talk, I will revisit the theory of cosmic ray transport through the magnetized plasma of the interstellar medium and decipher the various modes of cosmic ray propagation: advection, diffusion and streaming. Finally, I will show that we can observationally test these theoretical considerations with high-sensitivity MeerKAT radio observations of the Galactic center and conclude that the popular assumption of dominant cosmic ray diffusion is ruled out by the data which requires us to consider plasma wave-particle scatterings for cosmic ray transport.'

Collaborations

Keywords and Comments
'Supernova remnants; particle acceleration; cosmic ray transport; plasma physics; gamma-rays; radio synchrotron; Galaxy', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Phenomenology of CR-scattering on pre-existing MHD modes

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 01 Magnetic Fields and CR Propagation | CRI
Presenter Forum Table

Presenter
Ottavio Fornieri
Author and Co-Author
Ottavio Fornieri | Daniele Gaggero | Silvio Sergio Cerri | Pedro De La Torre Luque | Stefano Gabici,

Abstract
'We present the phenomenological implications of the micro-physics of cosmic-ray (CR) diffusion as resulting from particle scattering onto the three modes in which *Magneto-Hydro-Dynamics* (MHD) cascades are decomposed. We calculate the diffusion coefficients from first principles based on reasonable choices of the physical quantities characterizing the different environments of our Galaxy, namely the *Halo* and the *Warm Ionized Medium*, and implement for the first time these coefficients in the DRAGON2 numerical code. Remarkably, we obtain the correct propagated slope and normalization for all the charged species taken into account, without any *ad-hoc* tuning of the transport coefficients. We show that fast magnetosonic modes dominate CR confinement up to $\\sim 100 \\, \\mathrm{TeV}$; Alfvénic modes are strongly subdominant due to the anistropy of the cascade (in agreement with previous findings) up to rigidities in the sub-PeV domain, where their contribution may show up as a spectral feature, potentially observable in the upcoming years. We also find that such framework cannot be responsible for CR confinement below $\\sim 200 \\, \\mathrm{GeV}$, possibly leaving room for an additional confinement mechanism, and that the Kolmogorov-like scaling of the B/C ratio cannot be reproduced. Therefore this scaling might not be the imprint of the pre-exisiting turbulence spectrum.'

Collaborations

Keywords and Comments
'Cosmic-ray propagation; MHD turbulence; Plasma Astrophysics', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Simulations of radio emission from air showers with CORSIKA 8

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table 106

Presenter
Nikolaos Karastathis
Author and Co-Author
Nikolaos Karastathis | Remy Prechelt | Tim Huege | Juan Ammerman Yebra,

Abstract
'CORSIKA 8 is a new framework for air shower simulations implemented in modern C++17, based on past experience with existing codes like CORSIKA 7. The flexibility of this framework allows for the inclusion of radio-emission calculations as an integral part of the program. Our design makes radio simulations general and gives the user the freedom to choose between different formalisms, such as the “Endpoints” and “ZHS” formalisms. In addition, it takes advantage of the flexibility of the CORSIKA 8 environment and geometry design, allowing future updates to more complex scenarios such as showers crossing from air into dense media. Our first results, along with comparisons with other simulation programs like CoREAS in CORSIKA 7 and ZHAireS are going to be presented. In the future, based on our design, the opportunity arises for radio simulations to achieve a significant boost in performance by deploying parallel computing techniques, in particular employing GPUs, and hence, perform more sophisticated radio-emission studies.'

Collaborations
CORSIKA-8,

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Electromagnetic Shower Simulation for CORSIKA 8

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 13 New Instrumentation and Tools for EAS Detection | CRI
Presenter Forum Table

Presenter
Jean-Marco Alameddine
Author and Co-Author
Jean-Marco Alameddine | Jaime Alvarez-Muñiz | Juan Ammerman Yebra | Wolfgang Rhode | Maximilian Sackel | Alexander Sandrock | Jan Soedingrekso | Enrique Zas,

Abstract
'Extensive air showers in astroparticle physics experiments are commonly simulated using CORSIKA. The electromagnetic shower component has been treated using EGS4 in the Fortran 77-based versions, which have been developed in the last thirty years. Currently, CORSIKA is being restructured and rewritten in C++, leading to the new version CORSIKA 8. In this process, the electromagnetic component is now being treated by the high-energy lepton and photon propagator PROPOSAL. Originally designed for the efficient simulation of high-energy muons and tau-leptons in large volume neutrino telescopes, the Monte Carlo library PROPOSAL has been extended to also treat electrons, positrons, and high-energy photons.\r\nValidating this new implementation of the electromagnetic shower model is very important.\r\nIn this talk, the electromagnetic shower component simulated with PROPOSAL is compared to previous versions of CORSIKA, the air shower simulator AIRES as well as the electromagnetic shower tool ZHS, which is optimzed for the radio signal.\r\nThis includes comparisons of the underlying theoretical models, the runtime performance as well as lateral and longitudinal shower characteristics, especially of parameters relevant for the radio component such as the charge excess.'

Collaborations
CORSIKA-8,

Keywords and Comments
'EAS;extensive air shower;CORSIKA;CORSIKA 8;PROPOSAL;lepton propagator;photon propagator;simulation;monte carlo;electromagnetic shower;AIRES;ZHS;radio component;muon puzzle;charge excess', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Parametrization of the Relative Amplitude of Geomagnetic and Askaryan Radio Emission from Cosmic-Ray Air Showers using CORSIKA/CoREAS Simulations

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 107

Presenter
Ek Narayan Paudel
Author and Co-Author
Ek Narayan Paudel | Alan Coleman | Frank G. Schröder,

Abstract
'Cosmic rays are messengers from highly energetic events in the Universe. These rare ultra-high-energy particles can be detected efficiently and in an affordable way by large arrays of radio antennas. Linearly polarized geomagnetic emission is the dominant emission mechanism produced when charged particles in air showers get deflected in the Earth's magnetic field. The sub-dominant Askaryan emission is radially polarized and produced due to the time-varying negative-charge excess in the shower front. The relative amplitude of these two emission components depends on various air shower parameters, such as the arrival direction and the depth of the shower maximum. We studied these dependencies using CoREAS simulations of the radio emission from air showers at the South Pole using a star-shaped antenna pattern. On the one hand, the parametrization of the Askaryan-to-geomagnetic ratio can be used as input for a more accurate reconstruction of the shower energy. On the other hand, if measured precisely enough, this ratio may provide a new method to reconstruct the atmospheric depth of the shower maximum.'

Collaborations

Keywords and Comments
'Cosmic rays; radio detection', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Analysis of capability of detection of extensive air showers by simple scintillator detectors

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 108

Presenter
Jerzy Pryga
Author and Co-Author
Jerzy Pryga | Weronika Stanek | for the CREDO Collaboration,

Abstract
'One of the main objectives of the CREDO project is to search for so-called Cosmic-Ray Ensembles (CRE). To confirm the existence of such phenomena a massive scale observation of even relatively low energy Extensive Air Showers (EAS) and an analysis of their correlations in time must be performed. To make such observations possible, an infrastructure of widely spread detectors connected in a global network should be developed using low-cost devices capable of collecting data for a long period of time. For each of these detectors or small detector systems the probability of detection of an EAS has to be determined. Such information is crucial in the analysis and interpretation of collected data. The standard approach based on detailed and extensive simulations is not possible for many such systems, thus a faster method is developed. Knowing the characteristics of EAS from more general simulations any required probability is calculated using appropriate parametrization taking into account EAS spectrum, energy dependence of particle density and zenith angle dependence. This allows to estimate expected number of EAS events measured by a set of small detectors. Results of calculations are compared with first measurements using a test system. These results can also be useful for the design of more effective small systems in the future.'

Collaborations
, Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'cosmic ray ensembles; "CORSIKA simulations; cosmic-ray detection; extensive air showers', 'The main results covered by this article will be summarised in a highlight talk to be presented by a representative speaker of the CREDO Collaboration, if only the Conference Organizers agree that such a talk is given (an appropriate request will be sent

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

COSMOS X as a general purpose air shower simulation tool

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 109

Presenter
Takashi Sako
Author and Co-Author
Takashi Sako, Toshihiro Fujii | Katsuaki Kasahara | Hiroaki Menjo | Naoto Sakaki | Nobuyuki Sakurai | Akimichi Taketa | Yuichiro Tameda | COSMOS team

Abstract
'An air shower simulation package COSMOS was born in 1970's and has been continuously developing. A recent major update enables particle tracking not only in the atmosphere but also in liquid and solid material by combining with the EPICS detector simulation package. This paper describes the properties of this extended version of COSMOS, namely COSMOS X. COSMOS X is coded using the FORTRAN language and can be compiled using the gFortran compiler and cmake tool. Combination of gas, liquid and solid materials in spherical shells with a common center can be defined as environment. Users can also arbitrary define the electric and magnetic fields. These features allow shower simulations even in the soil, concrete, sea and ice. Also simulations at the Sun and Mars are possible applications. Flexible output control since the previous versions of COSMOS, a set of user hook functions, is also available. In predefined user functions information of each particle in transportation can be easily accessed and users can extract information from them. General introduction to COSMOS and new functions of COSMOS X together with some interesting application cases will be presented in the conference.'

Collaborations

Keywords and Comments
'air shower simulation tool', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

A complete model of the signal in surface detector arrays and its application for the reconstruction of mass-sensitive observables.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 110

Presenter
Max Stadelmaier
Author and Co-Author
Max Stadelmaier | Ralph Engel | Markus Roth | Schmidt David | Darko Veberic,

Abstract
'The principle of Air Shower Universality yields a method of understanding Extensive Air Showers of UHECRs as a superposition of different particle components whose spatial and temporal distributions follow individual analytical profile functions. We present a model of the expected densities of particles in time and space that uses the depth of the shower maximum,\r\n$X_\\text{max}$, and the relative muonic content of the shower, $R_\\mu$, as input parameters. The model is fine-tuned and tested with simulated showers using different hadronic interaction models. Furthermore, we present results for the reconstruction of $X_\\text{max}$ and $R_\\mu$ that allow for an event-by-event estimation of the mass of the primary particle, based on the responses of the water-Cherenkov and scintillator surface detectors of the Auger Observatory.'

Collaborations

Keywords and Comments
'Air Shower Universality; Pierre Auger; Auger; Air Showers; UHECR', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Parameterization of muon production profiles in the atmosphere

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 111

Presenter
Stef Verpoest
Author and Co-Author
Stef Verpoest | Thomas Gaisser,

Abstract
'Production of high-energy muons in cosmic-ray air showers, relevant for deep underground detectors, depends on the properties of the primary cosmic ray as well as the atmospheric temperature through the competition between decay and re-interaction of charged pions and kaons. We present a parameterization of muon production profiles based on simulations as a function of the primary cosmic-ray energy, mass and zenith angle, the minimum energy for a muon to reach the detector and an atmospheric temperature profile. We illustrate how this can be used to calculate muon bundle properties such as multiplicity and transverse size and their seasonal variations in the context of underground measurements in coincidence with a surface detector which fixes the primary cosmic-ray energy.'

Collaborations

Keywords and Comments
'Muons; Multiplicity; Underground; Seasonal variation; Cosmic rays; Air showers', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

On the need for unbiasing azimuthal asymmetries in signals measured by surface detector arrays

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 112

Presenter
Quentin Luce
Author and Co-Author
Quentin Luce | Markus Roth | David Schmidt | Darko Veberic,

Abstract
'A surface detector array samples the lateral distribution of an extensive air-shower (EAS) at the ground, i.e. the density of particles as a function of the distance from the axis of the shower. The azimuthal symmetry of this measured lateral distribution is broken for EAS with a non-zero zenith angle. The resulting asymmetry, caused by atmospheric attenuation and geometrical effects, increases with the inclination of the shower and introduces a bias in the reconstruction of the shower parameters.\r\nUsing simulated sets of air-showers, we present a model to correct the azimuthal asymmetry in signals measured by water-Cherenkov detectors and exemplified using the geometry and detector response of the Pierre Auger Observatory. Testing showers initiated by proton and iron primaries using EPOS-LHC and QGSJetII-04 as hadronic models, we developed a fine-tuned model of the amplitude of the asymmetry as a function of the zenith angle, shower size and distance of a detector from the shower axis. The improvements resulting from the application of the correction are quantified in terms of the biases and resolutions in the impact-point and arrival direction.'

Collaborations

Keywords and Comments
'asymmetry; lateral distribution function; energy estimation; models of hadronic interactions; simulation of extensive air showers', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

The impact of photonuclear reaction models on propagation of ultrahigh energy cosmic rays

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 113

Presenter
Eiji Kido
Author and Co-Author
Eiji Kido | Tsunenori Inakura | Yutaka Utsuno | Kimura Masaaki | Shigehiro Nagataki | Atsushi Tamii,

Abstract
'Ultrahigh energy cosmic ray (UHECR) nuclei with Lorentz factors greater than about 10^9 lose their energies by the photodisintegration with cosmic microwave background photons in intergalactic space. The photodisintegration is a main process of the energy losses at the highest energies, so it is important to understand the model dependence of the photodisintegration to simulate propagation of UHECR nuclei. We implemented photonuclear reaction models which were obtained using calculations of the random-phase approximation (RPA) in a cosmic ray propagation code CRPropa and simulated the cosmic ray propagation. We present the comparison of the simulated observables such as energy spectra and compositions between the models.'

Collaborations

Keywords and Comments
'Ultrahigh energy cosmic rays; Cosmic ray propagation', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Detection of Above the Limb Cosmic Rays in the Optical Cherenkov Regime Using Sub-Orbital and Orbital Instruments

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 07 Where to go in UHECR observations | CRI
Presenter Forum Table

Presenter
Austin Cummings
Author and Co-Author
Austin Cummings, Johannes Eser | John Krizmanic | Roberto Aloisio

Abstract
'Many upcoming experiments seek to observe high energy cosmic events while observing from either sub-orbital or orbital altitudes, using the Earth atmosphere as an extremely large instrumental volume, thereby increasing the geometric acceptance over ground based instruments in addition to supplying uniform exposure of both hemispheres. In particular, the planned Extreme Universe Space Observatory aboard a Super Pressure Balloon-2 (EUSO-SPB2) and future Probe Of Extreme Multi-Messenger Astrophysics (POEMMA) experiments will both utilize UV sensitive optical cameras with nanosecond time resolution and observe near the Earth’s limb to attempt to capture the Cherenkov emission produced by upwards going extensive air showers (EASs) sourced from high energy cosmic neutrino interactions in the Earth. In addition, these Cherenkov cameras also have coverage above the Earth limb, allowing access to the Cherenkov emission produced by cosmic rays skimming the Earth atmosphere at high altitudes. \r\n\r\nWe show that sub-orbital and orbital based optical Cherenkov telescopes are quite sensitive to the above the limb cosmic ray signal, in particular the sub-orbital case being sensitive down to PeV scale energies, allowing for high event rates even for short observation periods. We argue that because the properties of the arriving Cherenkov photons are similar for neutrino induced EASs and those induced by above the limb cosmic rays, the latter provides an excellent benchmark for qualifying the technique developed for the neutrino observation with a well understood and guaranteed signal.'

Collaborations

Keywords and Comments
'Cosmic Rays; Optical Cherenkov Detection; Balloon-Based Instruments; Space-based instruments', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Study on the combined estimate of the cosmic-ray composition and particle cross-sections at ultrahigh energies

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Olena Tkachenko
Author and Co-Author
Olena Tkachenko, Ralph Engel | Ralf Ulrich | Michael Unger

Abstract
'The mass composition is one of the key observables to understand the nature and origin of ultrahigh-energy cosmic rays (UHECRs). The study of hadronic interactions at energies well beyond human-made accelerators is a fundamental probe of elementary particle physics. In previous analyses, the properties of the hadronic interactions were estimated under the assumption of a certain mass composition, typically proton-dominated, and the cross-sections were calculated by fitting the tail of the $X_\\mathrm{max}$ distribution. In such an analysis, the impact of a possible He-contamination on the cross-section measurement is quoted as a systematic uncertainty. Vice versa, the cosmic-ray mass composition is typically determined using air shower simulations by assuming the validity of the considered hadronic interaction models.\r\n\r\nIn this contribution, we present a fully self-consistent approach of varying the proton-proton cross-sections, with the nucleus-nucleus cross-sections being predicted via the Glauber theory, and making a full $X_\\mathrm{max}$ distribution fit to get an independent and simultaneous estimation of the interaction cross-sections and cosmic-ray primary composition. We will discuss the degeneracy between mass composition and hadronic interactions and compare the sensitivity of the proposed method to the one of previous approaches.'

Collaborations

Keywords and Comments
'Ultrahigh-energy cosmic rays; Mass composition; Interaction cross-sections', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Modeling the influence of the solar cosmic rays protons on the Earth's atmosphere over a wide range of heights

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 114

Presenter
Eugeny Maurchev
Author and Co-Author
Eugeny Maurchev | Yury Balabin | Alexey Germanenko | Boris Gvozdevsky,

Abstract
'The important applied problem of the cosmic ray physics is the assessment of radiation safety during solar flares, especially when events of an increase in the count rate on neutron monitors - GLE (Ground level enhancement) are observed. This effect is explained by the fact that the flux of primary protons with energies from 1 GeV to 10 GeV increases, which are capable of losing their energy both in ionization processes and through nuclear interactions. At the Polar Geophysical Institute, the RUSCOSMICS software package was developed, one of the possibilities of which is the ability to obtain an altitude ionization profiles for a given area of the atmosphere, using the spectra of primary protons of solar cosmic rays as input data. It should be noted that the methodology for calculating spectra, as well as reception cones and pitch-angle distributions, was also developed in the Polar Geophysical Institute. The important feature of this work can be called the use of parallel computing, which made it possible to expand the applicability of the model from a local site to the global geometry of the entire atmosphere of the Earth. The paper presents the results obtained for solar cosmic rays at heights from 1 km to 80 km with a step of 1 km for all values of latitude and longitude with a step of 5 degrees. Model verification was carried out in earlier works using data obtained during the launch of balloons.'

Collaborations

Keywords and Comments
'"cosmic rays";"Monte-Carlo method";"radiation safety"', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Harmonic correlators for UHECRs

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Federico Urban
Author and Co-Author
Federico Urban,

Abstract
'I will review the applications, advantages, limitations, and current status of harmonic techniques to detect anisotropies in the UHECR arrival direction distribution. In particular I will focus on the harmonic cross-correlation between the UHECR sky and galaxies, where the latter are taken as proxies for the locations of UHECR sources in the assumption that such sources correlate with the large-scale structure of the Universe. This type of harmonic cross-correlation has been proposed only recently, and it shows very promising complementarities with the well-known harmonic UHECR autocorrelation. After a brief introduction I will discuss novel tools and applications to account for different UHECR chemical composition and for the random deflections caused by the galactic magnetic field. I will show how the combination of UHECR harmonic auto-correlation and cross-correlations with large-scale structures can disentangle different UHECR primaries and could reverse-engineer some of the effects of the galactic magnetic field to a much better degree than the auto-correlation alone. I will conclude with an outlook on applications to other data sets, such as astrophysical neutrinos.'

Collaborations

Keywords and Comments
'UHECR anisotropies', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

Modified Characteristics of Hadronic Interactions

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Jiri Blazek
Author and Co-Author
Jiri Blazek, Jakub Vícha | Jan Ebr | Petr Travnicek | Ralf Ulrich | Tanguy Pierog

Abstract
"The development of hadronic cascades in extensive air-showers is modeled by hadronic interaction models based on extrapolations of collider data. The models' predictions at the highest energies are at a known tension with the description of measurements of the muonic component if the mass composition derived from the fluorescence technique is assumed. We apply an ad-hoc modification to the CORSIKA Monte-Carlo generator that allows for adjustment of features of hadronic interactions such as multiplicity, elasticity and cross-section. Compared to similar previous studies, we are now able to obtain not only information related to the longitudinal development of the shower, such as the mean depth of shower maximum, but also information about the lateral distribution of particles. Moreover, we generate a scan across the various possible combined modifications of the Sibyll 2.3d model using both protons and iron nuclei, quantify their effects on both the lateral and longitudinal features of a cosmic-ray shower and identify regions of the modification phase space which are explaining, within the stated systematics, both the ground-based and fluorescence-based measurements of cosmic rays at the highest energies."

Collaborations

Keywords and Comments
'Ultra-High Energy Cosmic Rays; Modified Hadronic Interaction Models; CORSIKA; Muonic Component', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Methods

A Spectral Cosmic Ray Model for Cosmological Simulations

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 115

Presenter
Ludwig Böss
Author and Co-Author
Ludwig Böss, Klaus Dolag | Harald Lesch

Abstract
'Cosmic Rays are the most likely source of non-thermal emission in galaxy clusters. These emissions are found at merger shocks where they can be observed as highly polarized radio relics, in jets of AGNs and sometimes as a diffuse radio halo across the entire galaxy cluster. Self-consistent simulations of these observations have been a challenge over the last decades, as they require models for (re-)acceleration of CRs at shocks, by AGN, or turbulence as well as accurate treatment of energy losses of CRs and their spacial diffusion. Since most of these effects depend on the distribution function of the CR population a simple two-fluid approach of CRs and gas is often not sufficient to self-consistently reproduce observations. We present a spectral cosmic ray model implemented in the cosmological MHD code OpenGadget3 that shows excellent scaling and can be used for the next generation of galaxy and galaxy cluster simulations that include the effects of both, magnetic fields and cosmic ray electrons and protons. After a detailed description of the model and its coupling to our large-scale simulation code, we will discuss the use case of a galaxy cluster merger simulation that includes magnetic fields and cosmic rays with a spectrum represented by up to 96 momentum bins. This simulation allows us to self-consistently investigate the emission from CR electrons while also constraining the kinematic impact of CR protons.'

Collaborations

Keywords and Comments
'Structure Formation; MHD Simulations; Fokker-Planck-Solver; Spectral Cosmic Ray Model;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Magnetic field amplification at planetary and astrophysical high Mach-number shocks

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Artem Bohdan
Author and Co-Author
Artem Bohdan, Martin Pohl | Jacek Niemiec | Paul Morris | Yosuke Matsumoto | Takanobu Amano | Masahiro Hoshino | Ali Sulaiman

Abstract
"Collisionless shocks are present everywhere in the universe, from the solar environment to distant supernovae. They are often associated with strong magnetic fields due to strong nonthermal radiation. However, it is still not well understood how magnetic fields are amplified at scales of the shock thickness. Here we use a set of large-scale Particle-In-Cell (PIC) simulations of non-relativistic perpendicular shocks in the high Mach number regime to clarify this issue. These shocks are Weibel mediated and we present evidence that the magnetic field is amplified at the shock transition due to the Weibel instability and the magnetic field strength strongly correlates with the Alfvénic Mach number. We propose a new explanation for this correlation. PIC simulation results can explain in-situ magnetic field measurements of Saturn's bow shock performed by the Cassini spacecraft."

Collaborations

Keywords and Comments
"collisionless shocks; magnetic field; SNR; Saturn's bow shock", "

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Particle acceleration in winds of star clusters

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 26 Galactic Sources & Winds | MM
Presenter Forum Table

Presenter
Giovanni Morlino
Author and Co-Author
Giovanni Morlino,

Abstract
'We investigate the process of particle acceleration at the termination shock that develops in the bubble excavated by star clusters' winds in the interstellar medium. We develop a theory of diffusive shock acceleration at such shock and we find that the maximum energy may reach the PeV region for very powerful clusters.\r\nWe show how the maximum energy is limited by two different processes: the particle escape from the bubble boundary and the drop of energy gain for particles able to diffuse up to the center of the cluster.\r\nA crucial role in this problem is played by the dissipation of kinetic energy of the wind to magnetic perturbations. Under reasonable conditions the spectrum of the accelerated particles has a power law shape with a slope 4.0-4.3, in agreement with what is required based upon standard models of cosmic ray transport in the Galaxy.'

Collaborations

Keywords and Comments
'particle acceleration; stellar clusters; Galactic cosmic rays', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

AGN jet heating with cosmic rays in magnetized, turbulent galaxy clusters

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 116

Presenter
Kristian Ehlert
Author and Co-Author
Kristian Ehlert | Christoph Pfrommer | Rainer Weinberger | Volker Springel,

Abstract
'Feedback processes by active galactic nuclei in the centres of galaxy clusters appear to prevent large-scale cooling flows and impede star formation. However, the detailed heating mechanisms remain uncertain. Promising heating scenarios invoke the dissipation of Alfvén waves that are generated by streaming cosmic rays (CRs) or the dissipation of cluster turbulence. In order to study the idea of CR heating, we use three-dimensional magneto-hydrodynamical simulations with the Arepo code that follow the evolution of jet-inflated bubbles filled with CRs in a turbulent, magnetized cluster atmosphere. We find that a single injection event recovers the correct CR distribution and heating rate for a successful heating model in Perseus over a duty cycle of 30 Myrs. In order to study the idea of turbulent heating, we analyzed the impact of active galactic nuclei (AGN)-induced turbulence on X-ray line broadening and compared our results to recent Hitomi data. We find that AGN jets drive turbulence, which however remains localized in the wake of the buoyantly rising bubbles after the jets have terminated. Cluster turbulence as inferred from broadened X-ray lines and Faraday rotation measures must hence be driven by other processes such as precipitation due to thermal instability or cosmological infall. In the final part, we present new simulations that study the interplay of radiative cooling and heating induced by AGN jets that self-regulate the cooling cluster cores and may provide the long-thought solution to the cooling flow problem in galaxy clusters.'

Collaborations

Keywords and Comments
'AGN; CR feedback; MHD simulations; galaxy clusters;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

The contribution of distant sources to the observed flux of ultra high-energy cosmic rays

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 117

Presenter
Ellis Owen
Author and Co-Author
Ellis Owen, Qin Han | Kinwah Wu | Y. X. Jane Yap | Pooja Surajbali

Abstract
"The Greisen-Zatsepin-Kuz'min (GZK) horizon traditionally sets the distance limit for sources generating the UHE CR flux detected on Earth. This horizon is caused by the strong attenuation of Ultra-high-energy (UHE) cosmic rays (CRs) due to their hadronic interactions with cosmic microwave background radiation. It has been argued that the propagation distance of UHE CRs of energies $\\sim (10^{18}-10^{20})~{\\rm eV}$ would be about several tens Mpc. We demonstrate that a non-negligible fraction of the UHE CRs arriving on Earth could originate from beyond the GZK horizon when heavy nuclear CRs, and the population and evolution of UHE CR sources are taken into account. Here we present how the multi-particle CR horizon is modified by different source populations and discuss how this leads to the natural emergence of an isotropic background component in the observed flux of UHE CRs. This background component would coexist with an anisotropic contribution associated with nearby foreground sources within the GZK horizon"

Collaborations

Keywords and Comments
'cosmic ray sources; ultra-high energy cosmic radiation; secondary cosmic ray; astronomical radiation sources; extragalactic astronomy', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Using PIC and PIC-MHD to investigate the occurrence of Fermi-1 acceleration in astrophysical shocks

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Allard Jan van Marle
Author and Co-Author
Allard Jan van Marle, Martin Pohl | Alexandre Marcowith | Paul Morris | Artem Bohdan

Abstract
'When charged particles cross an astrophysical shock, they can be accelerated through diffusive shock acceleration (DSA) aka Fermi-1 acceleration. This process involves repeated shock crossings, which occur if the particles are reflected toward the shock by the magnetic field. If the particles reach relativistic speeds, they become known as cosmic rays (CRs). \r\n\r\nThis process is difficult to simulate, because it involves both large scales (the size of the astrophysical shock, which is typically measured in pc) and microphysics (the interaction between individual particles and the magnetic field).\r\n\r\nWe investigate these interactions by combining both particle-in-cell (PIC) and combined PIC-MHD simulations. Using a PIC cell code, we simulate the formation of the shock, which allows us to determine which fraction of the total mass crossing the shock is reflected back upstream. Then, using the combined PIC-MHD method, we continue the simulation on a larger scale in order to follow the interaction between the reflected particles and the thermal gas. To determine whether they can trigger the magnetic instabilities that will allow for the particles to be reflected back toward the shock.\r\n\r\nWe find that this process depends on both the angle between the magnetic field and the flow and the Alfvenic Mach number. For large angles (quasi-perpendicular) the reflected particle fraction tends to be too small to trigger the required instabilities. However, this changes at high Alfvenic Mach numbers, where we find that even a low non-thermal particle fraction is enough to destabilize the magnetic field and initiate DSA.'

Collaborations

Keywords and Comments
'particle physics\r\nastrophysical shocks\r\nmagnetohydrodynamics\r\nparticle-in-cell\r\ncosmic rays', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Consequences of electron reflection back upstream in oblique shocks

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Paul Morris
Author and Co-Author
Paul Morris | Artem Bohdan | Martin Pohl,

Abstract
'Astrophysical shocks are believed to efficiently accelerate charged particles, yet electrons need to undergo pre-acceleration to be energetic enough to cross the shock and join the game of acceleration. Understanding the mechanisms responsible for electron pre-acceleration is crucial to solving the shock injection problem. Here, we present PIC simulations of Oblique shocks of varying obliquity angle, $\\theta_{\\rm{Bn}}$. Our analyses focus on the reflection of incident electrons back upstream, with these particles capable of generating upstream turbulence and transferring energy away from the shock itself and to the upstream plasma. In this work, we demonstrate that electron reflection occurs in the foot region of the shock, and discuss the cause of this phenomenon. We quantify the dependencies of the rate at which electrons are reflected and the amount of energy carried upstream as functions of shock parameters, showing the electron spectra vary as a function of $\\theta_{\\rm{Bn}}$ and for which parameter ranges the upstream is significantly modified by the reflected particles. We show that some electrons lose energy after their initial reflection and can be caught up to by the shock, where they either cross into the downstream, or are again reflected. We assess how these energy losses, when significant, could compromise the efficiency of electron injection at the shock.'

Collaborations

Keywords and Comments
'', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Predicting the UHE photon flux from GZK-interactions of hadronic cosmic rays using CRPropa 3

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 118

Presenter
Philip Ruehl
Author and Co-Author
Philip Ruehl | Anna Bobrikova | Marcus Niechciol | Markus Risse,

Abstract
'The spectrum of ultra high energy (UHE) cosmic rays as measured by the Pierre Auger Observatory indicates a strong flux suppression above 50 EeV. The origin of this suppression is still unclear. One possible explanation is the Greisen-Zatsepin-Kuzmin (GZK) process, in which UHE protons interact with the cosmic microwave background. Indirect evidence for the GZK-process could be provided by the search for UHE photons produced in such an interaction. A signal of UHE photons could not yet be identified among the cosmic rays. Hence, upper limits on the UHE photon flux have been derived from experimental data of various experiments. In order to interpret these limits, theoretical predictions are needed.\r\nIn this contribution, new predictions on the UHE photon flux above 0.1 EeV are derived assuming both pure and mixed compositions of the initial cosmic rays. The \r\nsimulation study has been done using CRPropa 3 taking into account latest results \r\nregarding the composition as measured by the Pierre Auger Observatory \r\nand the extragalactic medium. For all compositions, the predictions stay below the current upper limits on the UHE photon flux derived from experimental data. The main uncertainties on the predictions originate from the lack of knowledge about the sources of UHE cosmic rays. Future experiments like the AugerPrime upgrade of the Pierre Auger Observatory are expected to shed further light on the origin and composition of UHE cosmic rays and, hence, will help to improve the predictions.'

Collaborations

Keywords and Comments
'cosmic ray propagtion; CRPropa 3; GZK-process; GZK-cutoff; ultra-high-energy photons;', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

The pervasive mechanism that accelerates cosmic rays at all the energies

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 119

Presenter
Antonio Codino
Author and Co-Author
Antonio Codino,

Abstract
'The mechanism accelerating cosmic rays in the Galaxy and galaxy clusters is identified and described. The acceleration of cosmic rays is a purely electrostatic process which operates up to the maximum energies of \$10^{23}\$ \$eV\$ in galaxy clusters. Galactic cosmic rays are accelerated in a pervasive electrostatic field active in the whole Galaxy except in restricted regions shielded by interstellar and stellar plasmas as, for instance, the region occupied by the solar system.\r\nIt is proved that the energy spectrum of the cosmic radiation in the Milky Way Galaxy in the region where the solar system resides, has a constant spectral index comprised between 2.64-2.68 and the maximum energies of Galactic protons are \$3.0 \\times 10^{19}\$ \$eV\$. The agreement of these results with the experimental data is discussed in detail and underlined.\r\nThe physical processes that maintain the stability of the electrostatic structure in the Milky Way Galaxy are the same that generate the Galactic magnetic field. Accordingly, the intensity, orientation and direction of the Galactic magnetic field are evaluated. The results of the calculation are compared with the observational data, optical and mostly radio astronomy data. The accord of the intensity, orientation and direction of the observed magnetic field with calculation is excellent.'

Collaborations

Keywords and Comments
'"Cosmic-ray acceleration"', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Faraday rotation constraints on large scale Halo model

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 01 Magnetic Fields and CR Propagation | CRI
Presenter Forum Table

Presenter
Thomas Fitoussi
Author and Co-Author
Thomas Fitoussi | Gustavo Medina Tanco | Juan-Carlos D'Olivo,

Abstract
"The global structure of the magnetic field inside the disk of our Galaxy is quite well described by dynamo action and constrained by Faraday rotation measurements. The Halo, on the other hand, is much more of an enigma. Other face-on spiral galaxies show spiral magnetic structures in their disk, like the Milky Way, showing that our magnetic field is a rather typical feature for such class of galaxies. Furthermore, RM-synthesis of CHANGE-ES observations shows an increasing number of edge-on spiral galaxies presenting X-shaped structures surrounding the disk and extending orderly to distances of up to tens of kpc. Although the 4-dimensional topology of those magnetized halos and their physical nature is still unclear, they hint to the strong possibility that our galaxy also has a large and well organized magnetized Halo. Current models for the Milky Way's magnetic field extend very little out of the galactic plane and do not consider an extended, topologically well-organized field in the Halo. In this work, conceptually motivated by the possible existence of a Parker type galactic outflow, we propose a simple Archimedean-like field, for an extended Halo magnetic field. We add this component to a simple disk magnetic field, in order to model the Faraday rotation signal of extragalactic sources as observed on Earth and compare the results to published maps of Faraday rotation. We show that an extended magnetic field in the Halo is not only compatible with the observed Faraday rotation measurements, but it is actually favored by them."

Collaborations

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Cosmic ray feedback across the sequence of star-forming galaxies

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 14 CRs and ISM | CRD
Presenter Forum Table

Presenter
Roland Crocker
Author and Co-Author
Roland Crocker, Mark Krumholz

Abstract
'Star formation proceeds inefficiently in galaxies for reasons that remain under debate. In the local ISM it is known that the cosmic rays (CRs) provide a significant fraction of total ISM pressure and therefore contribute to hydrostatic balance. I will set out a model for the dynamical effect of CRs, directly accelerated as a result of star formation itself, on the ISM gas column. On the basis of this model, I will explain how CR feed-back sets an ultimate limit to the star formation efficiency of 'ordinary' galaxies (normal spirals and dwarfs). Interestingly, most such galaxies -- including the Milky Way -- have star formation efficiencies approaching the maximum allowed by cosmic ray feed-back, suggesting they exist in a state of delicate, dynamically-determined equilibrium. However, at the higher surface densities pertinent to star burst systems pionic losses imply that CRs are dynamically unimportant on global scales while, at the same time, guaranteeing that such galaxies are luminous gamma-ray sources. I will explain how our model leads to new insights about the observed GeV to TeV spectra of local starbursts and to the isotropic gamma-ray flux detected at GeV energies'

Collaborations

Keywords and Comments
'Star formation; cosmic ray feedback; gamma-ray emission', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

New cross section determination for secondary cosmic ray electron and positrons in the light of new data from collider experiments

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 120

Presenter
Luca Orusa
Author and Co-Author
Luca Orusa, Michael Korsmeier | MATTIA DI MAURO | Fiorenza Donato

Abstract
'The cosmic-ray fluxes of electrons and positrons ($e^{\\pm}$) are measured with high precision by the space-borne particle spectrometers AMS-02. To infer a precise interpretation of the dominant production process for $e^{\\pm}$ in our Galaxy, it is necessary to have a correct description of the secondary component, produced by the interaction of cosmic-ray proton and helium with the interstellar medium. We update the parametrization of the $e^{\\pm}$ cross sections in order to obtain a new estimate of the lepton secondary component flux of the cosmic radiation. In the light of new cross section measurements performed at collider experiments of p+p→$\\pi^{\\pm}$+X and p+p→$K^{\\pm}$+X, we update the parametrization of the cross sections for these processes and then compute the $e^{\\pm}$ ones from $\\pi^{\\pm}$ and $K^{\\pm}$ decays. We use for the first time in this field the $e^{\\pm}$ spectrum obtained from the muon decay computed till the next to leading order. By using pp, pHe and pC data we estimate the uncertainty on the Lorentz invariant cross section for p+He→$\\pi^{\\pm}$+X. The peculiarity of this work is the experiment based approach, that we adopt in order to obtain a better shape determination and a significant reduction of uncertainty of the current secondary cosmic ray $e^{\\pm}$ flux predictions.'

Collaborations

Keywords and Comments
'AMS-02; leptons; cross section; collider; secondary production;', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Ultra-high-energy cosmic ray acceleration by magnetic reconnection in relativistic jets and the origin of very high energy emission

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 11 UHECR Acceleration | CRI
Presenter Forum Table

Presenter
Elisabete de Gouveia Dal Pino
Author and Co-Author
Elisabete de Gouveia Dal Pino | Tania Medina-Torrejon | Luis Kadowaki | G. Kowal,

Abstract
'Relativistic jets are believed to be born magnetically dominated. \r\nVery and ultra-high energy cosmic rays can be efficiently accelerated by magnetic reconnection in these sources. We here demonstrate this by means of three-dimensional relativistic magnetohydrodynamical (3D-RMHD) simulations, injecting thousands of initial low-energy particles in the transition region of the relativistic jet from magnetically to kinetically dominated, where its magnetization parameter sigma ~1. In this region, there is efficient magnetic energy dissipation by fast magnetic reconnection which is naturally driven by kink instabilities (KI) in the initial helical magnetic fields of the jet. We find that the particles are accelerated up to energies $E \\sim 10^{18}$ eV for background magnetic fields $B \\sim 0.1$ G, and $E \\sim 10^{20}$ eV for $B \\sim 10$ G. We have also derived directly from the simulations the acceleration rate due to magnetic reconnection which has a dependence on the particles energy, $r_{acc} \\propto E^{-0.1}$. The energy spectrum of the accelerated particles develops a power-law tail with spectral index $p \\sim -1.2$. Our results may explain observed variable emission patterns, specially at very high energies as well as the associated neutrino emission recently detected in blazars.'

Collaborations
CTA,

Keywords and Comments
'AGN blazers; particle acceleration; relativistic MHD simulations; UHECRs', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Simulations of the cosmic-ray anisotropy down to TeV energies

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Gwenael Giacinti
Author and Co-Author
Gwenael Giacinti | Brian Reville,

Abstract
'We calculate the shape of the TeV-PeV cosmic-ray anisotropy (CRA) in 3D Kolmogorov turbulence. We present the first numerical calculations of the CRA down to TeV energies, using realistic values for the coherence length of the interstellar turbulence. At these low energies, the large-scale CRA aligns with the direction of local magnetic field lines around the observer. In this type of turbulence, the cosmic-ray intensity is flat in a broad region perpendicular to magnetic field lines. Even though the CRA is rather gyrotropic, we show that the local realization of the turbulence around the observer results in the appearance of weak, non-gyrotropic, small-scale anisotropies, which contain important information about the local turbulence level.'

Collaborations

Keywords and Comments
'Cosmic-ray anisotropy; Cosmic-ray propagation; Interstellar turbulence', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

A multi-wavelength view of the cosmic ray confinement in star-forming galaxies

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 26 Galactic Sources & Winds | MM
Presenter Forum Table

Presenter
Paula Kornecki
Author and Co-Author
Paula Kornecki, Enrico Peretti | Santiago del Palacio | Gustavo E. Romero | Leonardo J. Pellizza | Paula Benaglia

Abstract
'Cosmic rays (CRs) are responsible for a tight correlation between the star formation rate (SFR) and the radio and gamma-ray luminosity observed in star-forming galaxies (SFGs). This correlation can possibly be explained by a linear scaling between the SFR and the number of CR acceleration sites, such as supernova remnants, coupled to the dependence of particle escape with galaxy properties. \r\nObservations in radio and gamma rays are important tools to probe CR activity, but they may not be sufficient to fully probe the confinement properties of galaxies. For instance, CR calorimetry is one of the most intriguing unanswered aspects in star-forming regions which could result not only in emission through the neutrino channel but possibly also in the hard X-ray energy band.\r\nWe perform a multi-wavelength investigation with the aim of characterizing the CR population and the effective fields affecting their transport within SFGs with different levels of activity. In particular, we focus on the possibility of testing proton confinement in the X-ray and MeV bands. With this goal, we develop a model describing the CR transport in SFGs for a broad range of SFRs. Hadronic byproducts and pair production are computed self-consistently in a multi-wavelength context ranging from radio up to X-rays and gamma rays.\r\nWe conclude that a panchromatic view of the SFR-luminosity correlations in SFGs is key to place strong constraints on the physical processes that govern the non-thermal emission of these sources.'

Collaborations

Keywords and Comments
'cosmic ray; galaxies; starburst; star-formation; gamma-rays; X-rays; radio continuum', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Simulations of Cosmic Ray Ensembles originated nearby the Sun

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 121

Presenter
David Alvarez-Castillo
Author and Co-Author
David Alvarez-Castillo | Piotr Homola | Dariusz Gora | Dhital Niraj | Gabriela Opiła | Justyna Mędrala | Bożena Poncyljusz | for the CREDO Collaboration,

Abstract
"Cosmic Ray Ensembles (CRE) are yet not observed groups of cosmic rays with a common primary interaction vertex or the same parent particle. One of the processes capable of initiating identifiable CRE is an interaction of an ultra-high energy (UHE) photon with the solar magnetic field which results in an electron pair production and the subsequent synchrotron radiation. The resultant electromagnetic cascade forms a very characteristic line-like front of a very small width (~meters), stretching from tens of thousands to even many millions of kilometers. In this contribution we present the results of applying a toy model to simulate detections of such CRE at the ground level with an array of ideal detectors of different dimensions. The adopted approach allows us to assess the CRE detection feasibility for a specific configuration of a detector array. The process of initiation and propagation of an electromagnetic cascade originated from an UHE photon passing near the Sun, as well as the resultant particle distribution on ground, were simulated using the CORSIKA program with the PRESHOWER option, both modified accordingly. The studied scenario results in photons forming a cascade that extends even over tens of millions of kilometers when it arrives at the top of the Earth's atmosphere, and the photon energies span practically the whole cosmic ray energy spectrum. The topology of the signal consists of very extended CRE shapes, and the characteristic, very much elongated disk-shape of the particle distribution on ground illustrates the potential for identification of CRE of this type."

Collaborations
other (fill field below), Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'cosmic ray ensembles; large scale cosmic ray correlations; extensive air showers', 'The main results covered by this article will be summarised in a highlight talk to be presented by a representative speaker of the CREDO Collaboration, if only the Conference Organizers agree that such a talk is given (an appropriate request will be sent

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Magnetic field generation by the first cosmic rays

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 01 Magnetic Fields and CR Propagation | CRI
Presenter Forum Table

Presenter
Yutaka Ohira
Author and Co-Author
Yutaka Ohira,

Abstract
'We recently proposed that cosmic rays are first accelerated at the redshift of z~ 20 by supernova remnants of first stars without the large scale magnetic field. In this talk, we are going to talk about the large scale magnetic field generation by the first cosmic rays. We show that even though the current and charge neutralities are initially satisfied, the current neutrality is eventually violated if there is an inhomogeneity, so that the magnetic field is generated. In addition, we propose a new driving mechanism for the Biermann battery in an inhomogeneous plasma with streaming cosmic rays. We demonstrate the new generation mechanisms of the magnetic field by conducting three-fluid plasma simulations and particle in cell simulation. We propose that the first cosmic rays generate the magnetic field with a large scale at the redshift of z~20.'

Collaborations

Keywords and Comments
'Generation of magnetic fields; effects of cosmic rays', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Collective flow in ultra high energy cosmic rays within CORSIKA

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Maowu Nie
Author and Co-Author
Maowu Nie | Hengying Zhang | Li Yi | Cunfeng Feng,

Abstract
"In heavy ion collisions, the main goal is to create the quark-gluon plasma (QGP) and then study its properties in order to understand quantum chromodynamics at extreme conditions. Collective flow serves as an important probe to study the production and characterize the property of the QGP. In ultra high energy cosmic rays (UHECR), the collision energies are an order of magnitude higher than the current ion colliders. It is naturally to believe the QGP to be created in UHECR collisions. In this work, collective flow are analytically studied within CORSIKA model, with EPOS-LHC for high energy hadronic interaction. The collision energy dependence of collective flow will be also presented. These results will help the understanding of UHECR behavior and can be tested at China's large high altitude air shower observatory (LHAASO) experiments."

Collaborations

Keywords and Comments
", "

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Modeling the spectrum and composition of ultrahigh-energy cosmic rays with two populations of extragalactic sources

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 122

Presenter
Saikat Das
Author and Co-Author
Saikat Das, Soebur Razzaque | Nayantara Gupta

Abstract
'We fit the ultrahigh-energy cosmic-ray (UHECR, $E>0.1$ EeV) spectrum and composition data from the Pierre Auger Observatory at energies $E>5\\cdot10^{18}$ eV, i.e., beyond the ankle using two populations of astrophysical sources. One population, accelerating dominantly protons (^{1}H), extends up to the highest observed energies with maximum energy close to the GZK cutoff and injection spectral index near the Fermi acceleration model; while another population accelerates light-to-heavy nuclei (^{4}He, ^{14}N, ^{28}Si, ^{56}Fe) with a relatively low rigidity cutoff and hard injection spectrum. A significant improvement in the combined fit is noted as we go from a one-population to two-population model. For the latter, we constrain the maximum allowed proton fraction at the highest-energy bin within 3.5$\\sigma$ statistical significance. In the single-population model, low-luminosity gamma-ray bursts turn out to match the best-fit evolution parameter. In the two-population model, the active galactic nuclei is consistent with the best-fit redshift evolution parameter of the pure proton-emitting sources, while the tidal disruption events could be responsible for emitting heavier nuclei. We also compute expected cosmogenic neutrino flux in such a hybrid source population scenario and discuss possibilities to detect these neutrinos by upcoming detectors to shed light on the sources of UHECRs.'

Collaborations

Keywords and Comments
'Ultrahigh-energy cosmic rays; Cosmogenic neutrinos; Hadronic interactions; UHECR composition; Shower depth distribution', 'Journal Ref:\r\nEur. Phys. J. C 81, 59 (2021)\r\n\r\nDOI:\r\n10.1140/epjc/s10052-021-08885-4'

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Upper limits on the cosmic-ray luminosity of supernovae in nearby galaxies

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 123

Presenter
Rodrigo Sasse
Author and Co-Author
Rodrigo Sasse | Rita de Cassia dos Anjos,

Abstract
'Interactions between cosmic rays and also between cosmic rays and particles of the Cosmic Microwave Background and the Extragalactic Background Light produce charged and neutral pions. The mechanisms that can produce gamma-ray fluxes associated with cosmic rays are the decay of neutral pions, bremsstrahlung, and inverse Compton scattering from pions. These cascading processes show a correlation between the upper limit on the integral GeV-TeV gamma-ray flux and the upper limit on the UHECR luminosity, motivating the study of the multi-messengers to calculate luminosities of UHECRs for specific point sources. We examine the possible sites of ultra-high energy cosmic-ray acceleration in supernovae in nearby galaxies, which were measured by the High Energy Stereoscopic System (H.E.S.S.). The upper limits on the UHECR cosmic-ray luminosity of these sources are calculated with a particular focus on the sources that produce a mixed composition.'

Collaborations
Auger,

Keywords and Comments
'UHECR; Gamma-Ray; Luminosity.', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Particle density fluctuations and correlations in low energy Cosmic-Ray showers simulated with CORSIKA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 124

Presenter
Weronika Stanek
Author and Co-Author
Weronika Stanek, Jerzy Pryga | for the CREDO Collaboration

Abstract
'The current studies of cosmic rays are focused on most energetic particles entering the atmosphere and producing a single Extensive Air Shower (EAS). There are, however, models predicting that interactions of high energy particles may result in Cosmic-Ray Ensembles (CRE) created far from the Earth. They could be observed as some number of correlated air showers of relatively low energies spread over a large area. The objective of the Cosmic Ray Extremely Distributed Observatory (CREDO) is to search for CRE using all available data from different detectors and observatories including even small but numerous detectors spread over large areas.\r\n\r\nInterpretation of such measurements require precise information on properties of EAS in a very wide energy spectrum. Low energy EAS are analysed using events from CORSIKA, the program performing air shower simulations. The primary cosmic ray particle energy range extends from 1 TeV up to 4 000 TeV. The secondary particles at the ground level are studied, their density fluctuations and correlations in location and time. Although the fluctuations observed in multiplicity distributions are consistent with random the more detailed analysis reveals that near a selected particle the density of other particles is enhanced over that expected in the absence of correlations. The results of the analysis may be useful in further calculations, for example to obtain probability of detection of an EAS without special simulations.'

Collaborations
, Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'cosmic ray ensembles; extensive air showers; CORSIKA simulations; particle density fluctuations; particle location correlations', 'The main results covered by this article will be summarised in a highlight talk to be presented by a representative speaker of the CREDO Collaboration, if only the Conference Organizers agree that such a talk is given (an appropriate request will be sent

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Air shower genealogy for muon production

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Maximilian Reininghaus
Author and Co-Author
Tanguy Pierog | Maximilian Reininghaus | Ralf Ulrich,

Abstract
'Measurements of the muon content of extensive air showers at the highest energies show discrepancies compared to simulations as large as the differences between proton and iron. This so-called muon puzzle is commonly attributed to a lack of understanding of the hadronic interactions in the shower development. Furthermore, measurements of the fluctuations of muon numbers suggest that the discrepancy is likely a cumulative effect of interactions of all energies in the cascade.\r\nA unique, novel feature of the air shower simulation code CORSIKA\xa08 allows us to access all previous generations of final-state muons up to the first interaction. With this technique, we study the influence of interactions happening at any intermediate stage in the cascade on muons depending on their energy and lateral distance in a quantitative way. We further relate our findings to recent and upcoming accelerator measurements and comment on the prospects of the proposed proton-oxygen run of the LHC.'

Collaborations
CORSIKA-8,

Keywords and Comments
'hadronic interactions; muon puzzle; air shower simulations', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

EXTREMELY HIGH ENERGY (E > 10^{20} eV) COSMIC RAYS: OBSERVATIONS AND POTENTIAL SOURCES

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 125

Presenter
Vadym Voitsekhovskyi
Author and Co-Author
Roman Hnatyk | Vadym Voitsekhovskyi,

Abstract
'Determination of the nature and sources of ultrahigh energy cosmic rays (UHECR, E>10^{18} eV) is still unsolved problem in cosmic ray physics. The observed high degree of UHECR isotropy, caused mainly by the deviations of the UHECR trajectories in extragalactic and Galactic magnetic fields, together with a significant uncertainty in their chemical composition (atomic mass), don't allow observed events to be linked to their sources. It is possible to reduce the influence of magnetic deflection in two ways - by considering events with extremely high energy (EHECR, E> 10^{20} eV) and taking into account modern models of the Galactic magnetic field for correction of their trajectories. In our work, the observed by Auger and TA detectors EHECR arrival directions are corrected for the influence of Galactic and random extragalactic magnetic fields. New (corrected) EHECR arrival directions are compared to four samples of potential EHECR sources: 17 AGNs with powerful gamma-ray emission (from the 2FHL catalog), 23 radio-flux-selected star-burst galaxies, as well as 42 radio-galaxies from the parameterized catalog of radio-galaxies. Taking into account the energy loss lengths of the EHECR nuclear components (H, He, C, Si, Fe) in the extragalactic environment and the expected typical distances to potential sources (~100 Mpc for H and Si – Fe and ~50 Mpc for He, C), the astrophysical objects of the above samples that could be sources of relevant EHECR events are highlighted. The potential acceleration mechanisms in the selected objects are analyzed, and the contribution of possible Galactic sources (magnetar giant flares) to the observed EHECR events is evaluated.'

Collaborations

Keywords and Comments
'ultra high energy cosmic rays; active galaxy nuclei; radio-galaxies; magnetars', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Formation and propagation of cosmic-ray ensembles

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 126

Presenter
Oleksandr Sushchov
Author and Co-Author
Oleksandr Sushchov | Piotr Homola | for the CREDO Collaboration,

Abstract
'High-energy particles undergo different interactions while propagating through the Universe. As a result, they initiate particle cascades of various types and sizes, referred to as\r\ncosmic-ray ensembles (CRE). Since recently, Cosmic-Ray Extremely Distributed Observatory \r\n(CREDO) Collaboration aims at pursuing a mission dedicated to CRE, since this observation\r\nchannel, i.e. correlated observation of cosmic rays on the global scale, complements the current\r\napproach to cosmic-ray research, which focuses on air showers initiated by individual cosmic rays. Recent results of Monte Carlo simulations showing that there might be a chance of observing a CRE originating from synchrotron radiation occurring even as far away from the Earth as at distances exceeding the Galaxy size, are presented. The issues and perspectives of the CRE-oriented research are discussed as well.'

Collaborations
, Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'Cosmic rays; Cosmic ray ensembles', 'The main results covered by this article will be summarised in a highlight talk to be presented by a representative speaker of the CREDO Collaboration, if only the Conference Organizers agree that such a talk is given (an appropriate request will be sent

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Subcategory Theoretical Results

Thermal-to-nonthermal element abundances in different Galactic environments

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 02 Constraining UHECR sources | CRI
Presenter Forum Table

Presenter
Björn Eichmann
Author and Co-Author
Björn Eichmann, Jörg Rachen

Abstract
'The nonthermal source abundances of elements play a crucial role in the understanding of cosmic ray phenomena from a few GeV up to several tens of EeV. In this presentation a first systematic approach is shown that describes the change of the abundances from the thermal to the nonthermal state via diffusive shock acceleration by a temporally evolving shock. Hereby, not only time-dependent ionization states of elements contained in the ambient gas are considered, but also elements condensed on solid, charged dust grains which can be injected into the acceleration process as well. This generic parametrized model is then applied to the case of particle acceleration by supernova remnants in various ISM phases as well as Wolf-Rayet wind environments. The resulting predictions for low energy cosmic ray (LECR) source abundances are compared with the data obtained by various experiments revealing the importance of dust grains as well as the possible contribution of different ISM environments to the observed LECR flux.'

Collaborations

Keywords and Comments
'SNR; Element abundances; Particle acceleration; Low-energy CR composition', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

The problematic connection between low-luminosity gamma-ray bursts and ultra-high-energy cosmic rays

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 02 Constraining UHECR sources | CRI
Presenter Forum Table

Presenter
Filip Samuelsson
Author and Co-Author
Filip Samuelsson, Damien Bégué | Felix Ryde | Asaf Pe'er | Kohta Murase

Abstract
'Ultra-high-energy cosmic rays (UHECR) are the most energetic particles ever observed. What astrophysical sources are responsible for their immense acceleration remains unknown despite decades of research. In this talk, I will investigate whether low-luminosity gamma-ray bursts (llGRBs), short-lived cosmic explosions currently seen as one of the most promising acceleration candidates, can be the main sources of UHECR. Our study focuses on the radiation from the less energetic electrons, which are inevitably accelerated in the same region. This radiation can be characterized and compared to observations of llGRBs. We find that the radiation from these electrons would be much too luminous, showing that llGRBs would have to be orders of magnitude brighter if they hosted significant UHECR acceleration. This result challenges llGRBs as accelerators of UHECR.'

Collaborations

Keywords and Comments
'Ultra-high-energy cosmic rays (UHECRs); low-luminosity gamma-ray bursts (llGRBs)', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Cosmic-ray transport in blazars: diffusive or ballistic propagation?

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 127

Presenter
Patrick Reichherzer
Author and Co-Author
Julia Becker Tjus | Marcel Schroller | Mario Hörbe | Fabian Schussler | Wolfgang Rhode | Ilja Jaroschewski | Patrick Reichherzer,

Abstract
'The detection of a PeV high-energy neutrino of astrophysical origin, observed by the IceCube Collaboration and correlated with a 3$\\sigma$ significance with Fermi measurements to the gamma-ray blazar TXS 0506+056, further stimulated the discussion on the production channels of high-energy particles in blazars. Many models also consider a hadronic component that would not only contribute to the emission of electromagnetic radiation in blazars but also lead to the production of secondary high-energy neutrinos and gamma rays. \r\n\r\nRelativistic and compact plasma structures, so-called plasmoids, have been discussed in such flares to be moving along the jet axis. The frequently used assumption in such models that diffusive transport can describe particles in jet plasmoids is investigated in the present contribution. While there is scientific consensus that the transport of particles in turbulent fields is diffusive in the limit of infinitely large times, the question arises under which conditions and on which time scale such a limit consideration is appropriate. \r\n\r\nWe present conditions based on analytical calculations that determine the time scale to reach the diffusion phase as a function of the model parameters in the jet.\r\nWe show that the type of the charged-particle transport, diffusive or ballistic, has a large influence on many observable parameters, including the spectrum of high-energy particles.'

Collaborations

Keywords and Comments
'AGN; Blazar; Diffusion; Ballistic; Transport', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

When heavy ions meet cosmic rays: potential impact of QGP formation on the muon puzzle

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Tanguy Pierog
Author and Co-Author
Tanguy Pierog, Sebastian Baur | Hans Dembinski | Matias Perlin | Ralf Ulrich | Klaus Werner

Abstract
'The deficit of muons in the simulation of extensive air showers is a long-standing problem and the origin of large uncertainties in the reconstruction of the mass of the high energy primary cosmic rays. Hadronic interaction models, re-tuned after early LHC data, have a more consistent description of the muon content among them but still disagree with data. Collective hadronization due to the formation of a quark gluon plasma (QGP) has already been studied as a possible cause for a larger production of muons under extreme conditions (rare, very central nuclear interactions), but without real success. However, in the view of the most recent LHC data, a collective hadronization phase might not only be limited to such extreme conditions. And because of its different ratio of electromagnetic to hadronic energy, a QGP may have the properties to solve the muon puzzle. This hypothesis is demonstrated using a theoretical approach and tested in a realistic way by the modification of hadronic model spectra in CONEX to mimic the production of a QGP also in less extreme conditions with a possible large impact on air shower physics.'

Collaborations

Keywords and Comments
'air shower; LHC; muon puzzle ; simulation;CONEX', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Extragalactic magnetic fields and directional correlations of ultra-high-energy cosmic rays with local galaxies and neutrinos

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 01 Magnetic Fields and CR Propagation | CRI
Presenter Forum Table

Presenter
Arjen Rene van Vliet
Author and Co-Author
Arjen Rene van Vliet, Andrea Palladino | Walter Winter | Andrew Taylor | Anna Franckowiak

Abstract
'Deflections of ultra-high-energy cosmic rays (UHECRs) in extragalactic magnetic fields (EGMFs) decrease the expected directional correlations between UHECR arrival directions on the one hand and UHECR source positions and neutrino arrival directions on the other hand. We use the recently observed correlation between UHECRs and local star-forming galaxies by the Pierre Auger Observatory to put limits on the EGMFs between these galaxies and the Milky Way [1]. In addition, using the same methods, we investigate whether correlations between UHECR and neutrino arrival directions can be expected [2]. We take into account deflections in extragalactic and Galactic magnetic fields, energy-loss interactions with background photon fields and UHECR spectrum and composition measurements. For a source density of star-forming galaxies we show that strong EGMFs ($B > 10$ nG Mpc$^{1/2}$) are required to reproduce the level of anisotropy that Auger has observed. For more numerous sources, e. g. spiral galaxies, weaker EGMFs are allowed. However, this would suggest that UHECR acceleration occurs in many regular galaxies, which is rather difficult to motivate. We demonstrate that even for the weakest EGMFs the non-observation of neutrino multiplets strongly constrains the possibility to find neutrino-UHECR correlations. For star-forming galaxies, or more numerous sources, no neutrino multiplets or neutrino-UHECR correlations are currently expected.\r\n\r\n--\r\n\r\n[1] A. van Vliet, A. Palladino, A. Taylor and W. Winter, in preparation.\r\n[2] A. Palladino, A. van Vliet, W. Winter and A. Franckowiak, Mon. Not. Roy. Astron. Soc. 494, 4255 (2020).'

Collaborations

Keywords and Comments
'ultra-high-energy cosmic rays; extragalactic magnetic fields; starburst galaxies; star-forming galaxies; neutrinos; simulations; arrival directions; neutrino multiplets; source density; Pierre Auger;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Acceleration of UHECR by local supermassive black hole candidates

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 128

Presenter
Arman Tursunov
Author and Co-Author
Arman Tursunov | for the CREDO Collaboration,

Abstract
'The origin and acceleration mechanism of ultra-high-energy cosmic rays (UHECR) with energy exceeding the GZK-cutoff limit remain unknown. It is often speculated that supermassive black holes (SMBHs) located at the centers of many galaxies can serve as possible sources of UHECR. This is also supported by recent observations of high-energy neutrinos from blazar, as neutrinos are the tracers of UHECR. In this contribution, we explore the capabilities of nearby SMBHs (located within 100Mpc distance) to accelerate UHECR of certain energy and composition by the novel, ultra-efficient regime of the magnetic Penrose process, in which protons and ions are energized near SMBH by the ionization or decay of low-energy neutral particles, such as e.g. a hydrogen ionization or neutron beta-decay. Extreme conditions around SMBHs increase chances for engagement of the accelerated UHECR in the production of the cosmic ray ensembles (CRE), i.e. a group of correlated two or more cosmic ray particles, including photons with the same parent particle or a common primary interaction vertex. We discuss the unique signatures of UHECR and CRE produced around SMBHs and potentially observable with a global network of detectors, as proposed by the Cosmic-Ray Extremely Distributed Observatory – CREDO.'

Collaborations
other (fill field below), Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'Particle acceleration; UHECR; black holes; AGN; energy extraction; local universe; cosmic ray ensembles; CREDO;', 'The main results covered by this contribution will be summarized in a highlight talk to be presented by a representative speaker of the CREDO Collaboration, if only the Conference Organizers agree that such a talk is given (an appropriate request will be

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Probing UHECR and cosmic ray ensemble scenarios with a global CREDO network

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 129

Presenter
Arman Tursunov
Author and Co-Author
Arman Tursunov | for the CREDO Collaboration,

Abstract
'Among theoretical approaches in unveiling the physics of ultra-high-energy cosmic rays (UHECR) one can distinguish the models assuming interactions of exotic super-heavy matter (including extra dimensions, Lorentz invariance violation, cosmic strings, dark matter particles or particles beyond the standard model etc.) and acceleration scenarios describing processes, in which the particles are accelerated by a particular astrophysical object (shocks in relativistic plasma jets, unipolar induction mechanisms, second-order Fermi acceleration, energy transfer from black holes or compact stars etc.). Special interest is also paid to understanding of the cosmic ray ensembles (CRE) – the phenomena composed of at least two cosmic ray particles, including photons, with a common primary interaction vertex or the same parent particle with correlated arrival directions and arrival times. In this contribution, we review various theoretical UHECR models and CRE scenarios potentially observable by the global Cosmic Ray Extremely Distributed Observatory (CREDO) network.'

Collaborations
other (fill field below), Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'UHECR; particle acceleration; cosmic ray ensembles; large scale cosmic ray correlations; CREDO;', 'The main results covered by this article will be summarized in a highlight talk to be presented by a representative speaker of the CREDO Collaboration, if only the Conference Organizers agree that such a talk is given (an appropriate request will be sent

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

On the muon scale of air showers and its application to the AGASA data

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Flavia Gesualdi
Author and Co-Author
Flavia Gesualdi, Hans Dembinski | Kenji Shinozaki | Alberto Daniel Supanitsky | Tanguy Pierog | Lorenzo Cazon | Dennis Soldin | Ruben Conceição | for the Working group on Hadronic Interactions and Shower Physics (WHISP)

Abstract
'Recently, several experiments reported a muon deficit in air-shower simulations with respect to the data. This problem can be studied using an estimator that quantifies the relative muon content of the data with respect to those of proton and iron Monte-Carlo air-shower simulations. We analyze two estimators. The first one, based on the logarithm of the mean of the muon content, is built from experimental considerations. It is ideal for comparing results from different experiments as it is independent of the detector resolution. The second estimator is based on the mean of the logarithm of the muon content, which implies that it depends on shower-to-shower fluctuations. It is linked to the mean-logarithmic mass $\\langle \\ln A \\rangle$ through the Heitler-Matthews model. We study the properties of the estimators and their biases considering the knowns and unknowns of typical experiments. Furthermore, we study these effects in measurements of the muon density at 1000 m from the shower axis obtained by the Akeno Giant Air Shower Array (AGASA). Finally, we report the estimates of the relative muon content of the AGASA data, which support a muon deficit in simulations. These estimates constitute valuable additional information of the muon content of air-showers at the highest energies.'

Collaborations
other (fill field below), WHISP

Keywords and Comments
'muon scale; muon deficit; AGASA', ''

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Subcategory Theoretical Results

Hadron cascades in CORSIKA 8

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Ralf Ulrich
Author and Co-Author
Ralf Ulrich | Maximilian Reininghaus | Tanguy Pierog | Anatoli Fedynitch | Felix Riehn,

Abstract
'We present characteristics of hadronic cascades from interactions of cosmic rays in the atmosphere, simulated by the novel CORSIKA 8 framework. The simulated spectra of secondaries, such as pions, kaons, baryons and muons, are compared with cascade equations solvers CONEX and MCEq in air shower mode and full 3D air shower Monte Carlo simulations using the legacy CORSIKA 7 and AIRES. A novel capability of CORSIKA 8 is the simulation of cascades in media other than air, widening the scope of potential simulation applications. We demonstrate this capability by simulating cosmic ray showers in the Martian atmosphere. The CORSIKA 8 framework demonstrates good accuracy and robustness compared to previous results, in particular in those relevant for the production of muons in air showers. Furthermore, hyperons are studied as a messenger from high-density QCD and as an important precursor for high-energy secondaries, including neutrinos. It was also found that interactions of strange baryons can have non-negligible importance for cascade development that require extra care when using any such model in all contexts.'

Collaborations
CORSIKA-8,

Keywords and Comments
'CORSIKA 8; UHECR; extensive air showers; interaction models', '... and I was really struggling with the "subcategory". If you find a better match, feel free to change that...'

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

What if new physics sets in above 50 TeV? Cosmic-ray air-shower simulations with increased cross-section and multiplicity.

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Stelios Romanopoulos
Author and Co-Author
Stelios Romanopoulos | Vasiliki Pavlidou | Theodore Tomaras,

Abstract
'We have used COSIKA to study, through air-shower simulations, observational signatures of a possible increase in cross-section and multiplicity in collisions with center-of-mass energies exceeding $\\sim$ 50 TeV. We have simulated collisions for primaries with energies in the range $10^8 - 10^{12}$ GeV. We have used two different high energy models for the simulations, EPOS LHC and QGSJETII-04, with Fluka for low energy interactions on both. A smooth transition from galactic to extra-galactic cosmic rays was implemented, by fitting a Galactic component with an exponential suppression at $\\sim 10^9$ GeV. The remaining flux in Auger data was interpreted as extra-galactic protons. Above $10^{9.3}$ GeV, the proton-air cross-section and the multiplicity of secondary particles were altered, so as to bring the simulated $\\langle X_\\text{max}\\rangle$ in agreement with Auger data. The parameter space of the viable cross-section and multiplicity in the scenario where the composition of Auger cosmic rays at the highest energies remain unchanged and light places constraints on the phenomenology of any new physics affecting the interactions for high energy protons that may be probed by $\\sqrt{s}>50$ TeV collisions. The muonic production of the showers was also studied in this context.'

Collaborations

Keywords and Comments
'EAS Simulations; Particle Physics; Beyond Standard Model; UHECR; Cross Section;', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Sub-TeV hadronic interaction model differences and their impact on air-showers

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 03 Muon Puzzle and EAS modeling | CRI
Presenter Forum Table

Presenter
Álvaro Pastor Gutiérrez
Author and Co-Author
Álvaro Pastor Gutiérrez | Harm Schoorlemmer | Dan Parsons | Michael Schmelling,

Abstract
'In the sub-TeV regime, the most widely used hadronic interaction models disagree significantly in their predictions for post-first interaction and ground-level particle spectra from cosmic ray induced air showers. These differences generate an important source of systematic uncertainty in their experimental use. We investigate the nature and impact of model uncertainties through a simultaneous analysis of ground level particles and first interaction scenarios. We focus on air shower primaries with energies close to the transition between high and low energy hadronic interaction models, where the dissimilarities have been shown to be the largest and well within the range of accelerator measurements. Interaction models are shown to diverge as several shower scenarios are compared, reflecting intrinsic differences in the model theoretical frameworks. Finally, we discuss the importance of interactions in the model switching energy regime (<1 TeV) and the model choice effect in the number of hadronic interactions within cosmic ray induced air showers of higher energies.'

Collaborations

Keywords and Comments
'Hadronic models; CORSIKA; Monte Carlo generators; Systematic Uncertainties', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Electron Pre-acceleration Through Stochastic Shock Drift Acceleration at Intracluster Shocks

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Jacek Niemiec
Author and Co-Author
Jacek Niemiec | Oleh Kobzar | Karol Fułat | Martin Pohl | Takanobu Amano | Masahiro Hoshino | Shuichi Matsukiyo | Yosuke Matsumoto,

Abstract
'Radio and X-ray observations of radio relics indicate acceleration of relativistic electrons at merger shocks in galaxy clusters. These large-scale shocks can also be sites of ultra-high-energy cosmic ray production. It is assumed that diffusive shock acceleration (DSA) produces synchrotron-radiating electrons but the process of electron pre-acceleration from thermal to supra-thermal energies is poorly known. Using large-scale fully-kinetic two-dimensional particle-in-cell (PIC) simulations of a quasi-perpendicular subluminal shock with low sonic Mach number ($M_s=3$) and propagating in hot intracluster medium with plasma beta $\\beta=5$, we have recently demonstrated that the main electron pre-acceleration mechanism is stochastic shock-drift acceleration (SSDA). In this process electrons are confined at the shock by pitch-angle scattering off turbulence and gain energy while drifting along the motional electric field. We showed that multi-scale magnetic turbulence, including ion-scale shock rippling modes, is essential for electron energization. This turbulence is driven by effective ion and electron temperature anisotropies in the entire shock transition. Wide-energy non-thermal electron distributions are formed both upstream and downstream of the shock and the maximum energy of the electrons is sufficient for their injection into DSA. Here we report on our new PIC simulation studies of SSDA process in a range of plasma beta ($\\beta=3-30$) and subluminal shock obliquity angles. We show that SSDA persists in facilitating the electron injection in rippled shocks. We also present how the SSDA efficiency vary with intracluster medium and shock parameters.'

Collaborations

Keywords and Comments
'particle acceleration; galaxy clusters; shock waves; intracluster medium; plasma instabilities; PIC simulations', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

A New Cosmic-Ray-driven Instability

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 14 CRs and ISM | CRD
Presenter Forum Table

Presenter
Mohamad Shalaby
Author and Co-Author
Mohamad Shalaby | Timon Thomas | Christoph Pfrommer,

Abstract
'Cosmic-ray-driven instabilities play a decisive role during particle acceleration at shocks and CR propagation in galaxies and galaxy clusters. These instabilities amplify magnetic fields and modulate CR transport so that the intrinsically collisionless CR population is tightly coupled to the thermal plasma and provides dynamical feedback. Here, we show that CRs with a finite pitch angle drive electromagnetic waves (along the background magnetic field) unstable on intermediate scales between the gyroradii of CR ions and electrons as long as CRs are drifting with a velocity less than half of the Alfvén speed of electrons. By solving the linear dispersion relation, we show that this new instability typically grows faster by more than an order of magnitude in comparison to the commonly discussed resonant instability at the ion gyroscale. We find the growth rate for this intermediate-scale instability and identify the growing modes as background ion-cyclotron modes in the frame that is comoving with the CRs. We confirm the theoretical growth rate with a particle-in-cell simulation and study the nonlinear saturation of this instability. We identify three important astrophysical applications of this intermediate-scale instability, which is expected to (1) modulate CR transport and strengthen CR feedback in galaxies and galaxy clusters, (2) enable electron injection into the diffusive shock acceleration process, and (3) decelerate CR escape from the sites of particle acceleration, which would generate gamma-ray halos surrounding CR sources such as supernova remnants.'

Collaborations

Keywords and Comments
'Galactic cosmic rays; Supernova remnants; Interstellar medium; CR feedback\r\nAstrophysics - High Energy Astrophysical Phenomena;', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Electron-beam instabilities in the foreshock of high Mach number oblique shocks

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Martin Weidl
Author and Co-Author
Martin Weidl, Artem Bohdan | Paul Morris | Martin Pohl

Abstract
'Motivated by simulations of non-relativistic high Mach number shocks in supernova remnants, we investigate the evolution of relativistic electron beams in the extended foreshock of oblique shocks. The instabilities mainly responsible for heating and scattering of shock-reflected electrons are identified in two-dimensional particle-in-cell simulations of the foreshock region.\r\n\r\nIn their early stage, the observed electrostatic and electromagnetic electron-beam instabilities agree very well with the predictions of linear dispersion theory for a wide range of angles between the background magnetic field and the shock velocity. The subsequent nonlinear evolution of the simulations allows us to develop a detailed model of the isotropisation of the reflected electron beams in the foreshock and estimate how far the electron foreshock region reaches into the upstream depending on shock obliquity and Mach number.'

Collaborations

Keywords and Comments
'supernova remnants; plasma instabilities; cosmic rays', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Improvised Explosive Devices and cosmic rays

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 130

Presenter
Adriana Vásquez Ramírez
Author and Co-Author
Adriana Vásquez Ramírez | Michael Ariza Gómez | Marcos Carillo Moreno | Victor G Baldovino Medrano | Hernán Asorey | Luis A. Núñez,

Abstract
"Homemade antipersonnel mines are improvised explosive devices (IED) deployed from unconventional local techniques and materials. IEDs kill thousands of civilians every year, inflicting grievous physical injuries, spreading fear and disruption across affected communities. Colombian mines, made of a combination of ammonium nitrate and fuel oil known as ANFO, may also pack faeces, glass, and plastic scrap for causing infectious diseases on the victims. Therefore, the detection and dismantling of such harmful devices must alleviate the insidious consequences of the internal conflicts that have plagued the country for more than half a century. In this work, we present results that suggest that cosmic rays can be used to detect the type of IED used in Colombia. We implement a GEANT4 simulation of an ANFO sphere of NH4NO3+diesel interacting with cosmic rays flux at the Bucaramanga level (959 m a.s.l.). Simulations considered the IED buried into different soil types: dry soil model, two humid soils, and two fertilized soils. The simulation showed that the studied interaction generates emerging electrons, gammas, neutrons, and protons. Notably, in the IED-soil interaction, protons' energy led to an excess of around 0.58 MeV. This peak is quite pronounced for all soil models, giving a clear indication of the feasibility of using a cosmic ray-based detector for detecting these IEDs in the different types of soils."

Collaborations

Keywords and Comments
", "

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Ultra-High-Energy Cosmic Rays and Neutrinos from relativistic jets of Active Galactic Nuclei

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 11 UHECR Acceleration | CRI
Presenter Forum Table

Presenter
Rostom Mbarek
Author and Co-Author
Rostom Mbarek, Damiano Caprioli | Kohta Murase

Abstract
'Using particle tracking in 3D relativistic magnetohydrodynamical simulations, we investigate the espresso mechanism, a one-shot reacceleration of galactic cosmic rays that may lead to the production of ultra-high-energy cosmic rays (UHECRs) in the relativistic jets of active galactic nuclei. In this work we also include UHECR diffusion due to small-scale magnetic fluctuations, photodisintegration, and neutrino production. We assess the impact of such a sub-grid scattering on UHECR spectra and the relative importance of espresso and stochastic acceleration, finding that the highest energy particles are invariably produced via the espresso mechanism. Finally, we study high-energy neutrino production, taking into account the effects of external photon fields, and incorporate the effects of photodisintegration and the production of secondary particles. We discuss our results in the light of recent observations by Auger, Telescope Array and IceCube.'

Collaborations

Keywords and Comments
'UHECRs; Neutrino production; AGN jets; Particle acceleration;', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

The Theory of Efficient Particle Acceleration at Shocks

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Damiano Caprioli
Author and Co-Author
Damiano Caprioli | Colby Haggerty | Pasquale Blasi,

Abstract
'The recent discoveries in the theory of diffusive shock acceleration (DSA) that originate from first-principle kinetic plasma simulations are discussed. We show that, when ion acceleration is efficient, the back-reaction of non-thermal particles and self-generated magnetic fields becomes prominent and leads to both enhanced shock compression and particle spectra significantly softer than the standard test-particle DSA theory. These results are discussed in the context of the non-thermal phenomenology of astrophysical shocks, with a special focus on the supernova remnant SN1006.'

Collaborations

Keywords and Comments
'Particle acceleration; supernova remnants; diffusive shock acceleration', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

A Kinetic Study of the Saturation of the Bell Instability

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Georgios Zacharegkas
Author and Co-Author
Georgios Zacharegkas, Damiano Caprioli | Colby Haggerty | Siddhartha Gupta

Abstract
'The nonresonant streaming (Bell) instability plays a crucial role in the confinement and acceleration of cosmic rays (CRs), but the mechanism ultimately responsible for its saturation has never been determined from first principles. We present 1D, 2D, and 3D hybrid (kinetic ions and fluid electrons) plasma simulations in which the saturation of the Bell instability is studied as a function of the CR current. We derive a prescription for the value of the amplified magnetic field at saturation, also providing a theoretical explanation for it. These results provide the necessary tools to self-consistently incorporate CR-driven magnetic field amplification into fluid simulations and analytical calculations.'

Collaborations

Keywords and Comments
'Magnetic field amplification; Particle acceleration; Bell instability; Kinetic simulations; Cosmic rays; Plasma; Nonresonant instabilities', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Lepton-driven Non-resonant Streaming Instabilities

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Siddhartha Gupta
Author and Co-Author
Siddhartha Gupta | Damiano Caprioli | Colby Haggerty,

Abstract
'Using fully-kinetic plasma simulations, we study the non-resonant (Bell) streaming instability driven by energetic leptons. We identify the necessary conditions to drive the Bell instability and the differences from the standard proton-driven case in both linear and saturated stages. A simple analytic theory is presented to explain simulations. Our findings are crucial for understanding the phenomenology of astrophysical environments where only electrons may be accelerated (e.g., oblique shocks) or where relativistic pairs are produced (e.g., around pulsar wind nebulae).'

Collaborations

Keywords and Comments
'', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Particles acceleration in quasi-perpendicular non-relativistic High Mach number shocks

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Naveen Kumar
Author and Co-Author
Naveen Kumar, Brian Reville

Abstract
'Electron and ion acceleration at a non-relativistic collisionless shock is studied by employing large scale one-dimensional particle-in-cell (PIC) simulations in the de-Hoffmann and Teller (dHT) frame of reference. We demonstrate that diffusive shock acceleration of both electrons and ions occurs in quasi-perpendicular shocks configurations at large Alfven Mach numbers. We also identify the role of precursor waves on the electron energization in the upstream region. The emergence of a significant non-thermal ion component holds important implications for observations of hadronic emission from collisionless shocks occurring for example in supernova remnants, and colliding stellar winds.'

Collaborations

Keywords and Comments
'Particle Acceleration; PIC simulations; High Mach number shocks', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

The origin of UHECR: the distance to the nearest source and the dipole

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Rodrigo Guedes Lang
Author and Co-Author
Rodrigo Guedes Lang | Andrew Taylor | Vitor de Souza,

Abstract
'The origin of UHECR remains one of the most intriguing open question in astroparticle physics. In this work, we delve into this matter by seeking to build a solid understanding of the role of local sources of UHECR, with a few tens of Mpc, in both the energy spectrum and the angular distribution of arrival directions. We present semi-analytical approaches for the propagation of UHECR in turbulent extra-galactic magnetic fields and for calculating the angular arrival distribution. With that, we are able to study both the spectrum and dipole evolution with energy. For the energy spectrum, we estimate the relative contribution of sources at different distance shells, showing the onset of a propagation horizon at the highest energies and a magnetic horizon at lower energies. Constrains on the distance to the nearest source are imposed, showing the need for local sources with few tens of Mpc. For the arrival directions, on the other hand, we show the arising of the dipolar behavior of the distribution, as well as how it evolves with energy and depends on the astrophysical hypotheses. We also argue for the need for an angular power spectrum analysis of the data.'

Collaborations

Keywords and Comments
", "

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

GDAS atmospheric models in astroparticle shower simulations

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 131

Presenter
Jennifer Grisales-Casadiegos
Author and Co-Author
Jennifer Grisales-Casadiegos, Luis A. Núñez | Christian Sarmiento-Cano | For de LAGO Collaboration

Abstract
"Atmospheric conditions affect the development of secondary particles produced by primary cosmic rays. In this work, we present a methodology to simulate the impact of the Global Data Assimilation System (GDAS) atmospheric models in secondary particle flux at the Earth's surface. GDAS implements global atmospheric models based on meteorological measurements and numerical weather predictions. GDAS gives latitude-longitude-altitude dependent profiles of the atmosphere's main state variables like temperature, pressure, and humidity.\r\n\r\nTo validate our methodology, we built monthly GDAS atmospheric profiles over Malargüe-Argentina between 2006 and 2011. The verification analysis consisted of comparing the maximum atmospheric depth (Xmax) with those calculated with the Auger atmospheric option used in CORSIKA simulations. The difference between the GDAS-based and the Auger standard atmospheric Xmax lags behind 2%.\r\n\r\nThe methodology was implemented for the city of Bucaramanga-Colombia, using ARTI for the year 2018. ARTI is a full computational framework, developed by the Latin American Giant Observatory (LAGO) Collaboration, to estimate the particle spectra on Water Cherenkov Detectors depending on the geographical coordinates. We observed that the most significant total flux differences, from the predefined atmospheric profile (subtropical) and GDAS-based, occur in November (~10.22%) and April (~24.12%). An inverse correlation also results between the particle flux and the monthly average temperature. Similarly, for muons on these dates, the difference is between 9.58% and 22.25% respectively. These results confirm the significance of the atmospheric variation in the flux of secondary particles measured at ground level during the year."

Collaborations
, LAGO

Keywords and Comments
'Astroparticle flux; Atmospheric models; Extensive air showers', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Transient Source for the Highest Energy Galactic Cosmic Rays

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 02 Constraining UHECR sources | CRI
Presenter Forum Table

Presenter
Glennys Farrar
Author and Co-Author
Glennys Farrar, Chen Ding | Marco Muzio

Abstract
'We analyze the Auger dipole anisotropy measurements below 8 EeV, to expose the existence of an individual source of the Galactic cosmic rays above 10^{17} eV. The source is incompatible with being in the direction of the Galactic center by a χ^2/dof > 6. Interpreting the amplitude and direction of the Galactic HE Dipole in terms of a transient, we find: \r\n\ta) The amplitude of the Galactic VHE dipole constrains the ratio of source distance and time since the transient event occurred.\r\n\tb) The Galactic VHE dipole is compatible with production in a transient event in the Galactic plane which occurred about 30 kyr ago at a distance of about 1 kpc. A SN remnant and pulsar consistent with being the relics of this event are identified.\r\n\tc) The peak rigidity of these VHE Galactic CRs is about 0.1 EV.\r\n\td) For reasonable estimates of the diffusion coefficient of the GMF, the energy emitted in CRs above 100 PeV by the transient Galactic source is about 10^{44-45} ergs —compatible with acceleration in the converging-flow shock of a core-collapse supernova exploding into the wind of a massive binary companion. \r\n\r\nThe estimated rate of such events in the Galaxy as a whole is compatible with the inferred space-time separation of this event. Comparable transient events in galaxies throughout the Universe may be an important source of astrophysical neutrinos. Implications and tests of this hypothesis for the origin of the highest energy Galactic cosmic rays will be discussed.'

Collaborations

Keywords and Comments
'Galactic Cosmic Rays;\r\nAstrophysical Neutrinos;\r\nSupernovae;\r\nMassive Binaries;\r\nTransients;\r\nParticle Acceleration;\r\nComposition;', "This is a new approach to a long-standing puzzle (the origin of the highest energy Galactic cosmic rays), both in methodology and concept, with implications also for the origin of Astrophysics Neutrinos. Thus it should be of interest to a wide audience

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

The Imprint of Large Scale Structure on the Ultra-High-Energy Cosmic Ray Sky

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 06 CR Anisotropies | CRI
Presenter Forum Table

Presenter
Chen Ding
Author and Co-Author
Chen Ding, Noemie Globus | Glennys Farrar

Abstract
'We account for the magnitude, direction and energy dependence of the large-scale anisotropy of ultra-high-energy cosmic rays at energies above 8 EeV and possibly Auger hot spot with the ansatz that the source distribution follows the matter distribution of the Universe. We consider the impact of energy losses during propagation and the deflections by the Galactic magnetic field. We further constrain the cosmic ray composition and the properties of extragalactic and Galactic magnetic fields. We show that the observed dipole anisotropy is incompatible with a pure proton composition in this scenario. Our work sets the stage for searching for individual sources, by enabling the continuous background to be removed as the analysis is refined.'

Collaborations

Keywords and Comments
'Cosmic rays; Ultra-high-energy cosmic rays; Cosmic-ray anisotropy; Cosmic-ray composition; Auger hotspot; Galactic magnetic field; Extragalactic magnetic field', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Excited isomer photons and the VHE emission from Centaurus A

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 02 Constraining UHECR sources | CRI
Presenter Forum Table

Presenter
Leonel Raul Morejon
Author and Co-Author
Leonel Raul Morejon | Xavier de Sousa Ferreira Rodrigues | Annika Rudolph | Shan Gao | Walter Winter,

Abstract
'The very-high-energy (VHE) emission from Centaurus A (Cen A) observed by the H.E.S.S. telescopes cannot be explained by simple synchrotron-self-Compton (SSC) models. Motivated by the reported UHECR hotspot in the direction of Cen A, we investigate a scenario in which excited isomer photons of heavy nuclei can account for these VHE photons.\r\nOur fully self-consistent model includes a leptonic SSC scenario with a hadronic high-energy component from the pc-scale core region which explains the SED below TeV energies. As expected, the core of the jet is optically thick to above TeV gamma-rays that are produced in nuclear disintegrations. However, of a fraction of excited isomers produced in photodisintegration interactions of cosmic-ray nuclei is long-lived enough for the isomers to escape the core region. We consider the isomeric emission produced in the decay of these isomers in a larger volume surrounding the core and show that it can explain the H.E.S.S. flux while being in agreement with the spatially extended emission region recently reported.'

Collaborations

Keywords and Comments
'AGN; UHECR; VHE gammas; nuclei', ''

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Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Particle acceleration at the discontinuous flow boundary of collimated cylindrical jets

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 11 UHECR Acceleration | CRI
Presenter Forum Table

Presenter
Stephen O'Sullivan
Author and Co-Author
Stephen O'Sullivan | Andrew Taylor | Brian Reville,

Abstract
'We revisit the acceleration of particles at the interface between a collimated laminar jet and the ambient medium. The contrast between standard diffusive scattering treatments and anomalous transport in synthetic field constructions is explored. A particular emphasis is placed on the necessity for physically consistent particle transport considerations. The temporal, spatial and spectral features of the process are discussed in the context of potential UHECR production and further observational consequences.'

Collaborations

Keywords and Comments
'Particle acceleration; shear acceleration; AGN', ''

Branch CRI | Cosmic Ray Indirect

Subcategory Theoretical Results

Neutron production in extensive air showers

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 10 EAS reconstruction and analyses | CRI
Presenter Forum Table

Presenter
Ralph Engel
Author and Co-Author
Ralph Engel | Alfredo Ferrari | Martin Schimassek | David Schmidt | Markus Roth | Darko Veberic,

Abstract
'We use FLUKA to study the production of neutrons in extensive air showers. In contrast to typical shower simulations, we consider the full range of neutron energies extending down to thermal neutrons. The importance of different neutron production mechanisms and their impact on the predicted neutron distributions in energy, lateral distance, and arrival time are discussed and compared with those of muons. In addition, the dependence of the predictions on the primary particle is studied.'

Collaborations

Keywords and Comments
'air shower physics; hadronic interactions; FLUKA', ''

Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

Searching for dark matter sources in Fermi-LAT's unIDs with Machine Learning

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 526

Presenter
Viviana Gammaldi
Author and Co-Author
Viviana Gammaldi, Javier Coronado-Blázquez | Miguel A. Sánchez-Conde | Bryan Zaldivar

Abstract
'Around one third of the point-like sources in the Fermi-LAT catalogs remain as unidentified sources (UniDs) today. Indeed, these unIDs lack a clear, univocal association with a known astrophysical source identified at other wavelengths, or to a well-known source type emitting only in gamma rays (such as certain pulsars). If the dark matter (DM) is composed of weakly interacting massive particles (WIMPs), there is the exciting possibility that some of these unIDs may actually be DM sources, emitting gamma rays by WIMPs annihilation. We propose a new search methodology that uses Machine Learning classification algorithms calibrated to a mixed sample of both experimental (known astrophysical objects) and theoretical (expected DM) data. With our methodology, we can correctly classify a promisingly high percent of astrophysical sources, opening a window to robustly search for DM source association among Fermi-LAT unIDs.'

Collaborations

Keywords and Comments
'Machine Learning; dark matter; Fermi-LAT; unidentified sources; classification algorithms;', ''

Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

In Search of Cosmic-Ray Antinuclei from Dark Matter with the GAPS Experiment

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Mengjiao Xiao
Author and Co-Author
Mengjiao Xiao,

Abstract
'The General Antiparticle Spectrometer (GAPS) is the first experiment optimized to identify low-energy (<0.25 GeV/n) cosmic antinuclei, in particular antideuterons from dark matter annihilation or decay. The GAPS program will deliver unprecedented sensitivity to cosmic antideuterons, an essentially background-free signature of various dark matter models, as well as a high-statistics antiproton spectrum in an unexplored energy range and leading sensitivity to cosmic antihelium. GAPS is currently under construction. The first Antarctic balloon flight of GAPS is scheduled for late 2022, and two additional flights are planned for the coming years. Based on measurements of our custom-developed instrument technology, including large-area silicon detectors and a large-acceptance time-of-flight system, as well as detailed instrument simulation and reconstruction studies, we present here the anticipated impact of the GAPS program on cosmic-ray searches for dark matter. This contribution will discuss the current status of cosmic antinuclei studies while focusing on the science potential of GAPS.'

Collaborations
GAPS,

Keywords and Comments
'Dark Matter Indirect Detection; GAPS; Cosmic Antideuterons', ''

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Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

Optical Microlensing by Primordial Black Holes with IACTs

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 40 Dark Matter Indirect Detection and Cosmological Substructures | DM
Presenter Forum Table

Presenter
Konstantin Johannes Pfrang
Author and Co-Author
Konstantin Johannes Pfrang | Tarek Hassan | Elisa Pueschel,

Abstract
'Primordial black holes (PBHs), hypothesized to be the result of density fluctuations during the early universe, are candidates for dark matter. When microlensing background stars, they cause a transient apparent enhancement of the flux. Measuring these signals with optical telescopes is a powerful method to constrain the PBH abundance in the range of $10^{-11}\\,M_{\\odot}$ to $10^{1}\\,M_{\\odot}$. Especially for galactic stars, the finiteness of the sources needs to be taken into account. In previous studies of galactic fields, this reduces the average event duration proportional to the black hole mass $\\langle t_e\\rangle \\propto m_{PBH}$ for masses $< 10^{-9}\\,M_{\\odot}$ leading to an expected duration of $\\mathcal{O}(\\mathrm{s})$ for $ m_{PBH}\\approx 10^{-11}\\,M_{\\odot}$. A fast sampling speed of the instrument could enable the detection of low mass PBHs. Current limits are set with sampling speeds of 2 minutes to 24 hours. Ground-based Imaging Atmospheric Cherenkov telescopes (IACTs) are optimized to detect the $\\sim$ns long optical Cherenkov signals induced by atmospheric air showers. As shown recently, their large mirror area allows the detection of fast ($\\ll 1\\,$s) optical transient signals such as asteroid occultations. We investigate whether optical observations by IACTs can contribute to extending microlensing limits to the unconstrained mass range $M_{PBH}<10^{-11}M_\\odot$. Therefore we discuss the limiting factors to perform these searches for each telescope type. We calculate the number of expected detectable microlensing events in the relevant mass range for the current and next-generation IACTs considering realistic source parameters.'

Collaborations

Keywords and Comments
'IACT; Primordial Black Holes; Dark Matter;', ''

Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

High-multiplicity neutron events registered by NEMESIS experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 527

Presenter
Marcin Kasztelan
Author and Co-Author
Marcin Kasztelan | Timo Enqvist | Jacek Szabelski | Wladyslaw Henryk Trzaska | Karol Jędrzejczak | Pasi Kuusiniemi | Julia Puputti | Marika Przybylak | Jari Joutsenvaara | Jerzy Orzechowski,

Abstract
'Neutron-induced interactions contribute to the signal-mimicking background in deep-underground searches for exotic phenomena such as Dark Matter, neutrino-less double beta decay, proton decay, etc. Apart from radioactive decay, the primary source of neutrons underground are high-energy muons from cosmic showers. While the maximum number of fission neutrons is around six and energies around one MeV, muon-induced interactions may generate hundreds of neutrons, also with high energies. Furthermore, these processes are not yet reproduced numerically with sufficient reliability. The main goal of the NEMESIS experiment is to improve our knowledge and understanding of cosmic muon-induced neutron production in high-Z targets. NEMESIS (New Emma MEasurement with neutronS In cosmic Showers) is taking data at a depth of 210 m.w.e. in Callio Lab at the Pyhäsalmi mine in Finland. The neutron setup consists of 14 ^{3}He counters in polyethylene blocks. Data from the helium counters and muon scintillation arrays are collected by proprietary electronics digitizing signal waveforms with adequate time overlap to detect delayed coincidences. The presented neutron spectra will include a 300-day run with a 565 kg Pb target, a 150-day run without the target, and the outcome of the relevant Geant4 simulations. The extracted neutron multiplicity spectrum shows a linear behaviour on a doubly logarithmic scale. The largest registered event had 36 neutrons. Correcting for a 10% detection efficiency, determined with Geant4, indicates the emission of 360 neutrons in this mega-event.'

Collaborations
other (fill field below), NEMESIS

Keywords and Comments
'Neutron; Dark Matter; Muons; neutron detection', ''

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Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

Design and construction of a high temperature superconducting demonstrator coil of a toroidal magnet for an astroparticle physics experiment in space

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 528

Presenter
Lucio Rossi
Author and Co-Author
Lucio Rossi | Magnus Dam | Gijs de Rijk | Enrico Chesta | Roberto Iuppa | Rita Carpentiero,

Abstract
'Magnetic spectrometers detect the rigidity of charged particles by measuring the bending of their trajectories as they pass through a magnetic field. A novel magnetic spectrometer for an astroparticle physics experiment in space should have a maximum detectable rigidity of about 100 TV. This motivates the design of a toroidal spectrometer magnet with a bending strength of 3 T m. To facilitate operation temperatures of about 20 K, the toroid consists of twelve high temperature superconducting (HTS) coil packs, where each coil pack contains two coils. The toroid is about 2 m in outer diameter and 2 m in height. The toroidal magnet requires about 60 km of 12 mm wide REBCO tape with a current density of 1200 A/mm2, and has a peak magnetic field of about 12 T. Within the HTS Demonstrator Magnet for Space (HDMS) project, we have designed and are building a small-scale demonstrator coil pack for the toroidal magnet system. The demonstrator coil pack consists of two individually built racetrack-shaped soldered metal insulation coils enclosed with copper bands. Self-protection against quenches is obtainable with the use of soldered metal insulation coils. The surrounding copper bands function as current leads and layer jumps. The coils are supported by a lightweight mechanical structure made from aluminium alloy. A copper block electrically connects the two coil layers. We describe the design and manufacturing method of the demonstrator coil.'

Collaborations

Keywords and Comments
'Magnetic Spectrometers\r\nDetector Magnets\r\nLarge Scale Superconductivity\r\nSpace magnets', ''

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Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

Searching for cosmic antihelium nuclei with the GAPS experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 529

Presenter
Achim Stoessl
Author and Co-Author
Achim Stoessl,

Abstract
'At low-energies, cosmic antideuterons and antihelium provide an ultra-low background signature of dark matter annihilation, decay, and other beyond the Standard Model theories. The General Antiparticle Spectrometer (GAPS) is an Antarctic balloon experiment designed to search for low-energy (0.1-0.3 GeV/n) antinuclei and is planned to launch in the austral summer of 2022. While optimized for an antideuteron search, GAPS has unprecedented capabilities for the detection of low-energy antihelium nuclei as well, utilizing a novel detection technique based on the formation, decay, and annihilation of exotic atoms. The AMS-02 collaboration has recently reported several antihelium nuclei candidate events, which sets GAPS in the unique position to set constraints on the cosmic antihelium flux in an energy region which is essentially free of astrophysical background. In this talk, we will illustrate the capabilities of GAPS to search for cosmic antihelium-3 utilizing complete instrument simulations, event reconstruction, and the inclusion of atmospheric effects. We will show that GAPS is capable of setting unprecedented limits on the cosmic antihelium flux and thus opening a new window on exotic cosmic physics.'

Collaborations
GAPS,

Keywords and Comments
'dark matter;antinuclei;anti helium;cosmic ray;exotic atom;x-ray;low background;exotic physics;Antarctica;balloon;LDB;', ''

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Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

Characterization of the DIMS system based on astronomical meteor techniques for macroscopic dark matter search

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 530

Presenter
Dario Barghini
Author and Co-Author
Dario Barghini | Kenji Shinozaki | Simone Valenti | Shinsuke Abe | Mizuho Arahori | Mario Edoardo Bertaina | Marco Casolino | Alberto Cellino | Toshikazu Ebisuzaki | Yasunori Fujiwara | Daniele Gardiol | Maria Hajdukova | Ryushin Ide | Yugo Iwami | Fumiy,

Abstract
'Nuclearites are SQM conglomerates that are hypothesized as possible candidates of macroscopic dark matter. When impacting the Earth's atmosphere, they should undergo quasi-elastic collisions with the air molecules and emit black-body radiation, thus generating atmospheric luminous events similar to meteors. However, nuclearites could be distinguished from meteors mainly by their altitude, velocity, and motion direction of the bright flight. For instance, nuclearites of galactic origins are expected to have a typical velocity of 220 km/s, whereas meteors observed in the Earth's atmosphere are bounded to 72 km/s. In the case of meteoroids of interstellar origin, this value may be exceeded but, considering the stellar velocity distribution in the vicinity of the Sun, only by several kilometers per second. The DIMS (Dark matter and Interstellar Meteoroid Study) experiment was designed to search for such fast-moving particles by observing the sky with wide-field, high-sensitivity CMOS cameras. We derived the calibration of the DIMS sensors by astrometry and photometry techniques applied to observed stars in the FOV and assessed the achieved positional precision and sensitivity levels. Since nuclearites and meteor events feature quite distinct observational conditions, we designed simulations to optimize the DIMS setup and analysis pipeline. Nuclearites may also have a certain spectrum of mass and velocity. We consequently evaluated the variability of nuclearites' dynamics in the atmosphere in this respect and assessed its impact on the search algorithm performances for such events, in comparison to standard meteor trigger schemes. In this contribution, we will present the current status of this work.'

Collaborations
, DIMS

Keywords and Comments
'macroscopic dark matter; strange quark matter; nuclearites; meteorites; meteors; meteoroids; interstellar meteoroids.', ''

Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

Development of a Vacuum Ultraviolet Detector for Dark Photon Searches

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 531

Presenter
Abaz Kryemadhi
Author and Co-Author
Abaz Kryemadhi | Niklas Hellgren | Ryan Thurber,

Abstract
'Dark photon arises as the extra gauge boson in a U(1) Standard Model extension and it couples to ordinary photon via kinetic mixing. The parameter space spans many orders of magnitude in energy and has been explored widely by terrestrial and astrophysical measurements. In this work, we focused on development of a detector system to study a narrow energy band from 7-8 eV motivated by other studies. The photons in this energy band have large absorption due to molecular oxygen where absorption length is of order of cm at atmospheric pressure, and the detection system has to be setup in vacuum or use nitrogen purging to reduce their attenuation. We constructed our detector system using low dark rate photomultipliers sensitive at these energies with aluminum reflector akin to FUNK experiment to enhance collection, and setup our experiment in a vacuum chamber. Results on performance and preliminary sensitivity will be reported.'

Collaborations
other (fill field below), Small R & D collaboration

Keywords and Comments
'Dark Photon; ultra-light dark matter; vacuum ultraviolet', ''

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Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

Solar Power Supply and Environmental Control System for DIMS Experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 532

Presenter
Daiki Shinto
Author and Co-Author
Daiki Shinto | Kaoru Nadamoto | Yugo Iwami | Fumiyoshi Kajino | Yuichiro Tameda | for the DIMS collaboration,

Abstract
'The DIMS (Dark matter and Interstellar Meteoroid Study) experiment is designed to study macroscopic dark matters such as nuclearites/strange quark matters (SQM) and interstellar meteoroids. The DIMS experiment system is under construction at the Telescope Array (TA) cosmic-ray experiment site in Utah, USA. The system consists of 4 high-sensitivity CMOS camera stations which will be installed at 3 sites, CLF (Central Laser Facility) and BRM(Black Rock Mesa fluorescence telescope site) of the TA experiment and Hinckley town in the Utah desert each about 20 km apart. \r\nSince electric power is not supplied to the CLF site by the power company, a solar power system is required. Therefore, we have developed a new solar power supply system and conducted observation tests in Japan. \r\nAs we are going to operate the camera system every night for an extended period of time, we need to control environmental parameters such as temperature, humidity inside the camera stations as well as monitoring conditions inside and outside the container. We, therefore, developed an environmental control system for the camera station.\r\nIn this paper, we will present details of the development and test results of the solar power supply system to be installed in CLF and the environmental monitoring and control system of the camera stations.'

Collaborations
, DIMS

Keywords and Comments
'macroscopic dark matter; nuclearite; strange quark matter; SQM; meteor; meteoroid; interstellar meteoroid; solar power supply; environmental monitor;', ''

Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

Towards observations of nuclearites in Mini-EUSO

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table

Presenter
Lech Piotrowski
Author and Co-Author
Lech Piotrowski | for the JEM-EUSO Collaboration,

Abstract
'Mini-EUSO is a small orbital telescope with a field of view of 44x44 deg, observing the night-time Earth mostly in 320-420 nm band. Its time resolution spanning from microseconds (triggered) to milliseconds (untriggered) and more than 300x300 km of the ground covered, allows it to register thousands of meteors. Such detections make the telescope a suitable tool in the search for hypothetical heavy compact objects, which would leave trails of light in the atmosphere due to their high density and speed. The most prominent example are the nuclearites - hypothetical lumps of strange quark matter that could be stabler and denser than the nuclear matter.\r\n\r\nThe presentation will focus on the discovery potential of Mini-EUSO in this area, as well as experimental challenges exemplified by the observed meteors.'

Collaborations
other (fill field below), JEM-EUSO

Keywords and Comments
'nuclearites; strangelets; meteors; heavy compact objects;', ''

Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

Reconstruction of antinucleus-annihilation events in the GAPS experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 533

Presenter
Alessio Tiberio
Author and Co-Author
Alessio Tiberio, For the GAPS Collaboration

Abstract
'The General Antiparticle Spectrometer (GAPS) experiment is designed to detect low-energy (< 0.25 GeV/n) cosmic-ray antinuclei as indirect signatures of dark matter. Several beyond-the-standard-model scenarios predict a large antideuteron flux due to dark matter decay or annihilation compared to the astrophysical background. The GAPS experiment will perform such measurements using long-duration balloon flights over Antarctica, beginning in the 2022/23 austral summer. The experimental apparatus consists of ten planes of Si(Li) detectors surrounded by a time-of-flight system made of plastic scintillators. The detection of the primary antinucleus relies on the reconstruction of the annihilation products: the low-energy antinucleus is captured by an atom of the detector material, forming an exotic atom then de-excites by emitting characteristics X-rays. Finally, the antinucleus undergoes nuclear annihilation, producing a “star” of pions and protons emitted from the annihilation vertex. Several algorithms were developed to determine the annihilation vertex position and to reconstruct the topology of the primary and secondary particles. An overview of the event reconstruction techniques and their performances, based on detailed Monte Carlo simulation studies, will be presented in this contribution.'

Collaborations
GAPS,

Keywords and Comments
'GAPS; cosmic rays; low energy; reconstruction; annihilation; antinuclei; antideuteron; antiproton; Hough', ''

Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

Sub-GeV dark matter and neutrino searches with Skipper-CCDs: status and prospects.

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 42 Direct Dark Matter: Present and Future | DM
Presenter Forum Table

Presenter
Ana Martina Botti
Author and Co-Author
Ana Martina Botti | Mariano Cababié | Juan Estrada | Guillermo Fernandez Moroni | Dario Rodrigues | Miguel Sofo Haro | Javier Tiffenberg,

Abstract
'High-resistivity silicon has made possible the fabrication of thick fully-depleted charge-coupled devices (CCDs) that have found a wide range of scientific applications, from particle detection to astronomical imaging. Their low noise and high charge collection efficiency allow us to reach unprecedented sensitivity to physical processes with low-energy transfers. The newly-developed Skipper-CCD enhances this sensitivity by reducing the read-out noise reaching a sub-electron resolution. In this work, we introduce the fundamentals of the Skipper-CCD operation and the prospects for both sub-GeV dark matter searches and the detection of coherent elastic neutrino-nucleus scattering. A discussion of the challenges associated with the construction of the foreseen detectors with multi-kilogram target mass is also presented.'

Collaborations

Keywords and Comments
'', ''

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Branch DM | Dark Matter

Subcategory Experimental Methods & Instrumentation

A Search for Neutrinos From Decaying Dark Matter in Galaxy Clusters and Galaxies with IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 534

Presenter
Minjin Jeong
Author and Co-Author
Minjin Jeong,

Abstract
'When the lifetime of dark matter is much longer than the age of the Universe, the current abundance of dark matter can be explained with non-thermal, superheavy dark matter models. In these scenarios, dark matter decays can produce highly energetic neutrinos, along with other Standard Model particles. To date, the IceCube Neutrino Observatory is the world’s largest neutrino telescope, located at the geographic South Pole. In 2013, the IceCube collaboration reported the first observation of high-energy astrophysical neutrinos. Since then, IceCube has collected a large amount of astrophysical neutrino data with energies up to tens of PeV, allowing us to probe the superheavy dark matter models using neutrinos. We search the IceCube data for neutrinos from decaying dark matter in galaxy clusters and galaxies. The targeted dark matter masses range from 10 TeV to 10 PeV, and the sources are stacked to optimize the sensitivity of the analysis. In this contribution, we present the method and sensitivities of the analysis.'

Collaborations
IceCube,

Keywords and Comments
'dark matter; IceCube; galaxies; galaxy clusters;', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Cherenkov Telescope Array sensitivity to branon dark matter models

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 535

Presenter
Alejandra Aguirre-Santaella
Author and Co-Author
Alejandra Aguirre-Santaella | Viviana Gammaldi | Miguel Sánchez-Conde | Daniel Nieto,

Abstract
'TeV DM candidates are gradually earning more and more attention within the community. Among others, extra-dimensional brane-world models may produce thermal DM candidates with masses up to 100 TeV, which could be detected with the next generation of very-high-energy gamma-ray observatories such as the Cherenkov Telescope Array (CTA).\r\nIn this work, we study the sensitivity of CTA to branon DM via the observation of dwarf spheroidal galaxies.\r\nWe computed annihilation cross section values needed to reach a 5σ detection as a function of the branon mass. Additionally, in the absence of a predicted DM signal, we obtained 2σ upper limits on the annihilation cross section.\r\nThese limits lie 1.5-2 orders of magnitude above the thermal relic cross section value.\r\nYet, CTA will allow to exclude a significant portion of the brane tension-mass parameter space in the 0.1-60 TeV branon mass range, and up to tensions of ~10 TeV. More importantly, CTA will significantly enlarge the region already excluded by AMS and CMS, and will provide valuable complementary information to future SKA radio observations.\r\n[Based on JCAP 10 (2020) 041, arXiv:2006.16706]'

Collaborations
CTA,

Keywords and Comments
'dark matter indirect searches; branons', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Searching for dark matter subhalos with the Fermi-LAT

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 40 Dark Matter Indirect Detection and Cosmological Substructures | DM
Presenter Forum Table

Presenter
Javier Coronado-Blázquez
Author and Co-Author
Javier Coronado-Blázquez | Miguel Sánchez-Conde,

Abstract
'$\\Lambda$CDM predicts the existence of dark matter (DM) subhalos, most of them not massive enough to retain gas (i.e., baryons) and become visible. If DM is composed of Weakly Interacting Massive Particles (WIMPs), we expect them to annihilate in subhalos, producing gamma rays which can be detected with the Large Area Telescope (LAT) onboard the Fermi satellite, and appearing as unidentified sources (unIDs) in the gamma-ray sky. We characterize the LAT sensitivity to DM and compare the sample of unIDs in LAT catalogs - previously filtered according to the expected DM annihilation signal - to predictions from the Via Lactea II (VL-II) N-body cosmological simulation, repopulated with low-mass subhalos below its mass resolution limit. This exercise allows us to place conservative and robust constraints on the annihilation cross section vs. WIMP mass parameter space. A spectral and spatial dedicated analysis is then performed for the best DM subhalo candidates, using a decade of Fermi-LAT data. Finally, we also quantify whether spatial extension is, as often claimed, a “smoking gun” for DM subhalo detection, by simulating the LAT response to extended subhalos. This talk will be based on [1906.11896, 1910.14429] and ongoing work within the Fermi-LAT collaboration.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'dark matter; indirect detection; gamma rays; N-body simulations', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Dark Matter search in dwarf irregular galaxies with the Fermi Large Area Telescope

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 40 Dark Matter Indirect Detection and Cosmological Substructures | DM
Presenter Forum Table

Presenter
Viviana Gammaldi
Author and Co-Author
Viviana Gammaldi, Judit Pérez-Romero | Javier Coronado-Blázquez | Mattia Di Mauro | Ekaterina V. Karukes | Miguel A. Sánchez-Conde | Paolo Salucci

Abstract
'Dwarf irregular (dIrr) galaxies have been shown to be dark matter (DM) dominated systems and proposed as interesting targets for the indirect search for DM with gamma rays. In this work, we analyze 11 years of Fermi-LAT data corresponding to the sky regions of 7dIrrs at a distance of less than ~1 Mpc. Due to the current uncertainty in the DM density distribution in these objects, we consider two different DM profiles, based on both the fit to the rotation curve (in this case a Burkert cored profile) and results from N-body cosmological simulations (i.e., NFW cuspy profile). We also include halo substructure in our analysis, which is expected to boost the DM signal importantly in field halos such as those of dIrrs. For each DM model and dIrr, we create a spatial template of the expected DM-induced gamma-ray signal to be used in the analysis of Fermi-LAT data. No significant emission is detected from any of the targets in our sample. Thus, we compute upper limits on the DM annihilation cross-section versus mass parameter space. Among the 7dIrrs, we find IC10 and NGC6822 to yield the most stringent individual constraints, independently of the adopted DM profile. We also produce combined DM limits for all objects in the sample. These results are independent from and complementary to those obtained by means of other targets. They also show the great potential of this type of objects in the context of DM searches, this work representing the first step in that direction.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'dark matter; dwarf irregular galaxies; gamma rays; Fermi-LAT data analysis; substructures boost; extended analysis; CLUMPY', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Search for axion-like-particle induced gamma-ray bursts from core-collapse supernovae with the Fermi LAT

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
Manuel Meyer
Author and Co-Author
Manuel Meyer | Tanja Petrushevksa, For the Fermi-LAT Collaboratioin

Abstract
'During a core-collapse supernova (SN), axion-like particles (ALPs) could be produced through the Primakoff process and subsequently convert into gamma rays in the magnetic field of the Milky Way. Using a sample of well studied extragalactic SNe at optical wavelengths, we estimate the time of the core collapse and search for a coincident gamma-ray burst with the Fermi Large Area Telescope (LAT). Under the assumption that at least one SN was contained within the LAT field of view, we exclude photon-ALP couplings within a factor of ~5 of previous limits from SN1987A. With the increasing number of SNe observed with optical surveys, our results demonstrate the potential to probe ALP dark matter with combined optical and gamma-ray observations.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'Axion-like particles; core-collapse supernova; gamma rays', ''

Branch DM | Dark Matter

Subcategory Experimental Results

Search for dark matter annihilation towards the inner Milky Way halo with the H.E.S.S. Inner Galaxy Survey

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 536

Presenter
Alessandro Montanari
Author and Co-Author
Alessandro Montanari | Denys Malyshev | Emmanuel Moulin, for the H.E.S.S. collaboration,

Abstract
'The presence of dark matter (DM) is suggested by a wealth of astrophysical and cosmological measurements. However, its underlying nature is yet unknown. Among the most promising candidates are weakly interacting massive particles (WIMPs): particles with mass and coupling strength at the electroweak scale and thermally-produced in the early universe have a present relic density consistent with that observed today. WIMP self-annihilation would produce Standard Model particles including gamma-rays, which have been long-time recognized as a prime messenger to indirectly detect dark matter signals. The centre of the Milky Way is predicted as the brightest source of DM annihilations. The H.E.S.S. collaboration is currently performing a survey of the inner region of the Milky Way, the Inner Galaxy Survey (IGS), intended to achieve the best sensitivity to faint and diffuse emissions in a region of several degrees around the Galactic Centre. We analyzed 2014-2020 observations taken with the five-telescope array to search for a DM annihilation signal. With the current dataset of about 600 hours, we found no significant excess and therefore derived the strongest constraints on the velocity-weighted annihilation cross-section so far. TeV thermal WIMPs can be probed in different annihilation channels.'

Collaborations
H.E.S.S.,

Keywords and Comments
'Dark matter; IACTs; Galactic halo', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Upper limits on the WIMP annihilation cross section from a joint analysis of dwarf spheroidal satellite galaxy observations with the MAGIC telescopes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 537

Presenter
Camilla Maggio
Author and Co-Author
Camilla Maggio | Daniel Kerszberg | Daniele Ninci, Vincenzo Vitale | For the MAGIC Collaboration

Abstract
'Dwarf spheroidal satellite galaxies (dSphs) are among the best candidates to perform indirect search for DM, having the highest known mass-to-light ratio and being free of gamma-ray emitting sources. The Major Atmospheric Gamma Imaging Cherenkov (MAGIC) telescopes, located on the Canary Island of La Palma, have observed a fair amount of optimal dSphs in the recent years. This is the outcome of diversifying the observation strategy in order to avoid possible biases in target selection and to improve previous results.\r\nIn this contribution we will report on new MAGIC results obtained from 52 hours of observation of the Draco dSph in 2018 and 50 hours of the Coma Berenices dSph in 2019. We will also present the results of a joint analysis of Draco and Coma Berenices dSphs with other dSphs observed by MAGIC so far. The selected dataset accounts for 355 hours of good quality data, resulting in one of the largest dSphs samples ever collected by an array of Cherenkov telescopes. This allows us to derive the most constraining limits, among Cherenkov telescopes, on the WIMP annihilation cross section for different annihilation channels in the WIMP mass range 70 GeV to 100 TeV.'

Collaborations
MAGIC,

Keywords and Comments
'dark matter; WIMP; dSphs; indirect DM searches; VHE gamma rays; IACTs', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Indirect Dark Matter searches in the gamma-ray channel toward the Sun with the Fermi LAT

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 538

Presenter
Francesco Loparco
Author and Co-Author
Francesco Loparco, Mario Nicola Mazziotta | Davide Serini

Abstract
'The Sun is a possible target for indirect dark matter (DM) searches, as it can gravitationally capture DM particles from the Galactic halo, which can be trapped in external orbits or sink into the solar core. We have performed a dedicated analysis of solar gamma rays collected by the Fermi Large Area Telescope (LAT) to search for possible flux excesses, which could be ascribed to DM. Gamma rays in final states of DM annihilations occurring outside the Sun can in fact reach the Earth and be detected by the LAT. Alternatively, DM particles can annihilate inside the Sun core into pairs of long-lived mediators, which are able to escape from the Sun and can decay outside the Sun, yielding gamma rays in the final state. All these processes are expected to yield an excess in the gamma-ray flux from the Sun, which appears as a specific spectral feature. Although no evidence of a DM signal has been found, we have obtained upper limits on the DM gamma-ray flux, which have been converted into constraints on the DM-nucleon scattering cross sections.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'', ''

Branch DM | Dark Matter

Subcategory Experimental Results

New results from NEMESIS experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 539

Presenter
Wladyslaw Henryk Trzaska
Author and Co-Author
Wladyslaw Henryk Trzaska,

Abstract
"A new experiment collects data at a depth of 210 m.w.e. in the Callio Lab [1] at the Pyhasalmi mine [2] in Finland. The setup, called NEMESIS (New Emma MEasurement with neutronS In cosmic Showers), incorporates infrastructure from the EMMA experiment [3] with neutron and large-area plastic scintillator detectors of the MAZE system [4]. The experiment's primary aim is to combine muon tracking with position-sensitive neutron detection to measure precision yields, multiplicities, and lateral distributions of high-multiplicity neutron events induced by cosmic muons in various materials. The data are relevant for background evaluation of the deep-underground searches for Dark Matter, neutrino-less double beta decay, etc. The setup consists of 4 layers of position-sensitive muon counters, two large-area, amplitude-sensitive scintillators, and 14 He-3 proportional counters in polyethylene casting for neutron detection. The detectors surround a removable target. The results of a 300-day run with a 565 kg Pb target and preliminary simulations will be presented. A significant upgrade of the setup is being prepared to improve the performance and increase the detection efficiency by one order of magnitude. The upgraded experiment would be well suited for searching for Dark Matter WIMP inelastic scattering events associated with the emission of an energetic charged lepton [5].\r\n\r\n1. Callio, https://callio.info \r\n2. W.H. Trzaska et al., (2018), https://arxiv.org/abs/1810.00909 \r\n3. P. Kuusiniemi et al., AP 102(2018)67 https://www.sciencedirect.com/science/article/abs/pii/S092765051730333X \r\nM. Kasztelan et al., (2006) Proc. the 20th ECRS, Lisbon\r\nhttps://www.lip.pt/events/2006/ecrs/proc/ecrs06-s0-92.pdf\r\n5. T.E. Ward et al., APS April Meeting 2019, https://meetings.aps.org/Meeting/APR19/Session/G17.1"

Collaborations
other (fill field below), NEMESIS

Keywords and Comments
'CR-induced muons; muon-induced neutron yields; high-multiplicity neutron events; NEMESIS experiment', ''

Branch DM | Dark Matter

Subcategory Experimental Results

VERITAS dark matter search in dwarf Spheroidal galaxies: an extended source analysis

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 540

Presenter
Chiara Giuri
Author and Co-Author
Chiara Giuri,

Abstract
'Dark matter (DM) is largely believed to be the dominant component of the matter content of the Universe. Astronomical measurements can be utilized to search for Standard Model annihilation or decay products of DM, complementing direct and collider-based searches. Among DM particle candidates, Weakly Interacting Massive Particles (WIMPs) are an attractive one. Their decay or annihilation could produce secondary particles including very-high-energy (VHE: E>100 GeV) gamma rays, which could be detected by imaging atmospheric Cherenkov Telescopes (IACTs). One of the most favourable target classes for DM searches are Dwarf Spheroidal galaxies (dSphs), dark matter-dominated objects with a negligible predicted gamma-ray emission due to apparent absence of gas and on-going star formation. The IACTs, whose Point Spread Function (PSF, defined as 68% containment) is typically 0.1 deg at 1 TeV, have the necessary angular resolution to detect extended emission from some dSphs. Thus, an extended source analysis may give an improvement to DM sensitivity, compared to a point source analysis. In this work, we use observations made since 2007 by VERITAS, an array of four imaging atmospheric Cherenkov telescopes sensitive to VHE gamma rays in the 100 GeV - 30 TeV energy range. We perform an unbinned combined likelihood analysis incorporating the dSph angular profiles of several dSphs. A new analysis technique utilising boosted decision trees has also been applied, to improve the overall dark matter sensitivity of the experiment. We interpret the results in terms of the DM self-annihilation cross-section as a function of the DM particle mass.'

Collaborations
VERITAS,

Keywords and Comments
'Dark Matter search in Dwarf Spheroidal galaxies with VERITAS (IACT)', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Antihelium-3 fluxes near Earth using data-driven estimates for annihilation cross section

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 541

Presenter
Laura Šerkšnytė
Author and Co-Author
Laura Šerkšnytė | For the ALICE Collaboration,

Abstract
'The studies of antinuclei cosmic rays (CR) are currently of great interest as they represent one of the most promising indirect probes of annihilations or decays of dark matter (DM) candidates and few experiments are looking for traces of antideuterons and antihelium near Earth. However, the antinuclei CR also contain a background contribution from antinuclei produced in CR collisions with interstellar gas. To properly simulate the signal and background contributions one needs antinuclei production, annihilation cross sections, and a state-of-the-art propagation model.\r\n\r\nWe studied the antihelium-3 CR using the GALPROP propagation model and we calculated the fluxes stemming from DM and from secondary processes. The results are based on the available production cross sections of antihelium-3, while the annihilation cross sections of antihelium-3 are estimated for the first time using a data-driven approach based on the novel measurements of antihelium-3 disappearance probability in the material of the ALICE detector at CERN LHC. To this purpose, the antihelium-3 annihilation on proton and helium-4 targets are obtained using the antihelium-3 cross sections implemented in Geant4, which have been scaled accordingly to the results obtained by ALICE.\r\n\r\nWe show that in the case of antihelium-3 stemming from DM one loses around half of the antinuclei due to annihilations in collisions with interstellar gas, while in the case of the background antihelium-3 flux, a strong energy-dependence, ranging from 75% at low energies and around 10% at high energies, is observed.'

Collaborations
, ALICE

Keywords and Comments
'DM; antinuclei; antihelium; annihilation; cosmic rays; LHC; particle acceleration; ALICE', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Characterization of natural radioactivity in the BSUIN and EUL underground laboratories based on the developed standard scheme

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 542

Presenter
Katarzyna Szkliniarz
Author and Co-Author
Katarzyna Szkliniarz, Agata Walencik-Łata | Kinga Polaczek-Grelik | Jan Kisiel | Karol Jędrzejczak | Marcin Kasztelan | Jacek Szabelski

Abstract
'Underground laboratories (ULs) are now becoming more and more popular, not only for scientific reasons. However, they are still very important as potential dark matter search sites. Therefore, the idea was born to create a network of underground laboratories operating in the Baltic Sea region. The result was the BSUIN (Baltic Sea Underground Innovation Network) project and its current continuation in the EUL (Empowering Underground Laboratories Network Usage) project. One of the most critical parameters in characterizing the ULs is the natural background radiation (NBR), mainly from surrounding bedrock and used construction materials. To this end, a standard scheme was created containing the NBR measurement results to characterize selected ULs participating in the BSUIN project. The developed scheme allows for an easy and transparent comparison of underground places (halls/rooms) in terms of the conditions prevailing there, not only in one UL but also between equal ULs. In this way, a potential client can choose the most convenient place to conduct his research or other types of tasks. This scheme is still supplemented with new measurement results and applied to other underground locations as one of the EUL project activities.\r\n\r\n\r\nThe scheme includes the results of in-situ measurements (gamma-ray, the radon concentration in air, thermal neutron flux measurements) and the results of laboratory measurements of rock and water samples taken from the studied locations. During the session, this scheme will be presented on the example of one of the ULs participating in the BSUIN and EUL projects.'

Collaborations

Keywords and Comments
'underground laboratory; natural background radiation', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Limits on primordial black hole evaporation from H.E.S.S. observations.

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 40 Dark Matter Indirect Detection and Cosmological Substructures | DM
Presenter Forum Table

Presenter
Thomas Tavernier
Author and Co-Author
Jean-Francois Glicenstein | Francois Brun | Thomas Tavernier | Vincent Marandon | for the H.E.S.S. collaboration,

Abstract
"Primordial Black Holes are expected to be formed in the early Universe by the gravitational collapse of overdense regions, among other mechanism. They are also expected to loose their mass over time by the Hawking radiation process. As the rates of this radiation increase with temperature, the PBH evaporation should result in a violent explosion.\r\nThe current upper limits on explosion rates are on the order of $10^4-10^5 pc^{-3}yr^{-1}$.\r\nIn this contribution we'll present the results of a search for TeV $\\gamma$-ray burst within timescale of few seconds, using nearly 5000 hours of H.E.S.S. data. The search algorithm and statistical estimation strategy will be presented as well as cosmological implications of this measurement."

Collaborations
H.E.S.S.,

Keywords and Comments
", "

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Branch DM | Dark Matter

Subcategory Experimental Results

Model independent search for macroscopic dark matter with EUSO-SPB2

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 543

Presenter
Thomas Paul
Author and Co-Author
Thomas Paul | Angela Olinto | Luis Anchordoqui,

Abstract
'Macroscopic dark matter (or macro) provides a broad class of alternative \r\ncandidates to particle dark matter. These candidates would transfer \r\nenergy primarily through elastic scattering, and this linear energy \r\ndeposition would produce observable signals if a macro were to traverse \r\nthe atmosphere. We study the fluorescence emission produced by a macro \r\npassing through the atmosphere. We estimate the sensitivity of EUSO-SPB2 \r\nto constrain the two-dimensional parameter space ($\\sigma$ vs. M), \r\nwhere M is the macro mass and $\\sigma$ its cross sectional area.'

Collaborations

Keywords and Comments
'macro; microscopic dark matter; EUSO-SPB2', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Search for Gamma-ray Line emission from Dark Matter annihilation in the Galactic Centre with the MAGIC telescopes

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
Tomohiro Inada
Author and Co-Author
Tomohiro Inada, Daniel Kerszberg | Moritz Hütten | Masahiro Teshima | Javier Rico | Daniele Ninci | For the MAGIC Collaboration

Abstract
"We present the first search for dark matter (DM) spectral lines in the Galactic centre (GC) region with the MAGIC telescopes. The MAGIC telescopes, located on the Canary island of La Palma (Spain), are sensitive to gamma rays in the energy range from 50 GeV to 50 TeV. MAGIC has performed indirect DM searches with various astrophysical targets, such as dwarf spheroidal galaxies and clusters of galaxies. Observations at high-zenith angles significantly increase the telescopes' collection area and sensitivity for gamma rays in the TeV regime. We present the results obtained with more than 200 hours of high-zenith angle observations of the GC region with MAGIC, which allow us to probe promising heavy SUSY models, and to obtain competitive limits to the DM annihilation cross-section at high DM particle mass, compared to existing constraints (e.g. $\\langle\\sigma v\\rangle$ $<\\sim$2.0 x 10^{-27} $\\mathrm{cm^3s^{-1}}$ for a DM mass of 3 TeV). We will discuss how we exploit the data from a complex sky region to search for a line-like DM signature."

Collaborations
MAGIC,

Keywords and Comments
'Dark Matter; Gamma-ray; IACT; TeV; Indirect dark matter search; the Galactic Centre', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Search for secluded dark matter with 6 years of IceCube data --- Christoph Toennis

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 544

Presenter
Christoph Toennis
Author and Co-Author
Christoph Toennis,

Abstract
'The IceCube neutrino observatory--installed in the Antarctic ice--is the largest neutrino telescope to date. It consists of 5,160 photomultiplier-tubes spread among 86 vertical strings making a total detector volume of more than a cubic kilometer. IceCube detects neutrinos via Cherenkov light emitted by charged relativistic particles produced when a neutrino interacts in or near the detector. The detector is particularly sensitive to high-energy neutrinos of due to its size and photosensor spacing. In this analysis we search for dark matter that annihilates into a metastable mediator that subsequently decays into Standard Model particles. These models yield an enhanced high-energy neutrino flux from dark matter annihilation inside the Sun compared to models without a mediator. Neutrino signals that are produced directly inside the Sun are strongly attenuated at higher energies due to interactions with the solar plasma. In the models considered here, the mediator can escape the Sun before producing any neutrinos, thereby avoiding attenuation. We present the results of an analysis of six years of IceCube data looking for dark matter in the Sun. We consider mediator lifetimes between 1 ms to 10 s and dark matter masses between 200 GeV and 75 TeV.'

Collaborations
IceCube,

Keywords and Comments
'IceCube; Dark Matter; Sun; Secluded Dark Matter', ''

Branch DM | Dark Matter

Subcategory Experimental Results

Constraining non-standard Dark Matter-Nucleon Interactions with IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 545

Presenter
Lilly Peters
Author and Co-Author
Lilly Peters | Koun Choi | for the IceCube Collaboration,

Abstract
'After scattering off nuclei in the Sun, dark matter particles can be gravitationally captured by the Sun, accumulate in the Sun’s core and annihilate into Standard Model particles. Neutrinos originating from these annihilations can be detected by the IceCube Neutrino Observatory, located at the South Pole. Due to the non-observation of these neutrinos, constraints on the standard spin-dependent and spin-independent dark matter-nucleon scattering cross sections have been placed. Based on these constraints, we present upper limits on the coupling constants of the non-relativistic effective theory of dark matter-nucleon interactions, including velocity and momentum dependent interactions.'

Collaborations
IceCube,

Keywords and Comments
'', ''

Branch DM | Dark Matter

Subcategory Experimental Results

Indirect Dark Matter searches from the Sun direction with ANTARES

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 546

Presenter
Chiara Poirè
Author and Co-Author
Chiara Poirè, For the ANTARES Collaboration

Abstract
'Dark matter particles, produced in astrophysical sources and gravitationally captured in massive celestial objects, can be indirectly detected through their annihilation into Standard Model particles.\u2028\r\nThe centre of those massive objects is, therefore, a place where to look for a possible neutrino excess from dark matter annihilations, using neutrino telescopes.\r\nThe deep-sea neutrino telescope ANTARES, located in the Mediterranean Sea, has shown to be very competitive on the quest for dark matter WIMPs produced in the Galactic Center.\r\nThe closest potential DM source is the Sun, where it is possible to have a very clean signal since the background from astrophysical sources is not expected.\r\nIn this work we show the results on the search for dark matter WIMPs from the Sun, using 13 years of data collected by ANTARES.\r\nThe results yield solar limits on the WIMP dark matter mass in the range of 50 GeV/c^2 to 20 TeV/c^2.'

Collaborations
Antares,

Keywords and Comments
'', 'on behalf of the ANTARES Collaboration'

Branch DM | Dark Matter

Subcategory Experimental Results

Indirect searches for dark matter in the Galactic Centre with IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 547

Presenter
Nadège Iovine
Author and Co-Author
Nadège Iovine | Juan Antonio Aguilar Sánchez | Sebastian Baur | Chaïmae El Aisati | Michael Gustafsson | Thomas Hambye,

Abstract
'Even though there are strong astrophysical and cosmological indications to support the existence of dark matter, its exact nature remains unknown. We expect dark matter to produce standard model particles when annihilating or decaying, assuming that it is composed of Weakly Interacting Massive Particles (WIMPs). These standard model particles could in turn yield neutrinos that can be detected by the IceCube neutrino telescope. The Milky Way is expected to be permeated by a dark matter halo with an increased density towards its centre. This halo is expected to yield the strongest dark matter annihilation signal at Earth coming from any celestial object, making it an ideal target for indirect searches. In this contribution, we present the sensitivities of two indirect searches for dark matter in the Galactic Centre using IceCube data. Together, these searches allow us to cover dark matter masses ranging from 5 GeV to 40 TeV. The sensitivities of both searches show considerable improvements over previous IceCube results in their respective energy range.'

Collaborations
IceCube,

Keywords and Comments
'Dark matter; Neutrino telescope; IceCube; Neutrino; Galactic Centre', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

First muon-induced neutron yields from NEMESIS experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 548

Presenter
Karol Jędrzejczak
Author and Co-Author
Karol Jędrzejczak | Marcin Kasztelan | Jacek Szabelski | Wladyslaw Henryk Trzaska | Timo Enqvist | Marika Przybylak | Jari Joutsenvaara | Pasi Kuusiniemi | Julia Puputti | Jerzy Orzechowski,

Abstract
'The NEMESIS experiment (New Emma MEasurement with neutronS In cosmic Showers) \r\n is located in Pyhasalmi Mine (Finland), and operates at a depth of 75\u202fm (210\u202fm.w.e.), \r\n corresponding to 50\u202fGeV cutoff energy for vertical muons.\r\n \r\n The experiment consists of a pixelized (11cm x 11cm) scintillation\r\n telescope, 14 helium counters, 2 1m^2 scintillating detectors,\r\n and Pb target. The scintillation telescope detect the cosmic ray muons\r\n passing through the Pb-target, while the helium counters detect the\r\n neutrons produced in Pb. The aim of the experiment is to precisely\r\n investigate production of neutrons and check whether it is well described\r\n by simulations. This is important for experiments which look for rare\r\n phenomenas, as the detector shelters are often made of lead.\r\n\r\n Detector was measuring for one year. One of the parameter is\r\n neutron yield per muon. Preliminary analysis of our data\r\n show the yield equal to 4.5 (+/- 0.5) e-4 per square centimeter\r\n per gram or the mean for muon energy = 50 GeV. This result is similar\r\n to yields reported in the literature.\r\n\r\n This work was financially supported by the EU (INTERREG for Baltic Sea\r\n program) as part of the BSUIN project, and by the Polish Ministry\r\n of Science and Higher Education (grant no. 3988/INTERREG BSR/2018/2).'

Collaborations
other (fill field below), NEMESIS

Keywords and Comments
'muons;neutron production; underground', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Search for dark matter from the center of the Earth with 8 years of IceCube data

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 549

Presenter
Giovanni Renzi
Author and Co-Author
Giovanni Renzi,

Abstract
'The nature of Dark Matter remains one of the most important unresolved questions of fundamental physics. Many models, including the Weakly Interacting Massive Particles (WIMPs), assume Dark Matter to be a particle and predict a weak coupling with Standard Model matter. If Dark Matter particles can scatter off nuclei in the vicinity of a massive object, such as a star or a planet, they may lose kinetic energy and become gravitationally trapped in the center of such objects, including Earth. As Dark Matter accumulates in the center of the Earth, self-annihilation of WIMPs into Standard Model particles can result in an excess of neutrinos which are detectable at the IceCube Neutrino Observatory, situated at the geographic South Pole. A search for excess neutrinos from these annihilations has been performed on 8 years of IceCube data, and results have been interpreted in the context of a number of WIMP annihilation channels ($\chi\chi \rightarrow \tau^+\tau^-/W^+W^-/b\bar{b}$) and masses ranging from 10 GeV to 10 TeV. We present the latest results from this analysis and compare the outcome with previous analyses by IceCube and other experiments, showing competitive results, which are even world-leading in some parts of the phase space.'

Collaborations
IceCube,

Keywords and Comments
'dark matter; WIMPs; Earth; neutrinos; IceCube; scattering; self-annihilation;', ''

Branch DM | Dark Matter

Subcategory Experimental Results

The DEAP-3600 experiment

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 42 Direct Dark Matter: Present and Future | DM
Presenter Forum Table

Presenter
Mark Stringer
Author and Co-Author
Mark Stringer | For the DEAP-3600 collaboration,

Abstract
'The DEAP-3600 experiment searches for dark matter via the interactions of WIMPs with a liquid argon target. The experiment is located at SNOLAB in Sudbury, Ontario 2 km underground to shield the detector from cosmic rays. The detector consists of an acrylic sphere with an inner diameter of ~170 cm containing ~3300 kg of liquid argon. Liquid argon is chosen as a target due to its ability to reject electromagnetic backgrounds by examining its scintillation pulse shape. The argon volume is instrumented with 255 PMTs which are connected to the vessel via acrylic light guides. As liquid argon scintillates at a wavelength of 128 nm, its scintillation light needs to be shifted to a wavelength into a region where the PMTs are more sensitive; this is done by coating the inside of the acrylic vessel with TPB wavelength shifter, which re-emits the argon scintillation light at a wavelength of 420 nm.\r\n\r\nThis talk will describe the current status of the experiment and some recent analyses performed by the collaboration. The status of planned upgrades to the detector and the plans for the future of the experiment will also be detailed.'

Collaborations
other (fill field below), DEAP-3600

Keywords and Comments
'low background;\r\nliquid argon;\r\ndirect dark matter search;', ''

Branch DM | Dark Matter

Subcategory Experimental Results

Combined dark matter searches towards dwarf spheroidal galaxies with Fermi-LAT, HAWC, H.E.S.S., MAGIC, and VERITAS

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 550

Presenter
Celine Armand
Author and Co-Author
Celine Armand | Vincent Poireau | Emmanuel Moulin | MATTIA DI MAURO | Louise Oakes | Chiara Giuri | Daniel Kerszberg | Eric Charles | Tjark Miener | Pat Harding | Elisa Pueschel | Dan Salaza | Kristen Tollefson | Javier Rico | Lucia Rinchiuso | Benjamin Z,

Abstract
'Cosmological and astrophysical observations suggest that 85% of the total matter of the Universe is made of Dark Matter (DM). \r\nHowever, its nature remains one of the most challenging and fundamental open questions of particle physics. \r\nAssuming particle DM, this exotic form of matter cannot consist of Standard Model (SM) particles. Many models have been developed to attempt unraveling the nature of DM such as Weakly Interacting Massive Particles (WIMPs), the most favored particle candidates.\r\nWIMP annihilations and decay could produce SM particles which in turn hadronize and decay to give SM secondaries such as high energy gamma rays.\r\nIn the framework of indirect DM search, observations of promising targets are used to search for signatures of DM annihilation.\r\nAmong these, the dwarf spheroidal galaxies (dSphs) are commonly favored owing to their expected high DM content and negligible astrophysical background. In this work, we present the very first combination of 20 dSph observations, performed by the Fermi-LAT, HAWC, H.E.S.S., MAGIC, and VERITAS collaborations in order to maximize the sensitivity of DM searches and improve the current results. We use a joint maximum likelihood approach combining each experiment individual analysis to derive more constrained upper limits on the WIMP DM self-annihilation cross-section as a function of DM particle mass. We present new DM constraints over the widest mass range ever reported, extending from 5 GeV to 100 TeV thanks to the combination of these five different instruments.'

Collaborations
H.E.S.S., VERITAS, MAGIC, HAWC, FERMI-LAT

Keywords and Comments
'Gamma rays; indirect detection; dark matter; dwarf galaxies', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Limits on Diffuse Dark Matter with HAWC

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 551

Presenter
Mora Durocher
Author and Co-Author
Mora Durocher | For the HAWC Collaboration, Pat Harding

Abstract
'In addition to dense regions of dark matter, such as galaxy clusters and dwarf galaxies, dark matter annihilation and decay are also expected to have a nearly isotropic distribution across the sky. This isotropic component is less model-dependent than the flux from isolated dark matter targets, and would produce both galactic and extra-galactic contributions to the Diffuse Gamma-Ray Background (DGRB). With its continuous monitoring of the gamma-ray sky from 300 GeV to 100 TeV and its wide field-of-view, the High Altitude Water Cherenkov (HAWC) observatory is well-suited to search for dark matter contributions in the DGRB. In this work, 535 days of HAWC data and Monte Carlo simulations were studied to set a limit on annihilating or decaying diffuse dark matter at TeV energies. With this data, we consider both leptonic and hadronic dark matter channels and are able to constrain dark matter up to masses >100 TeV.'

Collaborations
HAWC,

Keywords and Comments
", "

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Branch DM | Dark Matter

Subcategory Experimental Results

Search for TeV decaying dark matter from the Virgo cluster of galaxies

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 552

Presenter
Mehr Nisa
Author and Co-Author
Mehr Nisa | Pat Harding for the HAWC Collaboration,

Abstract
"Galaxy clusters' dynamics constitute a major piece of evidence for the existence of dark matter in astrophysical structures. The decay or annihilation of dark matter particles is hypothesized to produce a steady flux of very-high-energy gamma rays correlated with the direction of a cluster of galaxies. The Virgo cluster, being only ~16 Mpc away and spanning several degrees across the sky is an excellent target to search for signatures of particle dark matter interactions. The High Altitude Water Cherenkov (HAWC) observatory, due to its wide field of view and sensitivity to gamma rays at an energy-scale of 300 GeV—100 TeV is well-suited to perform the aforementioned search. We perform a search from the Virgo cluster for gamma-ray emission, assuming various dark matter sub-structure models using 1323 days of HAWC data. Our results provide the strongest constraints on the decay life-time of dark matter for masses above 10 TeV."

Collaborations
HAWC,

Keywords and Comments
'Galaxy clusters; WIMPs; decaying dark matter', ''

Branch DM | Dark Matter

Subcategory Experimental Results

An Optimized Search for Dark Matter in the Galactic Halo with HAWC

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 553

Presenter
Pat Harding
Author and Co-Author
Joseph Lundeen | Pat Harding,

Abstract
'With a mass of approximately ~10^12 solar masses, the Galactic Halo is the closest known large dark matter halo and a prime candidate for indirect dark matter detection. The High Altitude Water Cherenkov Observatory (HAWC) is a high energy (300 GeV to 100 TeV) gamma ray detector located in central Mexico. HAWC operates via the water Cherenkov technique and has both a wide field of view of ~2 sr and a >95% duty cycle, making it ideal for analysis of highly extended sources. We made use of these properties of HAWC and a new background-estimation technique optimized for extended sources to probe a large region of the Galactic Halo for dark matter signals. With this approach and taking into account electroweak corrections to the gamma-ray spectra, we set improved constraints on dark matter annihilation and decay between masses of 10 and 100 TeV Our constraints also take into account detector simulation systematics and are robust against uncertainties in the Galactic dark matter spatial profile.'

Collaborations
HAWC,

Keywords and Comments
'dark matter; galactic; constraints; HAWC; gamma ray', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Nuclearite search with ANTARES

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 554

Presenter
Mohammed Bouta
Author and Co-Author
Mohammed Bouta, Jürgen Brunner | Abdelilah MOUSSA | Gabriela Emilia Pavalas | Yahya TAYALATI | For the ANTARES Collaboration

Abstract
'ANTARES is a Cherenkov underwater neutrino telescope operating in the Mediterranean Sea since 2008 in its full configuration. Even though optimised for the search of cosmic neutrinos, this telescope is also sensitive to nuclearites of strange matter.\r\n\r\nWe discuss here the possible detection of non-relativistic down-going nuclearites with the ANTARES telescope and present the first results of an updated analysis using data collected in the period 2009-2017.'

Collaborations
Antares,

Keywords and Comments
'ANTARES; nuclearite; exotic particles; strange quark matter', ''

Branch DM | Dark Matter

Subcategory Experimental Results

Constraints on decaying dark matter with LHAASO-KM2A

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
Marco Chianese
Author and Co-Author
Marco Chianese | Zhe Li | Kenny C.Y. Ng | Gennaro Miele | Damiano Francesco Giuseppe Fiorillo,

Abstract
'The measurement of diffuse gamma-ray emission could provide new insights into the propagation and acceleration of Galactic cosmic rays, the origin of neutrinos observed by IceCube, and the nature of dark matter. KM2A array in LHAASO is devoted to the detection of extensive air showers for gamma-ray astrophysics. Thanks to its large effective area and the good gamma/hadron separation, KM2A has\xa0an excellent\xa0sensitivity to the diffuse gamma-ray emission above\xa0tens TeV energies.\xa0 In this work, we use the data from half-KM2A to set diffuse gamma-ray flux upper limit at 90% confidence level for almost 2/3 of the sky. And we present the first constraints placed by this result to decaying dark matter particles, scrutinizing different final states and dark matter masses, from 10^5\xa0to 10^9\xa0GeV. These limits are mainly driven by galactic prompt and secondary gamma-rays emission, while the extragalactic dark matter contribution is typically subdominant due to gamma-ray absorption. Moreover, we show that in some cases LHAASO-KM2A is already probing an unexplored parameter space, and we discuss in a multi-messenger context the implications for dark matter signals in neutrino telescopes.arameter space, and we discuss in a multi-messenger context the implications for dark matter signals in neutrino telescopes.'

Collaborations
Lhaaso,

Keywords and Comments
'LHAASO-KM2A data; HE diffuse gamma-ray emission; decaying dark matter', 'Zhe Li is on behalf of LHAASO Collaboration, while the others are external collaborators.'

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Branch DM | Dark Matter

Subcategory Experimental Results

New flux limit in the low relativistic regime for magnetic monopoles at IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 555

Presenter
Frederik Lauber
Author and Co-Author
Frederik Lauber,

Abstract
'Magnetic monopoles are hypothetical particles that carry magnetic charge. Depending on their velocity, different light production mechanisms exist to facilitate detection. In this work, a previously unused light production mechanism, luminescence of ice, is introduced. This light production mechanism is nearly independent of the velocity of the incident magnetic monopole and becomes the only viable light production mechanism in the low relativistic regime (0.1-0.55c). An analysis in the low relativistic regime searching for magnetic monopoles in seven years of IceCube data is presented. While no magnetic monopole detection can be claimed, a new flux limit in the low relativistic regime is presented, superseding the previous best flux limit by 2 orders of magnitude.'

Collaborations
IceCube,

Keywords and Comments
'Magnetic; Monopole; luminescence; IceCube; limit;', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Light (anti)nuclei production cross section studies in p+C collisions at the NA61/SHINE experiment.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 556

Presenter
Michał Naskręt
Author and Co-Author
Michał Naskręt,

Abstract
'NA61/SHINE is a large-acceptance fixed-target experiment located at the CERN SPS, which studies final hadronic states in interactions of various particles and nuclei. It is unique in terms of providing data on a variety of collision systems at different collision energies. This allows for wide deuteron, antiproton and antideuteron production cross-section studies. The latter are currently considered a possible dark matter interaction signal with exceptionally small background. The measurements on carbon target are important to reduce systematic experimental effects due to experiment-internal antideuteron production, as the most abundant element in the path of an incoming particle for the AMS-02 experiment is carbon. My talk will focus on analysis of NA61/SHINE data on p+C thin target collisions in context of light (anti)nuclei production. I will present a preliminary analysis of experimental data and discuss quality cuts and the particle identification method as well as present deuteron and antideuteron yields.'

Collaborations
, NA61/SHINE

Keywords and Comments
'dark matter indirect signals; antideuterons; low background; heavy ion collisions;', ''

Branch DM | Dark Matter

Subcategory Experimental Results

Limits on the flux of heavy compact objects from the the "Pi of the Sky" project

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 557

Presenter
Lech Piotrowski
Author and Co-Author
Lech Piotrowski | for the Pi of the Sky collaboration,

Abstract
'The existence of heavy compact objects has been suggested many times throughout the years. In terms of sizes, they would belong to the realms of nuclear or atomic physics, but in terms of masses could extend to the macroscopic world, reaching kilograms, tones or more. The most notable candidates are nuclearites - hypothetical lumps of strange quark matter, Q-Balls, magnetic monopoles or primordial black holes. These objects may have originated in the early universe or could be produced by some stellar phenomena. Especially in the first case, they could be a component of dark matter.\r\n\r\nIf they exist, it is likely that they reach our planet at high speeds and cross the atmosphere, leaving behind a trail of light in the air. We present results of a search for such objects in visual photographs of the sky taken by the "Pi of the Sky" experiment, exemplified with the most stringent limits on the flux of incoming nuclearites of the masses spanning between 100 g and 100 kg.'

Collaborations
other (fill field below), Pi of the Sky

Keywords and Comments
'nuclearites; strangelets; heavy compact objects;', ''

Branch DM | Dark Matter

Subcategory Experimental Results

Indirect dark matter searches with neutrinos from the Galactic Centre region with the ANTARES and KM3NeT telescopes

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
Sara Rebecca Gozzini
Author and Co-Author
Sara Rebecca Gozzini | for the ANTARES and KM3NeT Collaborations,

Abstract
'An anomalous flux of neutrinos produced in hypothetical annihilations or decays of dark matter inside a source would produce a signal observable with neutrino telescopes. As suggested by observations, a conspicuous amount of dark matter is believed to accumulate in the Centre of our Galaxy, which is in neat visibility for the Mediterranean underwater telescopes ANTARES and KM3NeT. Searches have been conducted with a maximum likelihood method to identify the presence of a dark matter signature in the neutrino flux measured by ANTARES. Results of all-flavour searches for WIMPs with masses from 50 GeV/c^2 up to 100 TeV/c^2 over the whole operation period from 2007 to 2020 are presented here. Alternative scenarios which propose a dark matter candidate in the heavy sector extensions of the Standard Model would produce a clear signature in the ANTARES telescope, that can exploit its view of the Galactic Centre up to high energies. Limits on heavy dark matter decay rates computed using ANTARES public data are also discussed. The presentation of Galactic Centre searches is completed with ongoing analyses and future potential of the KM3NeT telescope, in phased construction in the Mediterranean Sea.'

Collaborations
KM3NeT, ANTARES

Keywords and Comments
'neutrino; indirect detection; dark matter', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Search for dark matter annihilation signals from unidentified Fermi-LAT objects with H.E.S.S.

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 40 Dark Matter Indirect Detection and Cosmological Substructures | DM
Presenter Forum Table

Presenter
Denys Malyshev
Author and Co-Author
Alessandro Montanari | Dorit Glawion | Emmanuel Moulin | Denys Malyshev | For the H.E.S.S. collaboration,

Abstract
'Cosmological N-body simulations show that Milky-Way-sized galaxies harbor a population of unmerged dark matter subhalos. These subhalos could shine in gamma rays and be eventually detected in gamma-ray surveys as unidentified sources. We search for very-high-energy (VHE, E ≥ 100 GeV) gamma-ray emission using H.E.S.S. observations carried out on a thorough selection of unidentified Fermi-LAT Objects (UFOs) as dark matter subhalo candidates. Provided that the dark matter mass is higher than a few hundred GeV, the emission of the UFOs can be well described by dark matter annihilation models. No significant VHE gamma-ray emission is detected in any UFO dataset nor in their combination. We, therefore, derive constraints on the product of the velocity-weighted annihilation cross-section <sigma v> by the J-factor on dark matter models describing the UFO emissions. Upper limits at 95% confidence level (CL) are derived on sigma v J in W+W- and \\tau+\\tau- annihilation channels for the TeV dark matter particles. Focusing on thermal WIMPs, strong constraints on the J-factors are obtained from H.E.S.S. observations. Adopting model-dependent predictions from cosmological N-body simulations on the J-factor distribution function for Milky Way-sized galaxies, the dark matter models for the UFO emissions could be ruled out at high confidence level.'

Collaborations
H.E.S.S.,

Keywords and Comments
'Dark Matter; Gamma-ray sources; Dark matter subhalos', ''

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Branch DM | Dark Matter

Subcategory Experimental Results

Results on low-mass weakly interacting massive particles from a 11 kg d target exposure of DAMIC at SNOLAB

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 42 Direct Dark Matter: Present and Future | DM
Presenter Forum Table

Presenter
Michelangelo Traina
Author and Co-Author
Michelangelo Traina | For the DAMIC Collaboration,

Abstract
'Experimental efforts of the last decades have been unsuccessful in detecting WIMPs (Weakly Interacting Massive Particles) in the 10-to-10^4 GeV/c^2 range, thus motivating the search for lighter dark matter. The DAMIC (DArk Matter In CCDs) at SNOLAB experiment aims for direct detection of light dark matter particles ($m_\\chi < 10$ GeV/c^2) by means of CCDs (Charge-Coupled Devices). Fully-depleted 675 $\\mu$m-thick CCDs are used to such end. The optimized readout noise and operation at cryogenic temperatures allow for a detection threshold of 50 eV$_{ee}$ electron-equivalent energy. Focusing on nuclear and electronic scattering as potential detection processes, DAMIC has so far set competitive constraints on the detection of low mass WIMPs and hidden-sector particles.\r\nIn this work, a 11 kg$\\cdot$d exposure dataset is exploited to search for light WIMPs by building the first comprehensive radioactive background model for CCDs. Different background sources are discriminated making conjoint use of the spatial distribution and energy of ionization events, thereby constraining the amount of contaminants such as tritium from silicon cosmogenic activation and surface lead-210 from radon plate-out.\r\nDespite a conspicuous, statistically-significant excess of events below 200 eV$_{ee}$, this analysis places the strongest exclusion limit on the WIMP-nucleon scattering cross section with a silicon target for $m_\\chi < 9~$GeV/c^2.'

Collaborations

Keywords and Comments
'Direct detection; WIMP; CCD; DAMIC;', ''

Branch DM | Dark Matter

Subcategory Experimental Results

Neutrinoless double beta decay search with XENON1T and XENONnT

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 42 Direct Dark Matter: Present and Future | DM
Presenter Forum Table

Presenter
Maxime Pierre
Author and Co-Author
Maxime Pierre | for the XENON Collaboration,

Abstract
'With the lowest background level ever reached by detectors searching for rare-events, XENON1T proved to be the most sensitive dark matter direct detection experiment on earth. The unprecedented low level of radioactivity reached, made the XENON1T experiment suitable also for other interesting rare-events searches including the neutrinoless double beta decay of 136Xe. In this talk I will report on the current status of neutrinoless double beta decay of 136Xe search in XENON1T.\r\n\r\nFurthermore, in the context of the advancement of the XENON program, the next generation experiment, XENONnT, designed with a high level of background reduction aiming to increase the predecessor sensitivity in rare-events searches is currently under commissioning phase in the underground National Laboratory of Gran Sasso (LNGS): it will host 5.9 tonnes of liquid xenon as a target mass.\xa0 I will also discuss the discovery potential of XENONnT in the search for neutrinoless double beta decay events and its general physics program.'

Collaborations
Xenon 1T,

Keywords and Comments
'dark matter; neutrinoless double beta decay; xenon; TPC; low background; rare-events; XENON1T; XENONnT; DM; LXe; 0vbb', ''

Branch DM | Dark Matter

Subcategory Experimental Results

Dark Matter annihilation to neutrinos: New limits and future prospects

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
Ali Kheirandish
Author and Co-Author
Ali Kheirandish | Carlos Arguelles | Diaz Alejandro | Ibrahim Safa | Aaron Vincent,

Abstract
'Neutrinos can escape dense environments, otherwise opaque to photons, and travel cosmic distances unscathed by background radiation or magnetic fields. While ideal cosmic messengers, they present a unique opportunity to test physics beyond the Standard Model, especially dark matter. Moreover, there is a distinct possibility that the neutrino sector is the principal portal through which the dark matter interacts with the Standard Model. In this talk, we will discuss new opportunities offered by high-energy neutrinos and provide new model-independent limits on dark matter annihilation into neutrinos based on measurements of neutrinos. We present the most up-to-date and comprehensive results on dark matter annihilation into neutrinos using the most recently available data from neutrino telescopes, with measurements spanning a wide energy range. Finally, we will present the projections for next-generation of neutrino experiments.'

Collaborations

Keywords and Comments
", "

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Branch DM | Dark Matter

Subcategory Experimental Results

Constraining the diffuse supernova axion-like-particle background with high-latitude Fermi-LAT data

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 558

Presenter
Christopher Eckner
Author and Co-Author
Christopher Eckner | Francesca Calore | Alessandro Mirizzi | Pierluca Carenza,

Abstract
"Axions and axion-like particles (ALPs) are thought to be produced along with Standard Model particles in a variety of astrophysical processes. Core-collapse supernovae (SNe) have been identified as a promising target to probe the existence of these hypothetical particles, which could make up at least a fraction of the universe's dark matter content.\r\nThe cumulative signal from all past SNe events would contain an ALP component and create a diffuse flux with energies $\\mathcal{O}(50)$ MeV. Due to their coupling to photons and the related Primakoff process, the diffuse SNe ALP flux is converted into a diffuse gamma-ray flux while traversing the magnetic field of the Milky Way. The spatial morphology of this signal is expected to follow the shape of the Galactic magnetic field lines.\r\nWe perform a template-based analysis to constrain the ALP parameter space via the spatial structure of this ALP-induced diffuse gamma-ray flux using Fermi-LAT data from 12 years and an energy range from 50 MeV to 500 GeV. We find an improvement of the upper limit on the ALP-photon coupling constant $g_{a\\gamma}$ of about an order of magnitude compared to a previous analysis solely based on the spectral shape of the signal. Our results are robust against variations in the modelling of high-latitude Galactic diffuse emission and systematic uncertainties of the LAT."

Collaborations

Keywords and Comments
", "

Branch DM | Dark Matter

Subcategory Future projects

Sensitivity of the Cherenkov Telescope Array to dark subhalos

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 40 Dark Matter Indirect Detection and Cosmological Substructures | DM
Presenter Forum Table

Presenter
Javier Coronado-Blázquez
Author and Co-Author
Javier Coronado-Blázquez | Miguel Sánchez-Conde | Michele Doro | Alejandra Aguirre-Santaella,

Abstract
'In this work, we study the potential of the Cherenkov Telescope Array (CTA) for the detection of Galactic dark matter (DM) subhalos. We focus on low-mass subhalos that do not host any baryonic content and therefore lack any multiwavelength counterpart. If the DM is made of weakly interacting massive particles (WIMPs), these dark subhalos may thus appear in the gamma-ray sky as unidentified sources. A detailed characterization of the instrumental response of CTA to dark subhalos is performed, for which we use the ctools analysis software and simulate CTA observations under different array configurations and pointing strategies, such as the scheduled extragalactic survey. This, together with information on the subhalo population as inferred from N-body cosmological simulations, allows us to predict the CTA detectability of dark subhalos, i.e., the expected number of subhalos in each of the considered observational scenarios. In the absence of detection, for each observation strategy we set competitive limits to the annihilation cross section as a function of the DM particle mass. Interestingly, we find the best constraints to be reached with no dedicated observations, by just accumulating exposure time from all scheduled CTA programs and pointings over the first 10 years of operation. This way CTA will offer the most constraining limits from subhalo searches in the intermediate range between 1 − 3 TeV, complementing previous results with Fermi-LAT and HAWC at lower and higher energies, respectively. This work is based on [2101.10003] and has been developed within the CTA Consortium.'

Collaborations
CTA,

Keywords and Comments
'Dark Matter; Indirect detection; gamma-ray; CTA', ''

Branch DM | Dark Matter

Subcategory Future projects

Hunting for Dark Matter and New Physics with (a) GECCO

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
Profumo Stefano
Author and Co-Author
Profumo Stefano,

Abstract
'I will outline the science opportunities in the areas of searches for dark matter and new physics offered by a proposed future MeV gamma-ray telescope, the Galactic Explorer with a Coded Aperture Mask Compton Telescope (GECCO). I will point out that such an instrument would play a critical role in opening up a discovery window for particle dark matter with mass in the MeV or sub-MeV range, in disentangling the origin of the mysterious 511 keV line emission in the Galactic Center region, and in potentially discovering Hawking evaporation from light primordial black holes.'

Collaborations
, GECCO

Keywords and Comments
'Dark matter; gamma rays', ''

Branch DM | Dark Matter

Subcategory Future projects

The sensitivity of the Cherenkov Telescope Array to gamma-ray emission from the Perseus galaxy cluster

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 40 Dark Matter Indirect Detection and Cosmological Substructures | DM
Presenter Forum Table

Presenter
Judit Pérez-Romero
Author and Co-Author
Judit Pérez-Romero | for the CTA Consortium,

Abstract
"We estimate the sensitivity of the Cherenkov Telescope Array (CTA) to detect diffuse gamma-ray emission from the Perseus galaxy cluster, both from interactions of cosmic rays (CR) with the intra-cluster medium, or as a product of annihilation or decay of dark matter (DM) particles in case they are weakly interactive massive particles (WIMPs). The observation of Perseus constitutes one of the Key Science Projects to be carried out by the CTA Consortium in the first years of operation. In this talk, we will focus on the DM-induced component of the flux. Our DM modeling includes the substructures we expect in the main halo of Perseus, as predicted within the standard cosmological model hierarchical structure formation scenario, which will boost the annihilation signal significantly. We compute the expected CTA sensitivity using a likelihood maximization analysis including the most recent CTA instrument response functions. We also model the expected CR-induced gamma-ray flux in the cluster, and both DM- and CR-related uncertainties via nuisance parameters. We will show the sensitivity of CTA to discover, at best, diffuse gamma-rays in galaxy clusters for the first time. Even in absence of signal, we show that CTA will allow us to provide stringent and competitive constraints on TeV DM, that will rely on state-of-the-art modeling of the cluster's DM distribution. Finally, we will discuss the optimal strategy for CTA observations of Perseus."

Collaborations
CTA,

Keywords and Comments
'dark matter; galaxy cluster; Perseus; halo model; substructure boost; likelihood analysis', ''

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Branch DM | Dark Matter

Subcategory Future projects

Sensitivity of the Cherenkov Telescope Array to a dark matter signal from the Galactic centre

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
Christopher Eckner
Author and Co-Author
Lili Yang | Torsten Bringmann | Christopher Eckner | Gabrijela Zaharijas | Anastasia Sokolenko, for the CTA Consortium

Abstract
'High-energy gamma rays are promising tools to constrain or reveal the nature of dark matter, in particular Weakly Interacting Massive Particles. Being well into its pre-construction phase, the Cherenkov Telescope Array (CTA) will soon probe the sky in the 20 GeV - 300 TeV energy range. Thanks to its improved energy and angular resolutions as well as significantly larger effective area when compared to the current generation of Cherenkov telescopes, CTA is expected to probe heavier dark matter, with unprecedented sensitivity, reaching the thermal annihilation cross-section at ~1 TeV. \r\n\r\nThis talk will summarise the planned dark matter search strategies with CTA, focusing on the signal from the Galactic centre. As observed with the Fermi LAT at lower energies, this region is rather complex and CTA will be the first ground-based observatory sensitive to the large scale diffuse astrophysical emission from that region. We report on the collaboration effort to study the impact of such extended astrophysical backgrounds on the dark matter search, based on Fermi-LAT data in order to guide our observational strategies, taking into account various sources of systematic uncertainty.'

Collaborations
CTA,

Keywords and Comments
'', ''

Branch DM | Dark Matter

Subcategory Future projects

DARWIN – a next-generation liquid xenon observatory for dark matter and neutrino physics

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 42 Direct Dark Matter: Present and Future | DM
Presenter Forum Table

Presenter
Kevin Thieme
Author and Co-Author
Kevin Thieme, for the DARWIN Collaboration

Abstract
'Benefiting from more than a decade of experience in WIMP searches with dual-phase xenon time projection chambers, the DARWIN (DARk matter WImp search with liquid xenoN) collaboration intends to build a next-generation detector involving 50 tonnes (40 tonnes active) of xenon. The primary goal of the observatory is to explore the entire experimentally accessible parameter space for WIMP masses above 5 GeV/c^2 down to the irreducible neutrino floor. With its low energy threshold and ultra-low background level, DARWIN will be an excellent platform to search for various other rare interactions. These include the neutrinoless double beta decay of ^{136}Xe, a high-precision measurement of the low-energy solar neutrino flux, as well as searches for solar axions and axion-like-particles. In this talk, we will present the detector concept, the sensitivity to the various science channels, and ongoing R&D efforts.'

Collaborations
other (fill field below), DARWIN

Keywords and Comments
'low background; dark matter; WIMP; neutrinoless double beta decay; solar neurinos; axions; ALP; TPC; Xenon;', ''

Branch DM | Dark Matter

Subcategory Future projects

Dark Matter Phenomenology from Upcoming Neutrino Telescopes:

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 560

Presenter
Andrew Cheek
Author and Co-Author
Andrew Cheek, Suzan Basegmez du Pree | Chiara Arina | Marco Chianese | Ariane Dekker | Shin’ichiro Ando

Abstract
'Experimental developments in neutrino telescopes are drastically improving their ability to constrain the annihilation cross-section of dark matter. In this talk we project the future sensitivity of a Neutrino telescope similar to KM3NeT. Focusing on particle models for dark matter, we assess how these future limits will complement the existing landscape of dark matter searches. This brings together results from gamma-ray telescopes, measurements of the cosmic microwave background and direct dark matter detection. We will emphasisze the importance of using the Angular Power Spectrum method, which is a powerful tool for reducing astrophysical uncertainties. We find that neutrino telescopes will be able to competitively probe significant portions of parameter space and will provide critical complementary information. Furthermore, we identify models that can potentially be explored where the relic abundance is achieved through thermal freeze-out.'

Collaborations

Keywords and Comments
'Dark Matter; Neutrino Telescopes; Particle Phenomenology; Global Studies.', ''

Branch DM | Dark Matter

Subcategory Future projects

Probing the properties of superheavy dark matter annihilating or decaying into neutrinos with ultra-high energy neutrino experiments

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 561

Presenter
Claire Guépin
Author and Co-Author
Claire Guépin | Roberto Aloisio | Luis A. Anchordoqui | Austin Cummings | John Krizmanic | Angela V. Olinto | Mary Hall Reno | Tonia Venters,

Abstract
'The evidence for dark matter particles, $\\chi$, is compelling based on Galactic to cosmological scale observations. Thus far, the promising weakly interacting massive particle scenario have eluded detection, motivating alternative models of dark matter. We consider scenarios involving superheavy dark matter (SHDM) that potentially can decay or annihilate to neutrinos and antineutrinos.\r\n\r\nIn the mass range $m_\\chi = 10^7-10^{15}\\,{\\rm GeV}$, we evaluate the sensitivities of future observatories POEMMA and GRAND for indirect dark matter detection via the measurement of neutrino-induced extensive air showers (EAS). We compare their sensitivities to the dark matter thermally averaged annihilation cross section and dark matter decay width with the ones of IceCube, Auger and ANITA. We also show that the uncertainties related to the dark matter distribution in the Galactic halo have a large impact on the neutrino flux.\r\n\r\nWe show that a ground-based radio detector such as GRAND can achieve high sensitivities due to its large effective area and high duty cycle. Space-based Cherenkov detectors such as POEMMA that measure the EAS optical Cherenkov signal have the advantage of full-sky coverage and rapid slewing, enabling an optimized SHDM observation strategy focusing on the Galactic Center. We show that increasing the field of view of the Cherenkov detectors can significantly enhance the sensitivity. Moreover, POEMMA’s fluorescence observation mode that measures EAS above 20 EeV will achieve state-of-the-art sensitivity to SHDM properties at the highest mass scales.'

Collaborations
, POEMMA, GRAND

Keywords and Comments
'superheavy dark matter; indirect detection; ultra-high energy neutrinos', ''

Branch DM | Dark Matter

Subcategory Future projects

Exploring MeV gamma rays from dark matter annihilation and evaporating primordial black holes in the GRAMS experiment

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 40 Dark Matter Indirect Detection and Cosmological Substructures | DM
Presenter Forum Table

Presenter
Jonathan LeyVa
Author and Co-Author
Jonathan LeyVa,

Abstract
'The proposed GRAMS (Gamma-Ray and\xa0AntiMatter\xa0Survey) experiment aims to provide unprecedented sensitivity to a poorly-explored region of the cosmic gamma-ray spectrum from 0.1-100 MeV, often referred to as the “MeV gap”. Utilizing Liquid Argon Time Projection Chamber (LArTPC) technology to detect these MeV gamma rays, GRAMS has the potential to uncover crucial details behind a variety of processes in multi-messenger astrophysics.\xa0Various theories on particle interactions beyond the standard model predict that dark matter annihilations may contribute to the cosmic gamma spectrum via monochromatic gamma emissions (spectral lines), the annihilation of decay products, and the radiation of electromagnetically charged final states. MeV gamma rays may also be emitted from\xa0primordial black holes (PBHs), which are currently gaining interest as candidates for dark matter. By looking for the Hawking radiation from such objects, GRAMS can likely probe for ultra-light PBHs, which theoretically may comprise the majority of dark matter seen in the universe. Here, we will describe how the analyses of the targeted gamma-ray regime will enable GRAMS to uniquely and complementarily place constraints on low-mass dark matter models.'

Collaborations
, GRAMS

Keywords and Comments
'PBH; primordial black hole; Hawking radiation; gamma ray spectrum; cosmic gamma ray; dark matter; indirect search; low-mass dark matter', ''

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Branch DM | Dark Matter

Subcategory Future projects

Simulations and background estimates for the DAMIC-M experiment

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 42 Direct Dark Matter: Present and Future | DM
Presenter Forum Table

Presenter
Claudia De Dominicis
Author and Co-Author
Claudia De Dominicis | Mariangela Settimo | For the DAMIC-M Collaboration,

Abstract
'DAMIC-M (Dark Matter in CCDs at Modane) is a near-future experiment aiming to search for low-mass dark matter particles through their interactions with silicon atoms in the bulk of charge-coupled devices (CCDs). This technique was pioneered by the DAMIC experiment at SNOLAB. Its successor DAMIC-M will have a 25 times larger detector mass and will employ a novel CCD technology (skipper amplifiers) which allows to achieve a readout noise of 0.07 e-. With these novelties, DAMIC-M will reach unprecedented sensitivities to dark matter candidates of the so-called hidden sector. A challenging requirement is the control of the radiogenic background at the level of a fraction of events per keV per kg-day of target exposure. Accurate Geant4 simulations are being employed to optimise the detector design and drive the material selection and handling. This poster provides a comprehensive overview of the explored detector designs, the estimated background, and the strategies for its mitigation.'

Collaborations
other (fill field below), DAMIC-M

Keywords and Comments
", "

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Branch DM | Dark Matter

Subcategory Future projects

DIMS Experiment for Dark Matter and Interstellar Meteoroid Study

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 42 Direct Dark Matter: Present and Future | DM
Presenter Forum Table

Presenter
Fumiyoshi Kajino
Author and Co-Author
Alberto Cellino | Soon-Wook Kim | Yoshiyuki Takizawa | Daniele Gardiol | Sachiko Tada | Yasunori Fujiwara | Yugo Iwami | Mario Edoardo Bertaina | Kenji Shinozaki | Fumiyoshi Kajino | Toshikazu Ebisuzaki | Lech Wiktor Piotrowski | Shinsuke Abe | Jagjit S,

Abstract
'DIMS (Dark matter and Interstellar Meteoroid Study) is a new experiment aiming\r\nto search for macroscopic dark matters and interstellar meteoroids. Nuclearites are nuggets of stable strange quark matter(SQM), neutral in charge and hypothetical super-heavy macroscopic particles (macros), and may be important components of the dark matter in our Universe. Nuclearites of galactic origins would have an expected typical velocity of about 220 km/s in galactic frame, whereas in the case of a head-on collision between interstellar meteoroids with a velocity that exceeds the escape velocity of the solar system and the Earth orbiting the Sun, the geocentric velocities will be larger than 72 km/s. We study the possibility to search for such fast-moving particles by using very high-sensitivity CMOS cameras with a wide field of view. \r\n Based on observational data of meteor events using such stereo camera systems at some locations, we estimate the observable mass ranges for the moving nuclearites and the interstellar meteoroids. Observable flux limits are also estimated for these mass ranges.\r\n We designed the DIMS experiment to search for such particles. In its first stage, the DIMS system consists of 4 high-sensitivity CMOS camera stations with a wide field of view. The system is going to be constructed at the Telescope Array cosmic-ray-experiment site in Utah, USA. \r\n Details of the project science, plans and present status with preliminary test results will be reported in this paper.'

Collaborations
, DIMS

Keywords and Comments
'macroscopic dark matter; nuclearite; strange quark matter; SQM; meteor; meteoroid; interstellar meteoroid', ''

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Branch DM | Dark Matter

Subcategory Future projects

Searching for Dark Matter with the Southern Wide-field Gamma-ray Observatory (SWGO)

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
Aion Viana
Author and Co-Author
Aion Viana | Andrea Albert | J. Pat Harding | Jim Hinton | Maria Kherlakian | Harm Schoorlemmer | Vitor de Souza | for the SWGO Collaboration,

Abstract
'Despite mounting evidence that dark matter (DM) exists in the Universe, its fundamental nature remains unknown. We present sensitivity estimates to detect DM particles with a future very-high-energy ($\gtrsim$ TeV) wide field-of-view gamma-ray observatory in the Southern Hemisphere, currently in its research and development phase under the name Southern Wide field-of-view Gamma-ray Observatory (SWGO). This observatory would search for gamma rays from the annihilation or decay of DM particles in many key targets in the Southern sky, such as the Galactic halo, several dwarf galaxies, including the promising Reticulum II, and the Large Magellanic Cloud. With a wide field of view and long exposures, such observatory will have unprecedented sensitivity to DM in the mass range of $\sim$100 GeV to a few PeV from observations of a large fraction of the Galactic halo around the Galactic Center, dwarf galaxies and Galactic subhalos targets. These results, combined with those from other present and future gamma-ray observatories, will likely probe the thermal relic annihilation cross section of Weakly Interacting Massive Particles for all masses from $\sim$80 TeV down to the GeV range in most annihilation channels.'

Collaborations
SWGO,

Keywords and Comments
'dark matter; gamma rays; indirect searches; Galactic Center; gamma-ray telescope; Southern Wide field-of-view Gamma-ray Observatory; SWGO', ''

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Branch DM | Dark Matter

Subcategory Future projects

Probing sterile neutrinos and axion-like particles from the Galactic halo with eROSITA

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 42 Direct Dark Matter: Present and Future | DM
Presenter Forum Table

Presenter
Ariane Dekker
Author and Co-Author
Ariane Dekker, Fabian Zimmer | Ebo Peerbooms | Kenny C.Y. Ng | Shin'ichiro Ando

Abstract
'The nature of dark matter remains an open question and could be in the form of warm dark matter. Sterile neutrinos are well motivated warm dark matter candidates and can decay into photons through mixing, which are consequently detectable by X-ray telescopes for sterile neutrino mass in the keV range. Moreover, axion-like particle are compelling warm dark matter candidates too and they can couple to standard model particles and decay into photons at keV range. Both particles could explain the observed unidentified 3.5 keV line and, interestingly, XENON1T observed an excess at a few keV that can originate from axion-like particles, which is not yet excluded by X-ray constraints for a suppressed coupling to photons with respect to the coupling to electrons.\r\nWe study the diffuse emission coming from the Galactic halo, and test the sensitivity of all-sky X-ray survey eROSITA to identify a sterile neutrino or axion-like particle. By Monte Carlo method, we set bounds on the mixing angle of the sterile neutrinos and coupling strength of the axion-like particles. I will show that with eROSITA, we will be able to set stringent constraints, and in particular, we will be able to firmly probe the best-fit of the unidentified 3.5 keV line, where we reach an order of magnitude better sensitivity. Moreover, eROSITA is able to confirm an axion-like particle origin of the XENON1T excess for an excess greater than $\\sim 3.5$ keV.'

Collaborations

Keywords and Comments
'Sterile neutrinos; Axion-like particle; Dark matter; eROSITA', ''

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Branch DM | Dark Matter

Subcategory Theoretical Methods

gammaALPs: An open-source python package for computing photon-axion-like-particle oscillations in astrophysical environments

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 562

Presenter
Manuel Meyer
Author and Co-Author
Manuel Meyer | James Davies,

Abstract
'Axions and axion-like particles (ALPs) are hypothetical particles that occur in extensions of the Standard Model and are candidates for cold dark matter. They could be detected through their oscillations into photons in the presence of external electromagnetic fields. gammaALPs is an open-source python framework that computes the oscillation probability between photons and axions/ALPs. In addition to solving the photon-ALP equations of motion, gammaALPs includes models for magnetic fields in different astrophysical environments such as jets of active galactic nuclei, intra-cluster and intergalactic media, and the Milky Way. Users are also able to easily incorporate their own custom magnetic-field models. We review the basic functionality and features of gammaALPs, which is heavily based on other open-source scientific packages such as Numpy and Scipy. Although focused on gamma-ray energies, gammaALPs can be easily extended to arbitrary photon energies.'

Collaborations

Keywords and Comments
'axion-like particles; gamma rays; open-source code', ''

Branch DM | Dark Matter

Subcategory Theoretical Methods

Formation models for cosmic ray antinuclei

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 563

Presenter
Jonas Tjemsland
Author and Co-Author
Jonas Tjemsland,

Abstract
'The expected low background of light antinuclei, such as antideuteron and antihelium-3, make them ideal detection channels for exotic physics, such as dark matter annihilations. At the same time, their small binding energies and composite structures make them promising probes for the QCD phase diagram in heavy ion collisions. In order to correctly interpret experimental data, however, a solid description of the formation process is needed. This can be achieved using phase space coalescence models based on the Wigner function representation of the produced nuclei states. Here, we discuss topics related to the production of light (anti)nuclei with a focus on its relevance for cosmic ray studies. In particular, we consider the importance of including both two-particle correlations and the size of the formation region on an event-by-event basis when describing the production in small interacting systems, such as e^+e^-, pp, pN and peripheral NN collisions. As such, we review the newly developed WiFunC model (Wigner Functions with Correlations) and comment on its generalisation to larger interacting systems.'

Collaborations

Keywords and Comments
'antinuclei; cosmic ray; coalescence; WiFunC; Wigner function; antideuteron; antihelium; AMS-02; GAPS; heavy ion', ''

Branch DM | Dark Matter

Subcategory Theoretical Methods

χarov: a tool for neutrino flux generation from WIMPs

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 564

Presenter
Qinrui Liu
Author and Co-Author
Qinrui Liu, Jeffrey Lazar | Carlos Arguelles | Ali Kheirandish

Abstract
'Indirect searches for signatures of corpuscular dark matter have been performed using all cosmic messengers: gamma rays, cosmic rays, and neutrinos. The search for dark matter with neutrinos is important since they are the only courier that can reach detectors from dark matter processes in dense environments, such as the core of the Sun or Earth, or the edge of the observable Universe. One thing essential to experiments is the prediction of the neutrino signature in the detector. I will introduce χarov, a software that bridges the dark sector and Standard Model by predicting neutrino fluxes from different celestial dark matter agglomerations in diverse scenarios. This package includes updated computation of neutrino production and propagation to the detector.'

Collaborations

Keywords and Comments
'indirect dark matter detection; neutrino; software; Monte Carlo simulation', 'based on arxiv:2007.15010'

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Branch DM | Dark Matter

Subcategory Theoretical Results

Multimessenger constraints on the dark matter interpretation of the Fermi-LAT Galactic center excess

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
MATTIA DI MAURO
Author and Co-Author
MATTIA DI MAURO | MARTIN WINKLER,

Abstract
'The excess of gamma rays in the data measured by the Fermi Large Area Telescope from the Galactic center region is one of the most intriguing mysteries in Astroparticle Physics. This Galactic center excess (GCE), has been measured with respect to different interstellar emission models, source catalogs, data selections and techniques. Although several proposed interpretations have appeared in the literature, there are not firm conclusions as to its origin. The main difficulty in solving this puzzle lies in modeling a region of such complexity and thus precisely measuring the characteristics of the GCE. In this presentation I will show the results obtained for the GCE by using 11 years of Fermi-LAT data, state of the art interstellar emission models, and the newest 4FGL source catalog to provide precise measurements of the energy spectrum, spatial morphology, position, and sphericity of the GCE. I will also present constraints for the interpretation as dark matter particle interactions using the GCE, a gamma-ray analysis of dwarf spheroidal galaxies with LAT data and AMS-02 cosmic-ray antiprotons and positrons flux data.'

Collaborations

Keywords and Comments
'dark matter; gamma ray; cosmic ray; Galactic center', ''

Branch DM | Dark Matter

Subcategory Theoretical Results

Shedding light on low-mass subhalo survival with numerical simulations

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 40 Dark Matter Indirect Detection and Cosmological Substructures | DM
Presenter Forum Table

Presenter
Alejandra Aguirre-Santaella
Author and Co-Author
Alejandra Aguirre-Santaella | Miguel Sánchez-Conde | Go Ogiya | Raúl Angulo | Jens Stücker,

Abstract
'In this work, we carry out a suite of specially-designed numerical simulations that employ a supercluster computational power to shed further light on dark matter (DM) subhalo survival at mass scales relevant for gamma-ray DM searches, a topic subject to intense debate nowadays. Specifically, we have employed a GPU N-body code to study the evolution of low-mass subhalos inside a Milky Way-like halo with unprecedented accuracy, paying particular attention to subhalos at the solar galactocentric radius. We have simulated subhalos with varying mass, concentration, and orbital properties, and considered the effect of the gravitational potential of the Milky-Way galaxy itself. These results provide detailed predictions that will aid current and future quests for the nature of dark matter.'

Collaborations

Keywords and Comments
'cosmological simulations; indirect detection of dark matter; subhalos', ''

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Branch DM | Dark Matter

Subcategory Theoretical Results

Cherenkov Telescope Array Sensitivity to the Putative Millisecond Pulsar Population responsible for the Galactic Center Excess

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
Oscar Macias
Author and Co-Author
Oscar Macias, Harm van Leijen | Deheng Song | Shin'ichiro Ando | Shunsaku Horiuchi | Roland Crocker

Abstract
'The leading explanation of the $\\textit{Fermi}$ Galactic center $\\gamma$-ray excess is the extended emission from a unresolved population of millisecond pulsars (MSPs) in the Galactic bulge. Such a population would, along with the prompt $\\gamma$ rays, also inject large quantities of electrons/positrons ($e^\\pm$) into the interstellar medium. These $e^\\pm$ could potentially inverse-Compton (IC) scatter ambient photons into $\\gamma$ rays that fall within the sensitivity range of the upcoming Cherenkov Telescope Array (CTA). In this talk, I will present the results of an examination of the detection potential of CTA to this signature by making a realistic estimation of the systematic uncertainties on the Galactic diffuse emission model at TeV-scale $\\gamma$-ray energies. We forecast that, in the event that $e^\\pm$ injection spectra are harder than E^{-2}, CTA has the potential to robustly discover the IC signature of a putative Galactic bulge MSP population sufficient to explain the GCE for $e^\\pm$ injection efficiencies in the range $\\approx 2.9-74.1\\%$, or higher, depending on the level of mismodeling of the Galactic diffuse emission components. On the other hand, for spectra softer than $E^{-2.5}$, a reliable CTA detection would require an unphysically large $e^\\pm$ injection efficiency greater than $\\approx 158\\%$. However, even this pessimistic conclusion may be avoided in the plausible event that MSP observational and/or modeling uncertainties can be reduced. We further find that, in the event that an IC signal were detected, CTA can successfully discriminate between an MSP and a dark matter origin for the radiating $e^\\pm$.'

Collaborations

Keywords and Comments
'Galactic Center Excess; Millisecond pulsars; gamma-rays; CTA; dark matter annihilation', ''

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Branch DM | Dark Matter

Subcategory Theoretical Results

Integral X-ray constraints on sub-GeV dark matter

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
Elena Pinetti
Author and Co-Author
Elena Pinetti, Nicolao Fornengo | Marco Cirelli | Bradley Kavanagh

Abstract
'Dark matter (DM) in cosmic structures is expected to produce signals originating from its particle physics nature, among which the electromagnetic emission represents a relevant opportunity. One of the major candidates for DM are weak-scale particles, however no convincing signal of them has been observed so far. For this reason, alternative candidates are getting increasing attention, notably sub-GeV particles, which are the subject of our work. The challenge in indirect detection of sub-GeV DM is that there is scarcity of competitive experiments in the energy range between 1 MeV and hundreds of MeV, hence we need to find alternative ways to study DM candidates with mass in this energy window. In our work we proposed to look at energies much lower than the mass of the sub-GeV DM particles by including the contribution from Inverse-Compton scattering (ICS) in the total flux. In particular, the electrons and positrons produced by DM particles give rise to X-rays by upscattering the low-energy photons of the radiation fields in the Galaxy (CMB, infrared from dust, optical starlight). These X-rays fall in the energy range covered by the INTEGRAL data, which we used to determine conservative bounds on the DM annihilation cross-section. We considered three annihilation channels: electron, muon and pion. As a result, we derived competitive constraints for DM particles with a mass between 150 MeV and 1.5 GeV.'

Collaborations

Keywords and Comments
'Gamma-rays; X-rays; dark matter; INTEGRAL telescope', ''

Branch DM | Dark Matter

Subcategory Theoretical Results

Searching for Millicharged particles produced in cosmic-ray showers

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 565

Presenter
Víctor Muñoz
Author and Co-Author
Víctor Muñoz,

Abstract
'Particles with fractional electric charge can be copiously produced in cosmic rays showers, propagating through the atmosphere and penetrating the earth until they reach different kinds of underground experiments. We will revisit their atmospheric production and provide novel sensitivity estimates for both, Cherenkov and Scintillator-based experiments.'

Collaborations

Keywords and Comments
'', ''

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Branch DM | Dark Matter

Subcategory Theoretical Results

Searching for isolated black holes in the Milky Way

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 40 Dark Matter Indirect Detection and Cosmological Substructures | DM
Presenter Forum Table

Presenter
Francesca Scarcella
Author and Co-Author
Francesca Scarcella, Daniele Gaggero

Abstract
'Primordial Black Holes (PBHs) have been proposed as a Dark Matter (DM) candidate. Even if they constitute only a component of the DM, their detection would have major implications for fundamental Physics. If a component of the DM is in the form of PBHs, we expect a significant portion of this black hole population to be present at the center of our Galaxy, a region rich of dense molecular clouds. Black holes located within a cloud will accrete the dense interstellar gas, which will emit radiation during the process. In this work, we study the possibility of detecting isolated accreting black holes in the Milky Way through this radiation. We focus on the radio and X-ray bands, considering existing catalogs and future experimental prospects. To model the accretion, we adopt the state-of-the-art model of Park-Ricotti, backed up by numerical simulations. We consider different mass functions for the PBHs and compare the results with those obtained for the black hole population of astrophysical origin.\r\nPartially based on arXiv:2012.10421'

Collaborations

Keywords and Comments
'Primordial black holes; accretion; Milky Way', ''

Branch DM | Dark Matter

Subcategory Theoretical Results

Decaying Dark Matter at IceCube and its Signature in High-Energy Gamma-Ray Experiments

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 566

Presenter
Barbara Skrzypek
Author and Co-Author
Barbara Skrzypek, Carlos Argüelles | Marco Chianese

Abstract
'Observations of high-energy astrophysical neutrinos in IceCube have opened the door to multi-messenger astronomy, by way of which questions in particle physics could be explored collaboratively between IceCube and optical experiments such as Fermi-LAT. However, the origin of these astrophysical neutrinos is still largely unknown. Among the tensions that still need to be resolved, for example, is the excess of neutrinos in the High Energy Starting Event (HESE) sample in the energy range of 40-200 TeV, a contribution that could come from dark matter decay. The dark matter decay hypothesis can be tested through comparisons with Fermi-LAT gamma-ray data, as the latter places strong constraints on decay parameters. However, HESE predicts a soft neutrino spectrum that extends below around 50 TeV, while such a spectrum is incompatible with current gamma-ray measurements and suggests that gamma-rays become heavily suppressed for sources dominating in this lower-energy range. A reason for this is that properties of the traversed medium, which consists of extragalactic background light (EBL), the cosmic microwave background (CMB), and the intergalactic magnetic field, significantly alter the final gamma ray spectrum that reaches telescopes on Earth. The existence of competing photon background models, moreover, complicates estimates of dark matter constraints. In this presentation, we address these questions by studying the impact that these different models have on indirect measurements of dark matter decay. I present my predictions for galactic, inverse-Compton, and extragalactic gamma-ray spectra undergoing attenuation by different backgrounds.'

Collaborations

Keywords and Comments
", "

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Branch DM | Dark Matter

Subcategory Theoretical Results

Decaying dark matter in dwarf spheroidal galaxies: Prospects for X-ray and gamma-ray telescopes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 567

Presenter
Fabian Zimmer
Author and Co-Author
Ebo Peerbooms | Fabian Zimmer | Shin'ichiro Ando,

Abstract
'In this work we revise the estimate of dark matter (DM) decay signals from dwarf galaxies in the Milky Way. They are ideal for indirect DM searches, since they are known to be DM dominated systems. We test both warm and cold DM candidates, i.e., sterile neutrinos decaying into X-ray photons and a heavier DM candidate decaying into gamma rays.\r\nWe analyze the sensitivity to such a signal for both ground- and space-based detectors: Athena, XRISM and eROSITA for X-rays and HAWC and CTA for very-high-energy gamma rays. We consider sterile neutrinos with masses between 4-20 keV and masses for the heavier DM candidate in the range of 200 TeV to 20 PeV, decaying via a \$b\\bar{b}\$ or a \$\\tau^+\\tau^-\$ channel.\r\nWe make projections for future dwarf galaxies that would be newly discovered with the Vera Rubin Observatory Legacy Survey of Space and Time, which will further improve the expected sensitivity to DM decays both in the keV and TeV mass ranges. Our results show that all of these X-ray telescopes will be able to critically assess the claim of 7 keV sterile neutrino decays from stacked galaxy clusters and nearby galaxies, reaching sensitivities of \$\\sin^2(2\\theta) \\sim 10^{-12} – 10^{-13}\$.\r\nFor TeV dark matter, both HAWC and CTA will be sensitive to DM lifetime of \$10^{27} - 10^{28}\$ seconds.'

Collaborations

Keywords and Comments
'Sterile Neutrinos; Dwarf Galaxies; Sensitivity Projection; eROSITA; XRISM; ATHENA; HAWC; CTA', ''

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Branch DM | Dark Matter

Subcategory Theoretical Results

Dark matter constraints from measurements of cosmic-ray positrons

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 568

Presenter
Isabelle John
Author and Co-Author
Isabelle John,

Abstract
'Cosmic-ray positron measurements provide a powerful probe of dark matter annihilation. A possible contribution to the measured positron flux could come from dark matter annihilating or decaying into e+e- pairs. In this work, we combine a detailed scan of the cosmic-ray propagation parameter space using Galprop with a new time-, charge- and rigidity-dependent model for solar modulation to present improved constraints on the dark matter mass in the range from 20 to 600 GeV from recently published cosmic-ray positron data. Our models provide particularly strong constraints on dark matter annihilation into leptonic final states, which fall below the thermal cross-section for much of our mass range.'

Collaborations

Keywords and Comments
'', ''

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Branch DM | Dark Matter

Subcategory Theoretical Results

Searching for Dark Matter Neutrino Scattering in the Galactic Centre with IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 569

Presenter
Adam McMullen
Author and Co-Author
Adam McMullen | Aaron Vincent | Carlos Arguelles,

Abstract
'While there is evidence for the existence of dark matter, its properties have yet to be discovered. Simultaneously, the nature of high-energy astrophysical neutrinos detected by IceCube remains unresolved. If dark matter and neutrinos are coupled to each other, they may exhibit a non-zero elastic scattering cross section. Such an interaction between an isotropic extragalactic neutrino flux and dark matter would be concentrated in the Galactic Centre, where the dark matter column density is greatest. This scattering would attenuate the flux of high-energy neutrinos, which could be observed in IceCube. Using the seven-year Medium Energy Starting Events (MESE), we perform an unbinned likelihood analysis, searching for a signal based on four possible DM-neutrino interaction scenarios. We search for a suppression of the high-energy astrophysical neutrino flux in the direction of the Galactic Centre, and compare these constraints to complementary low-energy information from large scale structure surveys and the cosmic microwave background.'

Collaborations
IceCube,

Keywords and Comments
'Dark matter; neutrino; scattering; bayesian analysis; emcee; markov chain monte carlo;', ''

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Branch DM | Dark Matter

Subcategory Theoretical Results

Cosmic-ray combined analyses to shed light in the antiproton excess and its possible dark matter origin

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 570

Presenter
Pedro De la Torre Luque
Author and Co-Author
Pedro De la Torre Luque, Daniele Gaggero | Mario Nicola Mazziotta

Abstract
'Recent cosmic-ray (CR) antiproton studies have claimed the possibility of an excess of data over the predicted flux at around 10 GeV, which can be the signature of dark matter annihilating into antiprotons. Nevertheless, this excess is subject to many uncertainties related to the evaluation of the antiproton spectrum produced from spallation interactions of CRs. \r\n\r\nWe implement a combined Markov chain Monte Carlo analysis of the secondary-to-primary ratios of B, Be and Li and the antiproton-to-proton spectrum (ap/p), also including nuisance parameters to consider the uncertainties related to the spallation cross sections (nuclear uncertainties). This analysis allows us to constrain the Galactic halo size and the rest of propagation parameters, evaluate the impact of the nuclear uncertainties in the determination of the antiproton spectrum and test the excess of antiprotons. We show that our predictions turn out to be compatible with the AMS-02 data, within the uncertainties related to the prediction of the antiproton spectrum from CR collisions. Nevertheless, we find that there is still an excess of ap/p data over our prediction, although this has a slightly different morphology with respect to that previously reported, due to the additional constraints on the diffusion coefficient that we include. Indeed, this leads to a possible signal of a WIMP of mass a factor 2 greater than that usually quoted and a thermal-averaged cross section of 3-10 times greater than previous studies claim.'

Collaborations

Keywords and Comments
'Dark matter indirect search; cosmic-ray antiprotons; cosmic ray diffusion', ''

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Branch DM | Dark Matter

Subcategory Theoretical Results

Classification of targets for gamma-ray dark matter searches with velocity-dependent annihilation and substructure boost

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 40 Dark Matter Indirect Detection and Cosmological Substructures | DM
Presenter Forum Table

Presenter
Martin Stref
Author and Co-Author
Martin Stref | Thomas Lacroix | Judit Pérez-Romero | Miguel Sánchez-Conde | David Maurin | Gaétan Facchinetti | Julien Lavalle,

Abstract
'Gamma-ray searches have long been used to constrain the properties of particle dark matter (DM) candidates. In this context, significant effort has been focused in the past decades on the vanilla weakly interacting massive particle (WIMP) DM scenario in which DM particles annihilate through a velocity-independent (s-wave) process. However, in the absence of clear-cut observational evidence for the simplest candidates, the interest of the community in more complex DM scenarios involving a velocity-dependent cross-section (such as p-wave processes and Sommerfeld enhancement) has been growing steadily over the past few years. \r\nIn this talk I will present the first systematic study of velocity-dependent DM annihilation in a variety of astrophysical objects, not only including the well studied dwarf spheroidal galaxies, but dwarf irregular galaxies and galaxy clusters as well. I will focus more specifically on the interplay between velocity dependence and DM substructures, relying on an analytic model of the DM subhalo boost that self-consistently accounts for dynamical constraints on each target of interest. I will present detailed predictions of the astrophysical factors entering DM-induced gamma-ray fluxes, emphasizing physical dependences and theoretical uncertainties. I will then discuss implications in terms of ranking of the various targets for gamma-ray searches, and consequences for DM models.'

Collaborations

Keywords and Comments
'Indirect searches; gamma-ray searches; dark matter subhalos; Sommerfeld enhancement', ''

Branch DM | Dark Matter

Subcategory Theoretical Results

New cosmic ray MIN-MED-MAX benchmark models for dark matter indirect signatures

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
PIERRE SALATI
Author and Co-Author
PIERRE SALATI, Mathieu Boudaud | Marco CIRELLI | Laurent Derôme | Yoann GÉNOLINI | Julien Lavalle | David Maurin | Pasquale Dario Serpico

Abstract
'Galactic charged cosmic rays, notably positrons, antiprotons and light antinuclei, are powerful probes of dark matter annihilation or decay, in particular for candidates heavier than a few MeV or tiny evaporating primordial black holes. Recent measurements by PAMELA, AMS-02, or Voyager on positrons and antiprotons already translate into constraints on several models over a large mass range. However, these constraints depend on galactic transport models, in particular the diffusive halo size L, subject to theoretical and statistical uncertainties.\r\n\r\nI will first discuss the new constraints which we have set on L as reported in A&A 639 (2020) A74. Using Be/B data on top of the secondary-to-primary ratios Li/C and B/C, we derive an average value of $L=5^{+3}_{-2}$ kpc at $1\\sigma$. These constraints improve by a factor of 2 when low-energy 10Be/9Be data are included.\r\n\r\nUsing these results, we have updated, in a comprehensive analysis soon to be released, the so-called MIN-MED-MAX benchmark transport parameters that yield generic minimal, median, and maximal dark matter produced fluxes. I will discuss how we have defined these benchmark configurations from a selection of models based on the diffusive halo height L and on a specific low-energy transport parameter that depends on the cosmic ray transport scheme. I will illustrate our results with a 100 GeV dark matter species annihilating into bb quark or electron-positron pairs, and present the positron and antiproton fluxes that this particle generates at the Earth. With our revised MIN-MED-MAX sets, the uncertainties on primary fluxes improve by a factor of 3-4 (positrons) and 7 (antiprotons) with respect to their former version.'

Collaborations
, Cosmic Ray Alpine Collaboration (CRAC)

Keywords and Comments
'Galactic transport; dark matter indirect signatures; antimatter cosmic rays; benchmark for indirect signals', ''

Branch DM | Dark Matter

Subcategory Theoretical Results

Testing the stability of heavy dark matter with up-coming radio neutrino telescopes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 571

Presenter
Rasmi Hajjar
Author and Co-Author
Rasmi Hajjar | Stefano Morisi | Damiano Francesco Giuseppe Fiorillo | Ninetta Saviano | Gennaro Miele | Marco Chianese,

Abstract
'In the next decade, ultra-high-energy neutrinos in the EeV-ZeV energy range will be potentially detected by next-generation neutrino telescopes. Although their primary goals are to observe cosmogenic neutrinos and to gain insight into extreme astrophysical environments, they have the great potential of indirectly probing the nature of dark matter. In this talk, we study the projected sensitivity of up-coming radio neutrino telescopes, such as RNO-G, GRAND and IceCube-gen2 radio array, to decaying dark matter scenarios. We investigate different dark matter decaying channels and masses, from 10^{7} to 10^{15} GeV. By assuming the observation of cosmogenic or newborn pulsar neutrinos, we forecast conservative constraints on the lifetime of heavy dark matter particles. We find that these limits are competitive with and highly complementary to previous multi-messenger analyses.'

Collaborations

Keywords and Comments
'Heavy dark matter; UHE neutrinos; neutrino telescopes', ''

Branch DM | Dark Matter

Subcategory Theoretical Results

Dark Matter Searches for heavy Dark Matter with LHAASO

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
Andrea Addazi
Author and Co-Author
Andrea Addazi | Marco Cirelli | Paolo Panci | Pasquale Serpico | Filippo Sala | Nicolao Fornengo | Antonino Marciano | Maxim Khlopov | Dimitry Semikoz | Andreii Neronov | Giuseppe Di Sciascio,

Abstract
'We show how the LHAASO experiment, located in the province of Sichuan (China), can provide a unique opportunity to test new heavy candidates of Particle Dark Matter (DM) beyond the currently explored regimes, namely ~1 PeV and higher. Such scenarios are motivated by several DM models featuring different mechanisms for DM production in the early Universe. In particular, PeV mass DM can decay into Standard Model particles producing Very High Energy (VHE) diffuse gamma rays in the LHAASO sensitivity window. In a multi-messenger approach, LHAASO DM phenomenology can therefore be combined with high-energy neutrinos' signals in order to test the Heavy DM hypothesis.'

Collaborations
other (fill field below),

Keywords and Comments
'Dark matter; LHAASO', ''

Branch DM | Dark Matter

Subcategory Theoretical Results

Dark matter or correlated errors? Systematics of the AMS-02 antiproton excess

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Heisig Jan
Author and Co-Author
Heisig Jan, Michael Korsmeier | MARTIN WINKLER

Abstract
'Several studies have pointed out an excess in the AMS-02 antiproton spectrum at rigidities of 10–20 GV. Its spectral properties were found to be consistent with a dark-matter particle of mass 50–100 GeV which annihilates hadronically at roughly the thermal rate. Here, we reinvestigate the antiproton excess, including all relevant sources of systematic errors. Most importantly, we perform a realistic estimate of the correlations in the AMS-02 systematic error which could potentially “fake” a dark-matter signal. The dominant systematics in the relevant rigidity range originate from uncertainties in the cross sections for absorption of cosmic rays within the detector material. We calculate their correlations within the Glauber-Gribov theory of inelastic scattering. The AMS-02 correlations enter our spectral search for dark matter in the form of covariance matrices. Remarkably, the consideration of all uncertainties eliminates the statistical preference for an additional contribution from dark matter. While these findings cast severe doubts on the robustness of the excess, the situation is not fully conclusive. Correlated uncertainties in the ‘effective acceptance’ and the modeling of the diffusion coefficient at low energies also play an important role.'

Collaborations

Keywords and Comments
'Cosmic rays; dark matter; AMS-02; nuclear cross sections;', ''

Branch DM | Dark Matter

Subcategory Theoretical Results

Testing of Palatini f(R) gravity Power law model in Cosmological Perspectives

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 572

Presenter
Dhruba Jyoti Gogoi
Author and Co-Author
Dhruba Jyoti Gogoi, Umananda Dev Goswami

Abstract
'We study the cosmological expansion history of the f(R) gravity Power law model in Palatini formalism by solving the field equations and expressing Hubble parameter as a function of redshift z. We also used a Markov Chain Monte-Carlo (MCMC) simulation to estimate the best fitting luminosity distance function value for a combination of cosmological parameters viz., matter density distribution and the Hubble uncertainty parameter. We used the Lambda Cold Dark Matter (ΛCDM) model results to constrain the priors of the Power law model. The study constrains the model and we found that the model is consistent with the Observational Supernovae type 1A Data.'

Collaborations

Keywords and Comments
'Lambda Cold Dark Matter; Modified Gravity', ''

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Branch DM | Dark Matter

Subcategory Theoretical Results

Indirect Searches for Secluded Dark Matter

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 41 Indirect Dark Matter Detection Through Photons and Neutrinos | DM
Presenter Forum Table

Presenter
Clarissa Siqueira
Author and Co-Author
Clarissa Siqueira,

Abstract
'Dark matter remains one of the most important open problems in particle physics and cosmology. Weakly interacting massive particles (WIMPs) appear as an appealing solution, providing the right relic density with a cross-section at the electroweak scale, however, no WIMP signals were observed until now. Secluded models are good alternatives to the standard ones. In this case, instead of a direct annihilation to the standard model (SM) particles, the dark matter annihilates into mediators which subsequently decay into SM particles. In this way, we can avoid the stringent limits from direct searches, and, at the same time, secluded models can be probed by indirect detection experiments. Motivated by the appearance of secluded dark matter in several model building endeavors, in this talk, we will present the sensitivity of several gamma-ray instruments (current and prospects), including Fermi-LAT, H.E.S.S., CTA, and SWGO, to secluded dark matter annihilations in the inner galactic halo, and in the dwarf spheroidal galaxies, covering a wide range of possible DM masses, from tens of GeV to hundreds of TeV.'

Collaborations

Keywords and Comments
'Gamma-rays; Secluded Models; galactic center; dwarf galaxies', ''

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Branch DM | Dark Matter

Subcategory Theoretical Results

A detectable antihelium flux from dark matter annihilation

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 573

Presenter
Martin Winkler
Author and Co-Author
Martin Winkler | Tim Linden,

Abstract
'Recent observations by the Alpha Magnetic Spectrometer (AMS-02) have tentatively detected a handful of cosmic-ray antihelium events. Such events have long been considered as smoking-gun evidence for new physics, because astrophysical antihelium production is expected to be negligible. However, the dark-matter-induced antihelium flux is also expected to fall below current sensitivities, particularly in light of existing antiproton constraints. Here, we demonstrate that a previously neglected standard model process -- the production of antihelium through the displaced-vertex decay of bottom-baryons -- can significantly boost the dark matter induced antihelium flux. This process can triple the standard prompt-production of antihelium, and more importantly, entirely dominate the production of the high-energy antihelium nuclei reported by AMS-02.'

Collaborations

Keywords and Comments
'antihelium; cosmic ray; dark matter', 'based on arXiv:2006.16251, accepted for publication in PRL'

Branch GAD | Gamma Ray Direct

Subcategory Experimental Methods & Instrumentation

Development and science perspectives of the POLAR-2 instrument: a large scale GRB polarimeter

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
Nicolas De Angelis
Author and Co-Author
Nicolas De Angelis | For the POLAR-2 Collaboration,

Abstract
'Despite several decades of multi-wavelength and multi-messenger spectral observations, Gamma-Ray Bursts (GRBs) remain one of the big mysteries of modern astrophysics. Polarization measurements are essential to gain a more clear and complete picture of the emission processes at work in these extremely powerful transient events. In this regard, a first generation of dedicated gamma-ray polarimeters, POLAR and GAP, were launched into space in the last decade. After 5 months of operation, the POLAR mission has detected 55 GRBs, among which 14 have been analyzed in detail, reporting a low polarization degree and a temporal evolution of the polarization angle. Starting early 2024 and based on the legacy of the POLAR results, the POLAR-2 instrument will aim to provide a catalog of high quality measurements of the energy and temporal evolution of the GRB polarization thanks to its large and efficient polarimeter. Several spectrometer modules will additionally allow to perform joint spectral and polarization analyzes. The mission is foreseen to detect about 50 good quality GRBs per year on board of the China Space Station (CSS). The technical design of the polarimeter modules will be discussed in detail, as well as the expected scientific performances based on the first results of the developed prototype modules.'

Collaborations
, POLAR-2

Keywords and Comments
'Polarimetry; GRB; Instrumentation; Pulsars; Satellite; POLAR-2; Gamma-ray', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Methods & Instrumentation

The Crystal Eye X and gamma ray detector for space missions

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
Felicia Barbato
Author and Co-Author
Felicia Barbato | Andrea Abba | Antonio Anastasio | Giancarlo Barbarino | Alfonso Boiano | Riccardo de Asmundis | Ivan De Mitri | Luigi Ferrentino | Fabio Garufi | Fausto Guarino | Riccardo Guida | Stefano Papa | Fabrizio Renno | Antonio Vanzanella,

Abstract
'Crystal Eye is a new concept of all sky monitor for the observation of 10keV-30MeV cosmic photons exploiting a new detection technique, which foresees enhanced localization capability with respect to current instruments. This is now possible thanks to the use of new materials and sensors.\r\nThe proposed detection module is designed to be easily installed either on free flyer satellites or onboard space stations. Science goals include Gamma Ray Bursts, electromagnetic counterpart of Gravitational Wave emissions, Active Galactic Nuclei and line emission from supernova explosions observations.\r\nA Crystal Eye pathfinder, made by 4 pixels, has been set up to fly aboard of the Space RIDER, an uncrewed reusable orbital spaceplane aiming to provide the European Space Agency (ESA) with affordable and routine access to space. \r\nThe mission will follow a LEO orbit (400 km, 5.3° of inclination) for two months then it will come back at the base. We here present the Crystal Eye detection method and characteristics and the first characterization of the pathfinder.'

Collaborations

Keywords and Comments
'gamma ray detection; all sky monitor; SiPM; LYSO; Space RIDER.', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Methods & Instrumentation

High Energy Gamma-Ray Emission from the Coma Cluster Region: Deep Morphological and Spectral Studies.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 255

Presenter
Davit Zargaryan
Author and Co-Author
Davit Zargaryan, Vardan Baghmanyan | Felix Aharonian | Sabrina Casanova | Jonathan Mackey | Ruizhi Yang

Abstract
"The Coma Cluster of Galaxies (at z=0.023) is one of the largest gravitationally-bound astrophysical structures in the local Universe (linear size of more than 2 Mpc). Considering the proximity of Coma in addition to the relatively large intracluster density and the high-velocity accretion shocks (estimated speed of 2-3 thousand km/s) that occur within-cluster, it provides a unique environment to search for high energy (HE) gamma-rays. Using 12.3 years of Fermi-LAT Pass 8 data, we analyzed the Coma cluster region between 100 MeV and 1 TeV energies. Here we report the detection of HE gamma-ray emission from the direction of the Coma cluster with significance ~5.6 sigma, which confirms the first detection of gamma-ray emission toward the Coma cluster region (Xi et al. (2018)). The resulting energy flux is \$(1.43\\pm0.31)\\times10^{−12}\$ erg cm\$^{-2}\$ s\$^{-1}\$ with \$\\Gamma=2.53\\pm0.22\$ photon spectral index. To understand the origin of the \$\\gamma\$-ray excess, detailed morphological and spectral studies of the cluster region have been implemented by applying different spatial models based on the residual structures in the 100 MeV-1 GeV and >1 GeV energy bands. Within the Coma cluster's virial radius, two point-like structures have been investigated, at \$\\sim0.34\$ Mpc distance from each other. They were successfully modelled with two similar \$\\Gamma \\sim2.5\$ power-law spectral indexes above 100 MeV with the detection significances of 4.2 \$\\sigma\$ and 3.3 \$\\sigma\$, respectively. Finally, we briefly discuss the origin of the detected gamma-ray emission."

Collaborations

Keywords and Comments
'Gamma Rays from Cluster of Galaxies; Coma Cluster; etc', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Methods & Instrumentation

Performance of the HEPD-02 LYSO calorimeter and expected sensitivity to GRBs detection

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
Stefania Perciballi
Author and Co-Author
Giuseppe Osteria | Francesco Nozzoli | Marco Mese | Valentina Scotti | Roberto Iuppa | Stefania Perciballi,

Abstract
'A High-Energy Particle Detector will be launched on board the CSES-02 satellite with the main purpose of deepening our comprehension of the Earth magnetosphere, investigating the Inner Van Allen belts and contributing to the understanding of sub-GeV cosmic rays.\r\nHEPD-02 is composed of two segmented scintillator layers for the trigger, a silicon pixel tracker and a calorimeter. The detector is surrounded by a plastic scintillator veto, except for the front side. \r\nThe calorimeter is composed of twelve layers of $1.1\\times15\\times15\\,\\text{cm}^3$ plastic scintillator pads and two layers of 3 LYSO bars, as large as $2.5\\times4.9\\times15\\,\\text{cm}^3$, disposed orthogonally to each other. \r\nThanks to its features, HEPD-02 could identify gamma-rays converting in the LYSO crystals by requiring all the other sub-detectors to act as a veto. \r\nIn particular, Gamma Ray Bursts (GRBs) are extremely energetic events generated billions of light years away from the Earth, possibly during neutron star mergers or supernova explosions. HEPD-02 would join the fleet of space detectors continuously monitoring the sky and searching for GRBs, widening the sky coverage and contributing to the knowledge of these phenomena. \r\nWe report the measured radioactive background of a HEPD LYSO crystal due to the decay of $^{176}\\text{Lu}\\,(2.6\\%\\text{ ab.},\\,T_½ = 3.78\\times10^{10}\\,\\text{y})$, then describing a possible triggering scheme for GRBs and the expected sensitivity to GRBs in the $2-20\\,\\text{MeV}$ energy window.'

Collaborations
other (fill field below), CSES-Limadou

Keywords and Comments
'"GRBs; HEPD; LYSO; scintillator; calorimeter; space detector; radioactive background"', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Methods & Instrumentation

High-resolution Imaging Calorimeter based on position-sensitive virtual Frisch-grid CdZnTe detectors for gamma-ray space instruments

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 256

Presenter
Aleksey Bolotnikov
Author and Co-Author
Aleksey Bolotnikov | On behalf of the GECCO collaboration,

Abstract
'We will present a conceptual design for an Imaging Calorimeter for space instruments based on a 3-dimensional position-sensitive virtual Frisch-grid CdZnTe (CZT) detectors. The calorimeter aims to measure photons with energies from 50 keV to 20 MeV with energy resolution of < 1% FWHM at 662 keV, and the photon interaction sites location accuracy of <1 mm in all 3 dimensions. Each detector is a crystal bar with dimensions of 8x8x30 mm3. The bars are arranged in 4x4 modules that can be integrated into a larger array of any shape. The 3D corrections approach solves a long-standing problem of CZT detectors associated with material non-uniformities that hamper their performance and limit their thicknesses. In addition, it allows us to relax the requirements to the quality of the crystals, while maintaining good performance, and reduce the instrument cost. Such imaging calorimeter can be used in space instruments as a standalone Compton telescope, and as focal plane detectors for a Coded Aperture Mask telescope with the superior angular resolution for imaging gamma-ray sources. This calorimeter can provide suitable energy resolution to enable spectroscopic measurements of gamma-ray lines from nuclear decays. We will present the test results for the calorimeter prototype. This imaging calorimeter combined with the Coded Aperture Mask is the heart of the Galactic Explorer with a Coded Aperture Mask Compton Telescope, GECCO, and can also be adopted for All-Sky Medium Energy Gamma-ray Observatory AMEGO.'

Collaborations
, GECCO

Keywords and Comments
'CdZnTe; CZT; position sensitive detectors; gamma rays; Compton telescope; virtual Frisch-grid detectors', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Methods & Instrumentation

Polarization measurements of the Crab Pulsar with POLAR

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems, Microquasars | GAD-GAI
Presenter Forum Table

Presenter
Hancheng Li
Author and Co-Author
Hancheng Li, Nicolas Produit | Merlin Kole | Shuangnan Zhang | Jianchao Sun

Abstract
'POLAR is a dedicated Gamma-Ray Burst polarimeter making use of Compton-scattering which took data from the second Chinese spacelab, the Tiangong-2 from September 2016 to April 2017. It has a wide Field of View of $\\sim6$ steradians and an effective area of $\\sim400\\ cm^2$ at 300 keV. These features make it one of the most sensitive instruments in its energy range (15-500 keV), and therefore capable almost continuously monitoring persistent sources such as pulsars. Significant folded pulsation from both PSR B0531+21 (the Crab Pulsar) and PSR B1509-58 has been observed. Observations of the Crab Pulsar with POLAR have previously been used for: 1). pulsar navigation test to predict orbit information of Tiangong-2; 2). phase-resolved spectroscopy of the Crab Pulsar to calibrate the instrumental responses of POLAR. In this work, we investigate a polarimetric joint-fitting method for observations of the Crab Pulsar with POLAR. Unlike a GRB observation with POLAR, the observations of the Crab Pulsar are complicated by multiple observational datasets during which the polarization plane rotates as well. So before fitting, we have to correct the modulation curves under different datasets, with taking into account the rotations of the Crab Pulsar's relative position in the detctor's local coordinate, and the changes of detector response in different datasets. Despite these difficulties and the low signal to background for such sources constraining, polarization measurements were possible with the POLAR data. We will present the developed methodology, which could be applied to any wide FoV polarimeter, and polarization results of the Crab pulsar with POLAR. Finally, the inferred ability of pulsar detection with POLAR-2 (the successor of POLAR) will also be discussed.'

Collaborations
other (fill field below), POLAR

Keywords and Comments
'POLAR; gamma-ray; neutron star; pulsars; PSR B0531+21 (Crab pulsar); polarimetry', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Methods & Instrumentation

GECCO, the Facets of its Science related to Active Galaxies

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 257

Presenter
Eugenio Bottacini
Author and Co-Author
Eugenio Bottacini | Chris Shrader | Steven Sturner | for the GECCO Collaboration,

Abstract
'Technological breakthroughs in telescope development have always driven discoveries in astronomy. Discoveries are yet to be made in the energy band between a few hundreds keV and a few MeV, which is currently very little explored due to the lack of sensitive enough telescopes. The telescope technology is challenged by the changing nature of the photon-matter interaction used to detect the astrophysical radiation. To address this issue, the Galactic Explorer with a Coded Aperture Mask Compton Telescope (GECCO) features a coded-mask telescope and a Compton telescope. The former allows disentangling sources in crowded regions with its high angular resolution of ~1 arcmin, which is complemented by the latter due to its high sensitivity to the diffuse emission. The ability to differentiate the diffuse and point sources allows for exploring the possible past high-energy activity of our Milky Way galaxy. The study of the activity in other galaxies is also possible only due to the superb, for this challenging energy band, angular resolution. This property of GECCO allows also for the serendipitous detection and identification of rare active galaxies including those at high redshift that hold the key for the assembly of supermassive black holes early in the Universe. In this talk we will review the science with GECCO related to active galaxies.'

Collaborations
other (fill field below), GECCO Collaboration

Keywords and Comments
'AGN science (blazars; Seyferts)', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Methods & Instrumentation

A Fast GRB Source Localization Pipeline for the Advanced Particle-astrophysics Telescope

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Marion Sudvarg
Author and Co-Author
Marion Sudvarg | Jeremy Buhler | James Buckley | Wenlei Chen, Zachary Hughes | Emily Ramey | Michael Cherry | Samer Alnussirat | Ryan Larm | Cristofer Berruz Chungata | For the APT Collaboration

Abstract
"We present a pipeline for fast GRB source localization for the Advanced Particle-astrophysics Telescope. APT records multiple Compton scatterings of incoming photons across 20 CsI detector layers, from which we infer the incident angle of each photon's first scattering to localize its source direction to a circle centered on the vector formed by its first two scatterings. Circles from multiple photons are then intersected to identify their common source direction. Our pipeline, which is designed to run in real-time on low-power hardware, uses an efficient tree search to determine the most likely ordering of scatterings for each photon (which cannot be measured due to the coarse time-scale of detection), followed by likelihood-weighted averaging and iterative least-squares refinement to combine all circles into an estimated source direction. Uncertainties in the scattering locations and energy depositions require that our pipeline be robust to high levels of noise.\r\n\r\nTo test our methods, we reconstructed GRB events produced by a Geant4 simulation of APT's detectors paired with a second simulator that models measurement noise induced by the detector hardware. Our methods proved robust against noise and the effects of pair production, producing sub-degree localization for GRBs with fluence 0.3MeV/cm^2. GRBs with fluence 0.03MeV/cm^2 provided fewer photons for analysis but could still be localized within 4 degrees 68% of the time. Localization time for a 1-second 0.3MeV/cm^2 GRB, measured on a quad-core, 1.4GHz ARMv8 processor (Raspberry Pi 3B+), was consistently under 0.5 seconds — fast enough to permit real-time redirection of other instruments for follow-up observations."

Collaborations

Keywords and Comments
'Multi-messenger astronomy; Gamma-ray bursts; Compton scattering; Source Localization; Reconstruction; Computational methods', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Methods & Instrumentation

A monitor of the Cosmic X-ray Background

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 259

Presenter
Hancheng Li
Author and Co-Author
Hancheng Li, Nicolas Produit | Roland Walter

Abstract
'We propose a monitor that attempts to measure the Cosmic X-ray Background (CXB) in the 10-100 keV energy band with unprecedented precision, so as to: 1). help to understand the source population of CXB, most of which are proposed to be Active Galactic Nuclei (AGNs); 2). study the anisotropy of CXB intensity over the sky, which helps to understand the large-scale structure of the Universe. An obstacle of the above studies is the difficulty of measuring the absolute intensity of the CXB. Detectors working at X-ray bands suffer from time-dependent backgrounds which are hard to be subtracted. Our design is similar to the projected MVN (Monitor Vsego Neba) Russian experiment, which mainly consist of four collimated spectrometers with a rotating aperture shutter on top. In this paper, we will show its detailed performance simulations and some preliminary tests of the prototype, we will also discuss some launch opportunities.'

Collaborations

Keywords and Comments
'Cosmic X-ray Background (CXB); Active Galactic Nuclei (AGNs); absolute intensity; anisotropy; spectrometer', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Methods & Instrumentation

The Advanced Particle-astrophysics Telescope: Simulation of the Instrument Performance

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 260

Presenter
Wenlei Chen
Author and Co-Author
Samer Al Nussirat | Corrado Altomare | Richard Bose | James Buckley | Jeremy Buhler | Eric Burns | Roger Chamberlain | Wenlei Chen | Michael Cherry | Georgia De Nolfo | Leonardo Di Venere | Manel Errando | Stefan Funk | Francesco Giordano | Zachary Hughes,

Abstract
'We will present simulations of the instrument performance of the Advanced Particle-astrophysics Telescope (APT), a mission concept of a $\\gamma$-ray and cosmic-ray observatory in a sun-Earth Lagrange orbit. The key concepts of the APT detector include a multiple-layer tracker composed of scintillating fibers and an imaging calorimeter composed of thin layers of CsI:Na scintillators and wavelength-shifting fibers. The design is aimed at maximizing effective area and field of view for $\\gamma$-ray and cosmic-ray measurements and subject to constraints on instrument cost and total payload mass. We simulate a detector design based on $3m$ scintillating fibers and develop reconstruction algorithms for $\\gamma$-rays from a few hundreds of keV up to a few TeV energies. At the photon energy above $30MeV$, a pair-production reconstruction is applied and the result shows that the APT could provide an order of magnitude improvement in effective area and sensitivity for $\\gamma$-ray detections compared with Fermi-LAT. A multiple-Compton-scattering reconstruction at photon energies below $10MeV$ achieves sensitive detections of faint $\\gamma$-ray bursts (GRBs) and other $\\gamma$-ray transients down to $\\sim0.01MeV/cm^2$ with a sub-degree level of localization error. The sensitivity of the polarization measurement in terms of degree of polarization for $\\sim1MeV/cm^2$ GRBs is below 20%. The multiple ionization-energy-loss measurements with the imaging calorimeter of the APT also makes it a capable detector for ultra-heavy cosmic-ray composition measurements. In addition, we will present the simulation of the instrument performance of the Antarctic Demonstrator for APT, a balloon experiment using a small portion $<1\\%$ of the APT detector.'

Collaborations
other (fill field below), APT (the Advanced Particle-astrophysics Telescope)

Keywords and Comments
'Gamma-ray detection; Multi-messenger astronomy; Gamma-ray burst', 'for the APT Collaboration'

Branch GAD | Gamma Ray Direct

Subcategory Experimental Methods & Instrumentation

Gamma ray study with Machine Learning

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Enrique Gonzalez Galicia
Author and Co-Author
Enrique Gonzalez Galicia, Jorge Cotzomi Palate | Eduardo Moreno Barbosa | Enrique Varela Carlos | Ruben Conde Sánchez | Irving Gabriel Ocampo

Abstract
'We report on preliminary results of the use of machine learning techniques to study high-energy gamma and cosmic rays. This study is implemented by training a neural network using simulated extended air showers (EAS) with different parameters. We use CORSIKA to simulate a large number of extensive air showers, initiated by primary gamma/cosmic rays, on a cluster of CPUs at the National Supercomputing Laboratory of Southeast Mexico (LNS), a primary interest to us, is study gamma-rays, These simulated events are generated due to cosmic rays, our background, that need to be removed from the data. Therefore, a good background rejection algorithm is necessary to detect gamma-rays.'

Collaborations

Keywords and Comments
'gamma-rays; extended air showers; algorithm; neural network', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Methods & Instrumentation

A compact germanium spectrometer for nuclear astrophysics

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
Zachary Hughes
Author and Co-Author
Zachary Hughes | Manel Errando | William Ho,

Abstract
'Emission from electron-positron annihilation at 511 keV was the first extrasolar gamma-ray line ever detected. Despite more than 30 years of theoretical and observational progress, the origin of the positron population has yet to be identified, with potential candidates ranging from microquasars and X-ray binaries to annihilation or decay of dark matter particles.\r\nAt energies between 200 keV and several MeV, where positron annihilation and most other gamma-ray lines of interest are located, the largest source of instrumental background are secondary protons, neutrons, and photons produced by the spacecraft when it is irradiated by cosmic rays in a space environment. This background is the main factor limiting the sensitivity of current gamma-ray spectrometers, and is proportional to the amount of mass around the detectors.\r\nWe present a compact, modular, high-purity Germanium spectrometer that can be integrated into future astrophysics payloads and be the basis of small-satellite missions. A CubeSAT or SmallSAT-class mission based on compact spectrometer modules would have up to 40% of the total spacecraft mass in active germanium crystal, compared to < 0.6% in current missions like INTEGRAL, leading to more than an order-of-magnitude improvement in signal-to-noise ratio due the reduction in overall spacecraft mass.'

Collaborations

Keywords and Comments
'germanium; Instrumentation; annihilation; microquasars; binaries', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Gamma-ray burst precursors as observed by Fermi-GBM

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Paul Coppin
Author and Co-Author
Paul Coppin, Nick van Eijndhoven | Krijn de Vries

Abstract
'Gamma-ray bursts (GRBs) are the most powerful outbursts of electromagnetic radiation in our Universe. A subset of GRBs are accompanied by precursors, dim gamma-ray flashes that precede the main outburst by tens to hundreds of seconds. We present an analysis of 11 years of Fermi-GBM data to identify these precursor flashes. For each of the 2364 analyzed GRBs, a time window of 2000 s centered on the GRB trigger was examined using a Bayesian block method. 217 GRBs (9%) with precursor emission were identified. Our results indicate that long bursts (T90>2 s) are $\\sim$10 times more likely to be preceded by a precursor than short bursts. In addition, we show that the distribution of the quiescent time, separating the precursor and the prompt (main emission) phase, is well modeled by a double Gaussian function. This suggests that at least two physical mechanisms contribute to the observed precursor flashes. One noteworthy GRB with precursor emission in our sample is the ultra-bright GRB 190114C, for which TeV gamma rays were observed by the MAGIC telescope. Our results, including the emission times and light curves of the identified precursors, have been made available via the GRBweb online tool (https://icecube.wisc.edu/~grbweb_public/Precursors.html).'

Collaborations

Keywords and Comments
'GRB; precursor; Fermi; GBM', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Search for new cosmic-ray acceleration sites within the 4FGL catalog sources

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Marianne Lemoine-Goumard
Author and Co-Author
Marianne Lemoine-Goumard | Jean Ballet,

Abstract
'Cosmic rays are mostly composed by protons accelerated to relativistic speeds. When those protons encounter interstellar material, they produce neutral pions which in turn decay into gamma rays. This offers a compelling way to identify the acceleration sites of protons. A characteristic hadronic spectrum was detected in the gamma-ray spectra of four Supernovae Remnants (SNRs), IC 443, W44, W49B and W51C, with the Fermi Large Area Telescope. This detection provided direct evidence that cosmic-ray protons are (re-)accelerated in SNRs. \r\n\r\nIn this review, we present the results from a comprehensive search for low energy spectral breaks. We use 8 years of data from the Fermi Large Area Telescope between 50 MeV and 1 GeV. This search is based on the 4FGL catalog from which we extracted the unidentified sources or those associated to SNRs with a significance above 3sigma at low energy in both cases. Several SNRs, binaries and one star forming region as well as a handful of unidentified sources are detected with our search. \r\nThese best candidates will be presented, thus enlarging our view to potential new cosmic-ray acceleration sites.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'gamma-ray; supernova remnants; Fermi-LAT; cosmic-rays', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

A study of super-luminous stars with the Fermi Large Area Telescope

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Raniere de Menezes
Author and Co-Author
Raniere de Menezes, Elena Orlando | Mattia Di Mauro

Abstract
'The gamma-ray emission from stars is induced by the interaction of cosmic rays with stellar atmospheres and photon fields. This emission is expected to come in two components: a stellar disk emission, where gamma-rays are mainly produced in atmospheric showers generated by hadronic cosmic rays, and an extended halo emission, where the high density of soft photons in the surroundings of stars create a suitable environment for gamma-ray production via inverse Compton (IC) scattering by cosmic ray leptons. Besides the Sun, no other isolated star has ever been detected in gamma-rays. However, by assuming a cosmic ray distribution similar to that observed on Earth, the predicted gamma-ray emission of super-luminous stars, like e.g. Betelgeuse and Rigel, should be high enough to be detected by the Fermi Large Area Telescope (LAT) after its first decade of operations. In this work, we use 12 years of Fermi-LAT observations along with IC models to study 9 luminous nearby stars, both individually and via stacking analysis. Our results show no significant gamma-ray emission from any of the targets, but allow us to derive gamma-ray flux upper limits and to use them to constrain the local density of electrons in different places of the Galaxy.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'', 'on behalf of the Fermi-LAT Collaboration'

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Gamma Rays from Fast Black-Hole Winds

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Chris Karwin
Author and Co-Author
Chris Karwin | Marco Ajello | Rebecca Diesing | Damiano Caprioli,

Abstract
'Massive black holes at the centers of galaxies can launch powerful wide-angle winds, which if sustained over time, can unbind the gas from the stellar bulges of galaxies. These winds, also known as ultra-fast outflows (UFOs), may be responsible for the observed scaling relation between the masses of the central black holes and the velocity dispersions of stars in galactic bulges. Propagating through the galaxy, the wind should interact with the interstellar medium creating a strong shock, similar to those observed in supernovae explosions, which is able to accelerate charged particles to high energies. In this talk I will present the Fermi Large Area Telescope detection of gamma-ray emission from these shocks in a small sample of galaxies exhibiting energetic winds. The detection implies that energetic black-hole winds transfer ~0.04% of their mechanical power to gamma rays and that the gamma-ray emission represents the onset of the wind-host interaction.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'AGN; ultra-fast outflows; AGN feedback;', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Gamma-ray emission from young radio galaxies and quasars

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Giacomo Principe
Author and Co-Author
Giacomo Principe | Leonardo Di Venere | Giulia Migliori | Filippo D'Ammando | Monica Orienti,

Abstract
'According to radiative models, radio galaxies are predicted to produce gamma rays from the earliest stages of their evolution onwards. The study of the high-energy emission from young radio sources is crucial for providing information on the most energetic processes associated with these sources, the actual region responsible for this emission, as well as the structure of the newly born radio jets. \r\nDespite systematic searches for young radio sources at gamma-ray energies, only a handful of detections have been reported so far. Taking advantage of more than 11 years of Fermi-LAT data, we investigate the gamma-ray emission of 162 young radio sources (103 galaxies and 59 quasars), the largest sample of young radio sources used so far for a gamma-ray study. We analyse the Fermi-LAT data of each individual source separately to search for a significant detection. In addition, we perform the first stacking analysis of this class of sources in order to investigate the gamma-ray emission of the young radio sources that are undetected at high energies. \r\nWe report the detection of significant gamma-ray emission from 11 young radio sources, including the discovery of significant gamma-ray emission from the compact radio galaxy PKS 1007+142. \r\nAlthough the stacking analysis of below-threshold young radio sources does not result in a significant detection, it provides stringent upper limits to constrain the gamma-ray emission from these objects.\r\nIn this talk we present the results of our study and we discuss their implications for the predictions of gamma-ray emission from this class of sources.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'AGN; galaxies evolution; gamma-ray origin;', 'on behalf of the Fermi-LAT collaboration'

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Probing Galactic cosmic rays with $gamma$-ray observations of giant molecular clouds

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Giada Peron
Author and Co-Author
Giada Peron, Felix Aharonian | Ruizhi Yang | Sabrina Casanova | Roberta Zanin

Abstract
'High-energy $\\gamma$ rays originating from interactions of cosmic rays (CRs) with the interstellar medium (ISM) carry direct information about the spatial and spectral distribution of these relativistic particles. Observations of Fermi-LAT of the diffuse gas show enhanced emission in the region around 4 kpc from the Galactic center. \r\nAnalyses of the diffuse emission however are performed on a large spatial scale, usually of several kpc^2. Giant Molecular clouds instead are a unique tool, which can be used as ‘barometers’ to infer the cosmic-ray density point by point, in distant and small regions of the Galaxy. Their enhanced density (n$_H$ > 100 cm^{-3}), compared to the diffuse gas, allows us to derive the CR energy density on scales comparable to the size of the clouds (10--100 pc). We report here the results of the analyses of Fermi-LAT Pass8 data, obtained in the direction of molecular clouds located in the entire galactic disk from 0.1 kpc to 12 kpc from the Galactic Center (GC). The CR densities measured at the locations of these clouds have a high degree of fluctuation and are not always compatible with the values derived from the diffuse gas. That can be explained if the cosmic-ray density gradient, inferred from the diffuse gamma-ray emission, is the result of the presence of recently accelerated cosmic-rays.'

Collaborations

Keywords and Comments
'Cosmic Rays; Giant Molecular Clouds; Gamma-rays; Fermi-LAT', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Gamma-ray observations of W44 and its surroundings

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 261

Presenter
Giada Peron
Author and Co-Author
Giada Peron, Felix Aharonian | Sabrina Casanova | Roberta Zanin | Carlo Romoli

Abstract
'We present the analysis of 9.7 years Fermi-LAT data of the middle-aged supernova remnant (SNR) W44 and the massive molecular gas complex that surrounds it. The derived spectral energy distribution of the SNR, derived over three decades is improved, with respect to previous observations, both at low (< 100 MeV) and at higher energies (> 100 GeV) allowing us to strongly constrain the hadronic origin of the emission. We also unveil the presence of two extended $\\gamma$-ray structures located at two opposite edges of the remnant along its major axis. These two sources do not coincide with any peak in the gas distribution, therefore are interpreted as “CR clouds”, namely as regions of enhanced CR density, consisting of particles that escaped collectively from the remnant along the magnetic field.'

Collaborations

Keywords and Comments
'Gamma-rays; Cosmic Rays; Supernova Remnants; Particle acceleration; particle escape.', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Gamma-Ray Polarization Results of the POLAR Mission and Future Prospects

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Merlin Kole
Author and Co-Author
Merlin Kole | For the POLAR and POLAR-2 Collaboration,

Abstract
'Despite over 50 years of observations of Gamma-Ray Bursts (GRBs) many open questions remain about their nature and their environments in which the emission takes place. Polarization measurements of the GRB prompt emission have long been theorized to be able to answer most of these questions. The POLAR detector was a dedicated GRB polarimeter developed by a Swiss, Chinese and Polish collaboration. The instrument was launched, together with the second Chinese Space Lab, the Tiangong-2, in September 2016 after which it took 6 months of scientific data. During this period POLAR detected 55 GRBs as well as several pulsars. From the analysis of the GRB polarization catalog we see that the prompt emission is lowly or fully unpolarized. There is, however, the caveat that within single pulses there are strong hints of an evolving polarization angle which washes out the polarization degree in the time integrated analysis. Although the POLAR results thereby exclude a large portion of the polarization parameter space, to fully probe GRB polarization a significantly more sensitive detector is required. Such a detector, called POLAR-2, was recently approved for launch in 2024 and is currently being developed by a Swiss, Chinese, Polish and German collaboration. Here we will present a full overview of the POLAR mission and all its scientific measurement results. Additionally, we will present a short overview of the follow-up mission: POLAR-2, and how it will answer some of the questions raised by the POLAR results.'

Collaborations
, POLAR & POLAR-2

Keywords and Comments
'Gamma-Ray Burst; Gamma-Ray; Polarization; Analysis; POLAR; POLAR-2', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Star-forming regions as potential contributors to Galactic cosmic rays: the case of NGC 3603

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Lab Saha
Author and Co-Author
Lab Saha, Alberto Domínguez | Luigi Tibaldo | Marco Ajello | Marianne Lemoine-Goumard | on behalf of the Fermi-LAT collaboration

Abstract
'The identification of the sources contributing to the acceleration of Galactic Cosmic Rays (CRs) is a long-standing puzzle. Star-forming regions (SFRs) may be one of these potential contributors, in fact, the detection of gamma rays from the Cygnus Cocoon indicates the existence of freshly accelerated high-energy particles in the region, making it the first case of a firm detection of CR acceleration in SFRs. However, the limited number of such gamma-ray detections are preventing any conclusion about the prevalence of SFRs as CR sources. In this talk, we present a detailed morphological and spectral study of the unidentified source 4FGL J1115.1–6118 using about ten years of data above 10 GeV taken with Fermi-LAT. This source is positionally coincident with the young massive stellar cluster NGC 3603, and represents one of the few cases already studied in gamma rays. We will also present perspectives for a systematic search of gamma-ray emitting SFRs. These are the first steps towards potentially establishing these types of sources as fundamental CR emitters.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'Gamma-rays; Star forming Regions; Galactic cosmic rays; Non-thermal radiation sources; Young massive clusters; Star clusters; Gamma-ray sources;', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Gamma-ray heartbeat powered by the microquasar SS 433

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems, Microquasars | GAD-GAI
Presenter Forum Table

Presenter
Jian Li
Author and Co-Author
Jian Li, Diego Torres | Ruo-Yu Liu | Matthew Kerr | Emma de Oña Wilhelmi | Yang Su

Abstract
'Microquasars, the local siblings of extragalactic quasars, are binary systems comprising a compact object and a companion star. By accreting matter from their companions, microquasars launch powerful winds and jets, influencing the interstellar environment around them. Steady gamma-ray emission is expected to rise from their central objects, or from interactions between their outflows and the surrounding medium. The latter prediction was recently confirmed with the detection at the highest (TeV) energies of SS 433, one of the most interesting microquasars known. We analyzed more than ten years of GeV gamma-ray data on SS 433. Detailed scrutiny of the data reveal emission associated with a terminal lobe of one of the jets and with another position in the SS 433 vicinity, co-spatial with a gas enhancement. Both gamma-ray sources are relatively far from the central binary, and the latter shows evidence for a periodic variation at the precessional period of SS 433, linking it with the microquasar. This result challenges obvious interpretations and is unexpected from any previously published theoretical models. It provides us with a chance to unveil the particle transport from SS 433 and to probe the structure of the local magnetic field in its vicinity.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'microquasar; SS 433; Gamma ray', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Search of Gamma Ray Burst detected by GBM alike to GRB170817A

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Rodrigo Sacahui
Author and Co-Author
Rodrigo Sacahui | Maria Magdalena Gonzalez | Nissim Fraija | Yunior Perez,

Abstract
'Since the detection of Gravitational Waves (GW), a new window of multi-messenger astronomy was opened. The first GW event with an electromagnetic counterpart was GRB 170817A, an under luminous burst with properties of a short burst that was detected by Fermi-GBM, among other observatories. This burst revealed two different spectral components in the GBM energy range, a short-lasting non-thermal pulse at early times followed by a soft thermal component. Previous studies have identified similar bursts based on these spectral and temporal features similar to GRB 170817A. In this work, we extend the search for short bursts alike GRB170817A in the northern sky detected from 2018 to 2020. The initial search based on temporal restrictions gave 56 possible candidates. From these, only two bursts were consistent with the spectral behavior. Here we report their spectral features, and based on the synchrotron-self Compton forward-shock model, we discuss the possible theoretical implications for these two bursts.'

Collaborations

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Low-energy gamma-ray observations above 1 GeV with CALET on the International Space Station

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 262

Presenter
Nicholas Cannady
Author and Co-Author
Nicholas Cannady | for the CALET Collaboration,

Abstract
'The CALorimetric Electron Telescope (CALET) was launched in August 2015 and installed on the International Space Station (ISS) Japanese Experiment Module Exposed Facility. Alongside the primary science targets of GeV—TeV energy cosmic-ray electrons and cosmic-ray hadrons up to PeV energies, CALET is sensitive to gamma rays from 1 GeV up to 1+ TeV, limited by statistics. Access to energies below 10 GeV is enabled by a dedicated low-energy gamma (LE-γ) trigger which is active only at low geomagnetic latitudes. In this work we review the analysis of gamma-ray events collected with this trigger including the mitigation of a secondary photon background from cosmic-ray interactions with ISS structures in the CALET field-of-view, the observation of persistent galactic and extragalactic sources, and the detection of emission from the quiescent Sun.'

Collaborations
CALET,

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Magnetar giant flare in NGC 253 seen by Fermi-GBM

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Elisabetta Bissaldi
Author and Co-Author
Elisabetta Bissaldi | Oliver Roberts | Peter Veres | Matthew Baring | Michael S. Briggs | Chryssa Kouveliotou | George Younes | Sarah Chastain | James J. DeLaunay | Daniela Huppenkothen | Aaron Tohuvavohu | P. N. Bhat | Ersin Göğüş | Alexander J. van der,

Abstract
"Magnetar giant flares (MGFs) are enormous eruptions likely triggered by surface disruptions in magnetars, neutron stars with the strongest-known magnetic fields. Such events can be detected in both X- and gamma-ray bands, but are very rare. Almost 30 magnetars have been cataloged in our Galaxy, exhibiting occasional X-ray activity, but only two have produced giant flares to date. The most recent one, emitted by SGR 1806-20 in 2004, showed an initial very short and bright main spike, causing the saturation of the observing instruments and thus precluding reliable flux measurements.\r\n\r\nHere we report the observation and analysis of GRB 200415A, a very short and bright Gamma-Ray Burst detected by the Fermi Gamma-Ray Burst Monitor (GBM) as well as by several other instruments participating in the InterPlanetary Network (IPN) system, which located it in a region spatially coincident with the nearby galaxy NGC 253. Analysis of the event revealed peculiar spectral and temporal properties, which are not typically seen in GRBs: a very short rise time of the initial hard spike, strong submillisecond variability, a flat spectrum, and an unusually low isotropic energy release. A mild hint of periodicity in the event's tail was also detected. Therefore we concluded that GRB 200415A is not a classical short GRB due to the merger of two binary neutron stars, but rather a MGF produced by an extragalactic magnetar."

Collaborations
Ferrmi-GBM,

Keywords and Comments
'Gamma-Ray Bursts; Magnetars; Gamma-rays;', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Exploring the variability properties of gamma-ray emission from blazars

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 263

Presenter
Gopal Bhatta
Author and Co-Author
Gopal Bhatta,

Abstract
'I present the results of variability study of a sample of 20 powerful blazars using Fermi/LAT (0.1-300 GeV) observations. We studied decade-long observations applying various analysis tools such as flux distribution, symmetry analysis, and RMS-flux relation. It was found that the γ-ray flux distribution closely resembles a log-normal probability distribution function and can be characterized by linear RMS-flux relation. The power spectral density analysis shows the statistical variability properties of the sources as studied are consistent with flicker noise, an indication of long-memory processes at work. Statistical analysis of the distribution of flux rise and decay rates in the light curves of the sources, aimed at distinguishing between particle acceleration and energy-dissipation timescales, counterintuitively suggests that both kinds of rates follow a similar distribution and the derived mean variability timescales are on the order of a few weeks. The corresponding emission region size is used to constrain the location of γ-ray production sites in the sources to be a few parsecs. Additionally, using Lomb-Scargle periodogram and weighted wavelet z-transform methods and extensive Monte Carlo simulations, we detected year-timescale quasi-periodic oscillations in the sources S5 0716+714, Mrk 421, ON +325, PKS 1424-418, and PKS 2155-304. We also performed recurrence quantification analysis of the sources and directly measure the deterministic quantities, which suggest that the dynamical processes in blazars could be a combination of deterministic and stochastic processes, while some of the source light curves revealed significant deterministic content.'

Collaborations

Keywords and Comments
'AGN; blazars; gamma-ray emission; relativistic jets; non-thermal emission; particle acceleration; time series analysis', ''

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Subcategory Experimental Results

The gamma-ray Moon seen by the Fermi LAT over a full solar cycle

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 264

Presenter
Salvatore De Gaetano
Author and Co-Author
Salvatore De Gaetano, Francesco Loparco | Mario Nicola Mazziotta | Nicola Giglietto

Abstract
'The Moon is among the brightest gamma-ray sources in the sky. We have reconstructed its gamma-ray spectrum in the energy range from 30 MeV up to a few GeV using the data collected by the Fermi Large Area Telescope during its first 13 years of operation since its launch in 2008, a period covering the duration of a whole solar cycle. We have also studied the evolution of the lunar gamma-ray emission by measuring the spectra in 6 months time intervals. The data show a strong correlation with the solar activity. Gamma rays produced on the lunar surface are in fact originated in the interactions of cosmic rays (mainly proton and helium), whose fluxes are affected by solar modulation. We have also developed a model based on the FLUKA simulation code to evaluate the yields of photons produced by cosmic-ray protons and helium nuclei impinging on the Moon. We have then folded the gamma-ray yields obtained from the model with the primary proton and helium spectra measured by the AMS-02 and PAMELA experiments in different time intervals and we have compared the simulation results with the experimental data, showing that the simulation reproduces correctly the time evolution of the lunar gamma-ray flux.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Investigating gamma-ray emission of the Cygnus cocoon with 12 years of Fermi-LAT data

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Xan Astiasarain
Author and Co-Author
Xan Astiasarain, Luigi Tibaldo | Pierrick Martin | Jürgen Knödlseder

Abstract
'Massive star-forming regions are genuine reservoirs of energy and potential sources of non-thermal particles, but their role in Galactic cosmic-ray acceleration and propagation is still poorly understood. Gamma-ray observations of the Cygnus X star-forming region revealed the presence of a cocoon of freshly-accelerated cosmic rays, making it one of the best examples to investigate these issues. However, the exact acceleration sites and mechanisms, the nature of the particles, and how they propagate through the cocoon have not been firmly established yet, and the contribution from other gamma-ray sources in this crowded region remains uncertain. We will present a new in-depth analysis of more than 12 years of observations from the Fermi Large Area Telescope combined with high-resolution interstellar medium tracer data to improve the understanding of gamma-ray emission from the Cygnus region. The evolution of the cocoon morphology as a function of energy and its spectrum up to 1 TeV will be used to shed new light on the open questions about the physical processes shaping the young cosmic-ray population in Cygnus X.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'Gamma-ray analysis; interstellar emission model; Cygnus; OB association; acceleration of cosmic rays; propagation of cosmic rays', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Study of the gamma-ray state changes of PSR J2021+4026 with Fermi-LAT

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems, Microquasars | GAD-GAI
Presenter Forum Table

Presenter
Alessio Fiori
Author and Co-Author
Alessio Fiori, Massimiliano Razzano | Pablo Miguel Saz Parkinson | Roberto Mignani

Abstract
'The peculiar radio-quiet PSR J2021+4026, in the Gamma Cygni supernova remnant, is one of the brightest of the >250 pulsars detected by *Fermi*-LAT. It is unique in being the only known isolated gamma-ray pulsar to undergo abrupt flux changes simultaneous with spin-down variations. The first change was observed by *Fermi*-LAT in October 2011, and it was followed by a recovery over a timescale of ~100 days around December 2014. A second change occurred in February 2018. In the last few years, PSR J2021+4026 has been widely studied at different wavelengths. We report our latest results on this source, based on a *Fermi*-LAT analysis of its gamma-ray variability. In particular, we have studied the changes in the spectral and timing parameters on different timescales. Our results are essential to relate the observed events to changes in the geometry of the particle acceleration regions in the pulsar magnetosphere. Therefore, this study will allow us to enhance our knowledge of this source and its behavior.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'gamma rays: stars; pulsars: individual: PSR J2021+4026; stars: neutron', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Bridging the Gap - The first sensitive 20-200 MeV catalog

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
Lea Marcotulli
Author and Co-Author
Lea Marcotulli, Chris Karwin | Marco Ajello | Yong Sheng

Abstract
'The under-explored MeV band has an extremely rich scientific potential. Awaiting an all-sky MeV mission, it is now the prime time to take full advantage of the capabilities of the Fermi Large Area Telescope to explore this regime. With more than 12 years of the best available dataset (Pass8), we have developed an all-sky analysis to build a sensitive catalog of sources from 20 to 200 MeV. This work will allow us to cover the SED peak of most gamma-ray sources, fundamental to understand their nature, and possibly discover a whole new population of MeV ones. Importantly, this program will start bridging the gap between the MeV and GeV energy bands, strongly supporting the scientific case for a future all-sky MeV mission and enhancing the legacy of the Fermi mission. In this talk I will present the preliminary results of this analysis, highlighting the scientific potential of this project. I will also discuss the difference with respect to the first catalog of low-energy sources (1FLE, Principe et al. 2018).'

Collaborations
Ferrmi-LAT,

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Study of Al-26 in the COSI 2016 Superpressure Balloon Flight

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 265

Presenter
Jacqueline Beechert
Author and Co-Author
Jacqueline Beechert, For the COSI collaboration

Abstract
"The Compton Spectrometer and Imager (COSI) is a balloon-borne compact Compton telescope (CCT) designed to survey the gamma-ray sky in 0.2-5 MeV. COSI's wide field of view, excellent energy resolution from cross-strip high-purity germanium semiconductor detectors, and improved angular resolution make it uniquely capable to probe this under-explored energy regime and make contributions to understanding of stellar nucleosynthesis, particularly through studies of diffuse emission from radioisotope Al-26 at 1.809 MeV. In 2016, COSI was launched from Wanaka, New Zealand on a NASA Superpressure balloon and flew for 46-days. The flight was a technologic and scientific success, boasting live detection and polarization studies of GRB160530A, imaging of the Crab Nebula and the 511-keV positron annihilation emission at the Galactic Center, and detection of Cyg-X1. This presentation details a new maximum-likelihood search for the 1.809 MeV signature of Galactic Al-26 in the 2016 data. The analysis reveals promising signs of an Al-26 signature, and further exploration is currently underway to solidify a measurement. Hence, this work demonstrates COSI's ability to reveal critical astrophysical nuclear lines and the powerful capabilities of CCTs like COSI on a balloon platform."

Collaborations
other (fill field below), Compton Spectrometer and Imager (COSI)

Keywords and Comments
'Al-26; nucleosynthesis; gamma-ray detector; Compton telescope; COSI; balloon; diffuse emission; spectroscopy', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Probing the hadronic nature of the gamma-ray emission associated with Westerlund 2

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Emma Maria de Ona Wilhelmi
Author and Co-Author
Enrique Mestre | Tim Holch | Ullrich Schwanke | Diego Torres | Pablo Miguel Saz Parkinson | Emma Maria de Ona Wilhelmi | Felix Aharonian | Ruizhi Yang | Roberta Zanin,

Abstract
'Star-forming regions have been proposed as potential Galactic cosmic ray accelerators for decades. Cosmic ray acceleration can be probed through observations of gamma-rays produced in inelastic proton-proton collisions, at GeV and TeV energies. We analyze more than 11 years of Fermi-LAT data from the direction of Westerlund 2, one of the most massive and best-studied star-forming regions in our Galaxy. The spectral and morphology characteristics of the LAT source agree with the ones in the TeV regime (HESS J1023-575), allowing the description of the gamma-ray source from a few hundreds of MeV to a few tens of TeVs. We will present the results and discuss the implications of the identification with the stellar cluster and radiation mechanism involved.'

Collaborations

Keywords and Comments
'Stellar Clusters; Fermi LAT; Westerlund 2; Cosmic rays; gamma-rays', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Constraints on the antistar fraction in the Solar System neighborhood from the 10-years Fermi Large Area Telescope gamma-ray source catalog

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 266

Presenter
Simon Dupourqué
Author and Co-Author
Simon Dupourqué | Luigi Tibaldo | Peter von Ballmoos,

Abstract
'It is generally taken for granted that the observable Universe does not contain anti-matter objects or domains. Recently, the possible detection of anti-helium nuclei in cosmic rays by AMS-02 challenged this idea and reopened the debate on the existence of nearby reservoirs of antimatter, most plausibly in antistars. As antimatter domains surrounded by normal matter would produce a gamma-ray signal from baryon-antibaryon annihilation, we use the 10-years *Fermi* Large Area Telescope (LAT) gamma-ray source catalog to set constraints on the abundance of antistars in our local Galactic environment. We identify 14 antistar candidates not associated with any object belonging to established gamma-ray source classes and featuring spectra compatible with baryon-antibaryon annihilation. We evaluate the sensitivity of the LAT to antistars and set upper limits on the local antistar fraction with respect to normal stars using both a parametric and a Monte Carlo method. For antistars with properties similar to those of disk-population stars we derive constraints that are 20 times stronger than those previously available. For a primordial population of antistars in the Galactic halo, gamma-ray data combined with microlensing observations constrain the density of antistars to lower than O(10^{-5} pc$^{−3}$) to O($10^{−2}$ pc$^{−3}$) depending on their masses. Our limits can constrain models for the origin and propagation of anti-nuclei in cosmic rays.'

Collaborations

Keywords and Comments
'Antistar; Monte Carlo; Antimatter; Unassociated Sources', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

GeV-radio correlation in Markarian 421

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 267

Presenter
Sliusar Vitalii
Author and Co-Author
Sliusar Vitalii | Roland Walter | Matteo Balbo,

Abstract
'Markarian 421 is a high-synchrotron-peaked blazar showing relentless variability across the electromagnetic spectrum from radio to gamma-rays. We use 5 years of radio and GeV observations to study the correlation and connected variability in radio and GeV bands. Radio data was obtained in a 15GHz band by the OVRO 40-m radio telescope and GeV data is from Fermi Large Area Telescope. To determine the location of the gamma-ray emission regions in Mrk 421 we correlate GeV and radio light curves. We found that GeV light curve varies independently and accurately leads the variations observed in radio. Using a fast-rise-slow-decay profile derived for shock propagation within a conical jet, we manage to reproduce the radio light curve from GeV variations. The profile rise time is comparable with the Fermi-LAT binning, the decay time is about 7.6 days. The best-fit value for the response profile also features a 44 days delay between the GeV and radio, which is compatible with the wide lag range obtained from the correlation. Such a delay corresponds to 10^17 cm/c, which is comparable with the apparent light crossing time of the Mrk 421 radio core. Generally, the observed variability matches the predictions of the leptonic models and suggests that the physical conditions vary in the jet. The emitting region is moving downstream the jet while the environment becomes first transparent to gamma rays and later to the radio.'

Collaborations

Keywords and Comments
'AGN; Mrk 421; blazar; gamma-rays; radio', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Signatures of Recent Cosmic-Ray Acceleration in the High-Latitude gamma-Ray Sky

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Gudlaugur Johannesson
Author and Co-Author
Gudlaugur Johannesson | Troy Porter,

Abstract
"Cosmic-ray (CR) sources temporarily enhance the relativistic particle density in their vicinity over the background distribution accumulated by the past injection activity and propagation. If individual sources are close enough to the solar system, their localised enhancements may present as features in the measured spectra of the CRs and in the associated secondary electromagnetic emissions. The observation of large scale loop like structures in the radio sky is possible evidence of such nearby CR sources. If so, these loops should also be most visible in the high-latitude gamma-ray sky. Using ~10 years of data from the Fermi Large Area Telescope, applying Bayesian analysis including Gaussian Processes, we search for extended enhanced emission associated with putative nearby CR sources in the energy range from 1 GeV to 1 TeV for the sky region |b| > 30 deg. We carefully control the systematic uncertainty due to imperfect knowledge of the interstellar gas distribution. Radio Loop IV is identified for the first time as a gamma-ray emitter and we also find significant emission from Loop I. Strong evidence is found for asymmetric features toward the Galactic centre that may be associated with parts of the so-called ``Fermi Bubbles'', and some evidence is also found for gamma-ray emission from other radio loops. Implications for the CRs producing the features and possible locations of the sources of the emissions are discussed."

Collaborations
Ferrmi-LAT,

Keywords and Comments
'Cosmic rays; gamma rays; cosmic ray sources;', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Cosmic-ray variations in the solar neighbourhood

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Isabelle Grenier
Author and Co-Author
Isabelle Grenier | François Reda Kamal Youssef | Mario Nicola Mazziotta,

Abstract
'The gamma radiation produced in cosmic-ray and gas interactions has been used to probe the cosmic-ray spectrum in several clouds to distances of a few hundred parsecs around the Sun. Early measurements made with Fermi LAT data were found in good agreement with the proton and alpha cosmic-ray spectra measured in the Solar System, given the 10-15% uncertainty in target gas mass that is inherent to HI line observations (Casandjian 2015, Grenier et al. 2015). The local cosmic-ray uniformity was later questioned (Orlando 2018), then challenged by the finding of a 34% loss of cosmic rays in the nearby Eridu cirrus (Joubaud et al. 2020). \r\nWe have revisited the gamma-ray emissivity spectrum one would expect per gas nucleon from hadronic and bremsstrahlung emission using the latest cosmic-ray spectra inferred at the Sun (outside the heliosphere) from the existing data on different nuclear species and leptons. We have also used improved cross sections for photon production in nucleus-nucleus interactions.\r\nWe will discuss how the local variations in cosmic-ray flux, of order $\\pm$30%, relate in 3D to the contrasted gas distribution and gross magnetic-field configuration of the local interstellar valley.'

Collaborations

Keywords and Comments
'cosmic rays; gamma rays; local interstellar medium; propagation', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Evidence for inverse Compton emission from globular clusters

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems, Microquasars | GAD-GAI
Presenter Forum Table

Presenter
Deheng Song
Author and Co-Author
Deheng Song, Oscar Macias | Shunsaku Horiuchi | Roland Crocker | David Nataf

Abstract
'Millisecond pulsars are very likely the main source of gamma ray emission from globular clusters. However, the relative contributions of two separate emission processes-curvature radiation from millisecond pulsar magnetospheres vs. inverse Compton emission from relativistic pairs launched into the globular cluster environment by millisecond pulsars-has long been unclear. In this talk, I will present the result for searching inverse Compton emission in 8-year ${\\it Fermi}$-LAT data from the directions of 157 Milky Way globular clusters. We find a mildly statistically significant (3.8$\\sigma$) correlation between the measured globular cluster gamma-ray luminosities and their photon field energy densities. However, this may also be explained by a hidden correlation between the photon field densities and the stellar encounter rates of globular clusters. Analyzed ${\\it in\\ toto}$, we demonstrate that the gamma-ray emission of globular clusters can be resolved spectrally into two components: i) an exponentially cut-off power law and ii) a pure power law. The latter component-which we uncover at a significance of 8.2$\\sigma$-is most naturally interpreted as inverse Compton emission by cosmic-ray electrons and positrons injected by millisecond pulsars. We find the luminosity of this inverse Compton component is comparable to, or slightly smaller than, the luminosity of the curved component, suggesting the fraction of millisecond pulsar spin-down luminosity into relativistic leptons is similar to the fraction of the spin-down luminosity into prompt magnetospheric radiation.'

Collaborations

Keywords and Comments
'Globular clusters; Millisecond pulsars; Gamma ray; inverse Compton', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Joint Analysis of Fermi-LAT and HAWC Observations of SS 433/W50

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems,
Microquasars | GAD-GAI
Presenter Forum Table

Presenter
Ke Fang
Author and Co-Author
Ke Fang,

Abstract
'The extended jets of the microquasar SS 433 have been observed in radio, optical, X-ray, and recently very-high-energy gamma-ray by HAWC. The multi-wavelength detections motivate searches for high-energy gamma-ray counterparts in the Fermi-LAT data in the 100 MeV– 300 GeV band. We report on the first-ever joint analysis of Fermi-LAT and HAWC observations to study the spectrum and location of gamma-ray emission from a source inside a region-of-interest. Our analysis finds common emission sites of GeV-to-TeV gamma-rays inside the eastern and western lobes of SS 433. The observation suggests that the gamma rays from the eastern lobe is consistent with inverse-Compton emission by an electron population that is accelerated by jets. To explain both the GeV and TeV flux, the electrons need to have a soft intrinsic energy spectrum, or undergo a quick cooling process due to synchrotron radiation in a magnetized environment.'

Collaborations
Ferrmi-LAT, HAWC

Keywords and Comments
'black hole jets; joint analysis of gamma-ray data from multiple experiments', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

High-energy gamma-ray observations above 10 GeV with CALET on the International Space Station

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 268

Presenter
Masaki Mori
Author and Co-Author
Masaki Mori | for the CALET Collaboration,

Abstract
"Since the deployment of the CALorimetric Electron Telescope (CALET) on the exposure facility of the Japanese Experiment Module (JEM) 'Kibo' of the International Space Station in 2015, CALET is accumulating cosmic ray data steadily without any serious faults up to now. Although CALET is basically a high-energy cosmic-ray detector, its composite and thick detector structure allow us to separate gamma rays from charged cosmic rays clearly up the TeV energy region.\r\nIn this paper, analysis of gamma-ray events above 10 GeV obtained by the `high-energy' triggers, which is the basic trigger mode of CALET for cosmic-ray observations and is always effective regardless of the ISS position in orbit, are reported. Especially, good energy resolution (less than 3% at 10 GeV) of CALET enables us to search for spectral features in the gamma-ray energy spectrum such as lines possibly caused by annihilation of dark matter particles and preliminary studies will be presented. Lower energy gamma-ray observations and transient events are reported separately."

Collaborations
CALET,

Keywords and Comments
'CALET; International Space Station; gamma rays', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

A model-driven search for extreme BL Lacs among Fermi-LAT blazar candidates.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 269

Presenter
Mireia Nievas Rosillo
Author and Co-Author
Mireia Nievas Rosillo, Graziano Chiaro | Alberto Domínguez | Giovanni La Mura

Abstract
'The emission of very-high-energy photons (VHE, E>100 GeV) in active galactic nuclei (AGN) is closely connected with the production of ultra-relativistic particles. Among AGN, the subclass of extreme BL Lacertae are of particular interest because they challenge state-of-art models on how these cosmic particle accelerators operate. By cross-matching two gamma-ray catalogs (this is, 4FGL-DR2 and 2BIGB), we identified 23 high-synchrotron-peaked (HSP) blazar candidates with photometric or spectroscopic redshifts, good multi-wavelength coverage, that are possibly detectable by VHE instruments. We performed a new analysis of Fermi Large Area Telescope data including the effects of attenuation from the extragalactic background light and complemented these results by collecting multiwavelength data from optical, radio and X-ray archival observations. Their broadband spectral energy distributions were interpreted in terms of synchrotron-self-Compton models with external-Compton components and compared with the properties of prototypical extreme HSP blazars. Finally, we test their detectability with imaging atmospheric Cherenkov telescopes (IACTs) and propose a new method for selecting these extreme targets for these ground-based telescopes.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'extreme blazars; emission models; jets; agn', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

X-ray binaries with the Fermi Large Area Telescope: a large scale survey in time and space.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 270

Presenter
Max Harvey
Author and Co-Author
Max Harvey | Paula M. Chadwick | Cameron B. Rulten,

Abstract
'X-ray binaries present a particularly interesting class of gamma-ray emitter, with most emitting no detectable gamma-rays at all, and those that are detected falling into two distinct morphological classes: microquasars and gamma-ray binaries. Given the highly variable, and often faint, nature of these systems discovering them represents a unique challenge to the gamma-ray astronomy community, and a one size fits all approach fails to work for the majority of these systems. \r\nWe use 12.5 years of P8R3 Fermi-LAT observations, in addition to (when available) complementary AAVSO optical data and Swift-BAT X-ray data, to a detailed survey at the positions of approximately 300 X-ray binary systems. Spectral and variability analysis are carried out on a range of potential gamma-ray sources which are found to be coincident with the positions of the survey population.\r\nWe present initial results from our forthcoming works on this topic, and discuss the next steps to verifying whether any of these 300 systems can be confirmed as gamma-ray emitters.\r\nWe also discuss the challenges associated with a large data-driven project such as this, including statistical practices to avoid data dredging, and accounting for phenomena such as the Look-Elsewhere effect.'

Collaborations

Keywords and Comments
'X-ray binaries; gamma-rays; survey; Fermi-LAT', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

The new release of the fourth Fermi LAT source catalog

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
Benoit Lott
Author and Co-Author
Benoit Lott, for the Fermi-LAT collaboration | Jean Ballet | Toby Burnett | Philippe Bruel

Abstract
'The third release of the Fourth Catalog of Fermi-LAT Sources (4FGL-DR3), based on 12 years of data between 50 MeV and 1 TeV, is presented. Improvements in the analysis method relative to the original 4FGL catalog and new features are reviewed. The 4FGL-DR3 includes about 750 more sources than the previous release (4FGL-DR2, obtained with 10 years of data) and about 1500 more sources than 4FGL. About 40% of the new sources are associated with counterparts at other wavelengths, which are mostly blazar candidates. The properties of the global set of unassociated sources reported in the catalog are discussed, with particular attention to those lying close to the Galactic plane. A population of unassociated sources that do not fit in with already known classes of gamma-ray emitters is emphasized.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'Catalog; gamma-ray sources:', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Revealing G150.3+4.5 as a dynamically young supernova remnant with gamma-ray data

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Justine Devin
Author and Co-Author
Justine Devin | Marianne Lemoine-Goumard | Marie-Hélène Grondin | Daniel Castro | Jean Ballet | John Hewitt | Jamie Cohen,

Abstract
'Supernova remnants (SNRs) are considered one of the best candidates to accelerate the bulk of Galactic cosmic rays. Studying gamma-ray emission from young SNRs allows us to understand the nature of accelerated particles and the maximum energy they can reach. The SNR G150.3+4.5 was recently detected in radio and exhibits a shell-like morphology with an angular size of 3°, suggesting either an old or a nearby SNR. We present a spectro-morphological analysis of G150.3+4.5 with Fermi-LAT data that reveals emission up to hundreds of GeV. Using radio and X-ray data, we estimate the distance and the surrounding density of the SNR to understand its evolutionary stage. We find that G150.3+4.5 is spectrally similar to the young shell-type SNRs observed with the Fermi-LAT such as RX J1713.7-3946 or Vela Junior. The broadband nonthermal emission of G150.3+4.5 is explained by a leptonic scenario that implies particle acceleration at least up to TeV energies, making G150.3+4.5 a new dynamically young SNR.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'supernova remnant; gamma rays', 'on behalf of the Fermi-LAT collaboration'

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Hunting the gamma-ray emission from Fast Radio Burst with Fermi-LAT

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Giacomo Principe
Author and Co-Author
Giacomo Principe | Leonardo Di Venere | Francesco Longo | Nicola Omodei | NIcolò Di Lalla,

Abstract
'Fast radio bursts (FRBs) are one of the most exciting new mysteries of astrophysics. Their origin is still unknown, but recent observations seems to link them to Soft Gamma Repeaters and, in particular, to magnetar giant flares (MGFs). The recent detection of a MGF at GeV energies by the Fermi Large Area Telescope (LAT) motivated the search for GeV counterparts to the >100 currently known FRBs. \r\nTaking advantage of more than 12 years of Fermi-LAT data, we perform a search for gamma-ray emission from all the reported repeating and non-repeating FRBs. We analyze on different-time scales the Fermi-LAT data of each individual source separately, including a cumulative analysis on the repeating ones. In addition, we perform the first stacking analysis at GeV energies of this class of sources in order to constrain the gamma-ray properties of the FRBs that are undetected at high energies. The stacking analysis is a powerful method that allow a possible detection from below-threshold FRBs providing important information on these objects. In this talk we present the preliminary results of our study and we discuss their implications for the predictions of gamma-ray emission from this class of sources.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'FRB - magnetars - gamma-rays - Fermi-LAT', 'on behalf of the Fermi-LAT collaboration'

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

On the origin of the gamma-ray emission toward HESS J1813-178 with Fermi-LAT

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 271

Presenter
Yuliang Xin
Author and Co-Author
Yuliang Xin | Xiaolei Guo,

Abstract
'Supernova remnants (SNRs) are widely believed to be the dominant accelerators of Galactic cosmic rays (CRs) with energies up to the knee. The electrons and protons can be accelerated to be the ultra-relativistic particles by the shock of SNRs via the diffusive shock acceleration (DSA) mechanism. HESS J1813-178 is one of the brightest and most compact objects detected by the HESS Galactic Plane Survey and MAGIC observations. A young SNR G12.8–0.0 locates within the TeV extent of HESS J1813-178. And a pulsar wind nebula (PWN) driven by an energetic X-ray pulsar PSR J1813-1749 is embedded in the SNR. Previous studies show that the GeV emission around HESS J1813-178 is much more extended than its TeV emission. With the Fermi-LAT analysis, we did a detailed morphological and spectral analysis in the region of HESS J1813-178 and found that the GeV gamma-ray morphology is consistent with the TeV contours of MAGIC. Meanwhile, the GeV spectrum is hard with index of ~2.0, which connects smoothly with that of HESS J1813-178. The possible origins of the gamma-ray emission from HESS J1813-178 are discussed.'

Collaborations

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

The gamma-ray emission in the region of W49A with Fermi-LAT

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 272

Presenter
Yuliang Xin
Author and Co-Author
Yuliang Xin | Xiaolei Guo,

Abstract
'The young star clusters/star forming regions have been believed to be the Galactic CRs contributors. As the CR acceleration sites, the collective effect of stellar winds and/or supernova activity in the young stellar associations can produce a large-scale shock, which will accelerate the particles up to energies of hundreds of TeV. And these high-energy particles can produce the multi-wavelength emission by the different radiation mechanisms. The GeV or TeV gamma-ray emission from such sources also have been detected, like Cygnus Cocoon, Westerlund 1, etc. The W49 region is one of the most interacting regions in the Galaxy to study the CR acceleration and it contains two components: a star forming region W49A and a young SNR W49B. W49A, located 0.21o to the west of the SNR W49B, is one of the massive star formation region in the Galaxy and one of the richest clusters known. Using the Pass 8 Fermi-LAT data, we did a detailed analysis around W49A and found that the gamma-ray emission contains two spectral components. One has the soft spectrum and steady emission, while another has the hard spectrum and variable emission. We also discuss the possible origins of the gamma-ray emission of different components.'

Collaborations

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Energy-dependent Morphological Study of HESS J1857+026 with Fermi-LAT

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 53 PWN and Halos | GAD-GAI
Presenter Forum Table

Presenter
Xiao-Lei Guo
Author and Co-Author
Xiao-Lei Guo | Yu-Liang Xin,

Abstract
'HESS J1857+026 is an extended gamma-ray source discovered by H.E.S.S., and identified as a pulsar wind nebula (PWN) candidate associated with PSR J1856+0245. MAGIC performed a follow-up observation, and two gamma-ray sources, called MAGIC J1857.2+0263 and MAGIC J1857.6+0297, were detected above 1 TeV. Taking advantage of 11 years of Fermi-LAT data, we re-analyze the region around HESS J1857+026 in the energy range of 0.5-500 GeV. In this work, we perform the energy-dependent extension analysis of HESS J1857+026 for the first time and present the results of spectral analysis.'

Collaborations

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

The Origin of Gamma-ray Emission from Circinus Galaxy

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 273

Presenter
Xiao-Lei Guo
Author and Co-Author
Xiao-Lei Guo | Yu-Liang Xin | Neng-Hui Liao | Yi-Zhong Fan,

Abstract
'The Circinus galaxy is a nearby composite starburst/active galactic nucleus (AGN) system. In this work we re-analyze the GeV emission from Circinus with 10 years of Fermi-LAT data. Our 0.1–500 GeV flux is several times lower than that reported in previous literature, which is roughly in compliance with the empirical relation for star-forming and Local Group galaxies and might be reproduced by the interaction between cosmic rays and the interstellar medium. The ratio between the γ-ray luminosity and the total infrared luminosity is near the proton calorimetric limit, indicating that Circinus may be a proton calorimeter.'

Collaborations

Keywords and Comments
'', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Observations of SNR Candidate HESS J1614-518 with Fermi-LAT

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Xiao-Lei Guo
Author and Co-Author
Xiao-Lei Guo | Yu-Liang Xin,

Abstract
'It is widely believed that supernova remnants (SNRs) are the main accelerators of Galactic cosmic rays (CRs) with energies up to the knee. Gamma-ray observations of SNRs is crucial to investigate the particle acceleration process and the origin of Galactic CRs. HESS J1614-518 is a TeV gamma-ray source discovered by H.E.S.S., and show a shell-like morphology in TeV band. Since no associated SNRs are observed in other wavelengths, it is classified as a SNR candidate. In this work, we analyze the gamma-ray emission from HESS J1614-518 with more than 12 years of Fermi-LAT data. We present the results of spectral analysis and the extension analysis.'

Collaborations

Keywords and Comments
", "

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Detection of the third class of gamma-ray bursts: magnetar giant flares.

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Michela Negro
Author and Co-Author
Michela Negro | Burns Eric | Svinkin Dimitry | Hurley Kevin | Zorawar Wadiasingh | Younes Georges | Hamburg Rachel | Cook David,

Abstract
'Around 11.4 million years ago a young, highly magnetized neutron star, a magnetar, in the Sculptor galaxy released an enormous amount of energy in the form of a giant flare. On April 15$^{\\rm th}$ 2020 some of the emitted photons were detected by a number of gamma-ray telescopes around Earth and Mars. While the analysis of this event, GRB 200415A, was interesting in its own right, it resulted in broader implications for both magnetar and gamma-ray burst (GRB) science.\r\nThe resulting population study of magnetar giant flares (MGFs), led to the unambiguous identification of a distinct population of 4 local (<5 Mpc) short GRBs. While identified solely based on alignment to nearby star-forming galaxies, their rise time and isotropic energy release are independently inconsistent with the larger short GRB population at >99.9% confidence. These properties, the host galaxies, and non-detection in gravitational waves all point to an extragalactic MGF origin. The inferred volumetric rates for events above $4 \\times 10^{44}$erg of $R = 3.8^{+4.0}_{-3.1} \\times 10^5Gpc^{−3}yr^{−1}$ place MGFs as the dominant gamma-ray transient detected from extragalactic sources. As previously suggested, these rates imply that some magnetars produce multiple MGFs, providing a source of repeating GRBs. The rates and host galaxies favor common core-collapse supernova as key progenitors of magnetars.'

Collaborations

Keywords and Comments
'GRB; magnetar; giant flares;', 'Full list of authors in the paper: DOI: 10.3847/2041-8213/abd8c8'

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Observations of gamma-ray sources with DAMPE

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 274

Presenter
Kai-Kai Duan
Author and Co-Author
Kai-Kai Duan, Zhao-Qiang Shen | Wei Jiang | Zun-Lei Xu | Xiang Li | on behalf of the DAMPE collaboration

Abstract
'DArk Matter Particle Explorer (DAMPE), a space-borne high energy cosmic ray and gamma-ray detector, has surveyed the whole sky for five years and collected more than 220,000 photons above 2 GeV since the launching on Dec. 17, 2015. The instrument response functions (IRFs) are derived and a dedicated software named DmpST is developed for the gamma-ray data analysis of DAMPE. Here we present the method of DAMPE bright gamma-ray sources search and the spectral analyses of these sources.'

Collaborations
DAMPE,

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Search for gamma-ray lines in the Galaxy with DAMPE

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 275

Presenter
Zun-Lei Xu
Author and Co-Author
Zun-Lei Xu, Zhao-Qiang Shen | Kai-Kai Duan | Xiang Li | Mazziotta M. N. | on behalf of the DAMPE collaboration

Abstract
'DArk Matter Particle Explorer (DAMPE) is a high energy cosmic-ray and gamma-ray observatory with an excellent energy resolution, and therefore has an advantage in searching for gamma-ray line structures. Based on the 5-yr DAMPE observation, we construct a dedicated data set for line search which balances the energy resolution and acceptance. We also make use of the photons converted in the BGO calorimeter. We use the summed unbinned likelihood with sliding windows technique and calculate the 95% confidence limits of the velocity-averaged cross section for `$\\chi\\chi \\to \\gamma\\gamma$` and the decay lifetime for `$\\chi \\to \\gamma\\nu$`.'

Collaborations
DAMPE,

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Inter Galactic Magnetic field constraints through the gamma ray observations of the Extreme High-frequency-peaked BL Lac candidate HESS 1943+213

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 276

Presenter
Sofia Ventura
Author and Co-Author
Stefano Silvestri | Sofia Ventura | Giacomo Bonnoli,

Abstract
'Extreme High-frequency-peaked BL Lac (EHBL) objects, a subclass of blazars characterised by a synchrotron peak frequency exceeding 10^17 Hz, and, in some cases, an inverse Compton peak energy exceeding 1 TeV, are ideal sources to study the InterGalactic Magnetic Field (IGMF) due to the hardness of their spectrum. HESS J1943+213 is a Very High Energy (VHE, >100 GeV) γ-ray source shining through the Galactic Plane discovered by HESS. Recently, also VERITAS published a VHE spectrum spanning from 200 GeV up to about 2 TeV consistent with that of HESS within the errors (photon index=2.8). The archetypical EHBL source is 1ES 0229+200 which has a redshift z=0.14 and a similar VHE slope (photon index=2.9). Since the observed flux of HESS J1943+213 at 1 TeV is more than a factor of two larger, and its redshift is bigger (z<0.23), a much larger reprocessed power is expected, which allowed us to study the magnetic field strength with great accuracy. We used the simulation code CRpropa 3 to simulate the cascade emission assuming different IGMF configurations and a detailed analysis of the 10 years of Fermi-LAT data to extend the observed VHE spectrum down to 5 GeV. Comparing the cascade spectrum with the combined spectra from Fermi-LAT and Cherenkov telescopes we derived a lower limit on the IGMF strength of the order of 6e-14 G which is at least a factor of 4 larger than previously published results obtained with the source 1ES0229+200. Effects of the duty cycle are also taken into consideration.'

Collaborations

Keywords and Comments
'AGN; Inter Galactic Magnetic Field', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Systematic X-ray study of GeV gamma-ray emitting radio galaxies

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 277

Presenter
Hiroto Matake
Author and Co-Author
Hiroto Matake, Yasushi Fukazawa

Abstract
'Black Holes (BHs) at the center of galaxies have a 10^6 - 10^9 \r\nsolar mass and thus are called Supermassive Black hole (SMBH). When a large amount of matter accretes onto SMBH, the accreting matter shines brightly, and this phenomenon is called active galactic nuclei (AGN). Only 10$¥%$ of AGNs have a powerful radio jet, and these objects are roughly classified either radio galaxy or blazar. Blazar is bright but its radiation almost comes from the core jet because of strong beaming effect, while radio galaxy whose beaming effect is weak show various emission components from outer-layer jet, outer jet, and disk/corona. Therefore, radio galaxies are considered to be important objects to understand jet structure. To study the relation between jet and disk is considered to be an important point to understand jet ejection mechanism X-ray emission from radio galaxies contain both jet and disk/corona radiation. Thus, we have to investigate contributions from jet and disk/corona to the X-ray band.\r\nIn this work, we investigate X-ray and Gamma-ray properties of GeV emitting radio galaxies listed in the 4FGL-DR2 catalog. We use X-ray data of Swift/XRT. We studied time variability, the relation between X-ray and gamma-ray photon index, together with accretion rate, and found they are classified into 3 groups; X-ray emission in the first group is dominated by jet emission, X-ray of the second group is dominated by disk/corona emission, and for the third group both jet and disk/corona contribute to the X-ray band.'

Collaborations

Keywords and Comments
'AGN; Radio Galaxy', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Building a robust sample of Fermi-LAT blazars that exhibit periodic gamma-ray emission

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Pablo Peñil
Author and Co-Author
Pablo Peñil | Alberto Dominguez | Marco Ajello | Sara Buson on behalf of the Fermi-LAT collaboration,

Abstract
'Blazars can show variability on a wide range of timescales. However, the search for periodicity in the gamma-ray emission of blazars remains an on-going challenge. This contribution will show the results obtained when a systematic pipeline is used to implement ten well-established methods for searching for periodicity. We analyze the most promising candidates selected from our previous work, extending the Fermi-LAT light curves over three more years, for a total telescope time of twelve years. These improvements have allowed us to build the first sample of blazars that display a periodicity detected at a significance >5sigma. Finally, we will discuss the potential origins for the periodic behavior observed in blazars.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'AGN; Fermi-LAT; periodicity; 5sigma; systematic search', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Systematic search for halos around pulsars in Fermi-LAT data

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 53 PWN and Halos | GAD-GAI
Presenter Forum Table

Presenter
Soheila Abdollahi
Author and Co-Author
Soheila Abdollahi | For the Fermi-LAT Collaboration, Pierrick Martin | Luigi Tibaldo | Jürgen Knödlseder | MATTIA DI MAURO

Abstract
'Extended gamma-ray halos around middle-aged pulsars, discovered at TeV energies from HAWC observations, are a new and potentially rich source class. The phenomenon is interpreted as the inverse-Compton scattering of ambient photons by electron/positron pairs accelerated by pulsars and their nebulae and confined in their vicinity. Physically, the dynamics of this pair confinement remains poorly understood and halos offer an opportunity to probe the neighborhood of pulsar/supernova remnant systems, e.g., the magnetic field structure and conditions for energetic particle transport. As a population, due to their large sizes and long lifetimes, halos can be expected to have a non-negligible contribution to the GeV-TeV emission from the Galaxy, in the form of currently unidentified sources and/or unresolved emission on large scales.\r\nIn the GeV range, the first detections of halo candidates were achieved recently and the phenomenon essentially remains to be explored. We have performed a systematic search for halos around middle-aged pulsars using 12 years of Fermi-LAT data. We have set up an analysis suite to detect extended emission around a selection of ATNF pulsars likely to harbor halos at a detectable level. We present a list of promising halo candidates, together with dedicated studies in which we investigate the morphology and spectrum of a few selected targets. Combined with measurements at other wavelengths, this provides information on the physical processes underlying the formation of pulsar halos and contributes to a better assessment of halos as a population.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'Halos around pulsars; diffusion; gamma-ray astronomy', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Observation of sub-GeV atmospheric gamma rays on GRAINE 2018 balloon experiment and comparison with HKKM calculation

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 278

Presenter
Hiroki Rokujo
Author and Co-Author
Hiroki Rokujo, GRAINE collaboration

Abstract
'We report a precise measurement of the sub-GeV atmospheric gamma-ray spectrum at balloon altitude on GRAINE 2018 experiment, and comparisons with the predictions calculated by the latest HKKM, which is widely known as a model for atmospheric neutrino flux calculation.\r\nUnderstanding the interactions between cosmic rays and atmospheric nuclei is important for accurate atmospheric neutrino flux calculations. Observation data of sub-GeV atmospheric gamma rays at balloon altitudes are useful for verifying such hadronic interaction models and pion productions in the low energy region.\r\nIn April 2018, we conducted a balloon experiment (GRAINE 2018) in Australia with the aim of detecting and imaging cosmic gamma rays with the nuclear emulsion telescope. Following flight data analysis, we derived an atmospheric gamma-ray spectrum in 0.1-1 GeV region at altitudes of ~36 km (residual depth ~4 g/cm^{2}). The flux around the 1 GeV region is in good agreement with the HKKM prediction and smoothly connects to the multi-GeV observations of past balloon experiments. On the other hand, the flux around 0.1 GeV shows a discrepancy with the prediction.\r\nIn this presentation, the balloon experiment, flight data analysis, and observation results will be described in detail.'

Collaborations
other (fill field below), GRAINE

Keywords and Comments
'atmospheric gamma ray; hadronic interaction; atmospheric neutrino; balloon experiment; nuclear emulsion', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Analyzing the Fermi Bubbles with DAMPE

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Zhaoqiang Shen
Author and Co-Author
Zhaoqiang Shen | Kai-Kai Duan | zunlei xu | Xiang Li | Qiang Yuan | For the DAMPE Collaboration,

Abstract
'The Fermi Bubbles (FBs) are two large structures above and below the Galactic Plane. They are first discovered by Fermi-LAT and thought to be related to the jet or the wind from the Galactic center. In this work, we use more than 5 years of DAMPE photon data to analyze the FBs. We calculate the TS values of the FB lobes and the significance of its curved spectrum. The obtained spectral parameters are then compared with those from the Fermi-LAT. We also search for the emission from the Cocoon in the southeast part of FBs. Since the Galactic diffuse emission (GDE) model is a major source of systematic uncertainty, we switch to the GDE models calculated with Galprop and find its influence.'

Collaborations
DAMPE,

Keywords and Comments
'DAMPE; gamma-ray; Fermi bubbles; diffuse emission', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

The First Catalog of Extragalactic Fermi-LAT Transient Sources

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
Isabella Mereu
Author and Co-Author
Isabella Mereu, Sara Cutini | Elisabetta Cavazzuti | Gino Tosti

Abstract
'The first Fermi Large Area Telescope (LAT) catalog of gamma-ray transient sources (1FLT) comprises sources that were detected on monthly time intervals during the first decade of Fermi-LAT operations. The monthly time scale allows us to identify transient and variable sources that may have not been reported in Fermi-LAT general catalogs. \r\nThe analysis was performed for photon energies between 0.1 and 300 GeV using the Pass-8 event-level selection. In the analysis we considered only photons with |b| > 10° to exclude the Galactic plane and therefore to avoid confusion with low-latitude diffuse emission. We have analyzed 120 months and also performed a 15-day shift of each month in order to not lose any flare at the edges of each time bin. The monthly datasets were analyzed using a wavelet-based source detection algorithm that provided the candidate new transient sources. The transient candidates were then analyzed using the standard Fermi-LAT maximum likelihood analysis method. The resulting catalog list has 142 different sources detected with a statistical significance above 4-sigma in at least one monthly bin. About 70% are associated with spectrally soft AGN-type counterparts, principally blazar candidates of uncertain type and flat-spectrum radio quasars, and about 30% of 1FLT sources remain unassociated. This is similar to the fraction of unassociated sources found in the Fermi-LAT general catalogs. The median gamma-ray spectral index of the 1FLT-AGN sources is softer than the median index reported in the latest Fermi-LAT AGN general catalog (4LAC). The sources associated to a 4FGL-DR2 target are not reported in the 1FLT catalog while are reported 6 sources listed also in a previous general catalog (1-3FGL).'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'catalogs - gamma-rays; AGN; transients', ''

Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

Analysis of the W 44 Supernova Remnant and its surroundings with Fermi-LAT and MAGIC

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Leonardo Di Venere
Author and Co-Author
Leonardo Di Venere, David Green | Riccardo Di Tria | Francesco Giordano | Alexander Hahn | Francesca Romana Pantaleo | Marcel Strzys | for the Fermi-LAT and MAGIC collaborations

Abstract
'The well-known supernova remnant (SNR) W 44 is observed in high-energy gamma-rays and widely studied to investigate cosmic ray (CR) acceleration. Several analyses of the W 44 surroundings showed the presence of gamma-ray emission offset from the radio SNR shell. This emission is thought to originate from escaped high-energy CRs.\r\nWe present a detailed analysis of the W44 region as seen by Fermi-LAT above 50 MeV, focusing on the spatial and spectral characteristics of both W 44 SNR and its surroundings. The spatial analysis was limited to energies above 1 GeV in order to exploit the improved angular resolution of the instrument, deriving a detailed description of the region morphology. Observations of the northwestern region of W44, also known as SRC-1 from previous works, were conducted with the MAGIC telescopes in the very high-energy gamma-ray band, namely above 50 GeV. We analysed MAGIC data exploiting the spatial information derived with the Fermi-LAT analysis at GeV energies. Here we show the results of both analyses and the combined Fermi-LAT and MAGIC spectra, thus obtaining constraining information on the diffusion of the escaped CRs.'

Collaborations
Ferrmi-LAT, MAGIC

Keywords and Comments
'Galactic sources; Supernova Remnants; Cosmic Rays', ''

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Subcategory Experimental Results

Observational constraints on the blazar jet wobbling timescale

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 280

Presenter
Jakub Juryšek
Author and Co-Author
Jakub Juryšek | Vitalii Sliusar | Roland Walter,

Abstract
'Blazars are a subclass of radio-loud active galactic nuclei, where the jet is aligned close to the line of sight. Blazars emission is dominated by non-thermal processes, where Doppler boosted radiation originates from a relativistic population of charged particles within the jet. From radio to TeV energies, blazars are highly variable on timescales from minutes to over a year. There are several mechanisms proposed to explain such extreme variability, including changes in the viewing angle of the jet, propagating along the rotation axis of the accretion disc. If the angular momentum of matter accreting onto a spinning supermassive black hole (SMBH) is misaligned with the SMBH spin, Lense-Thirring precession of such tilted disc can be expected, which leads to variation of Doppler beaming of the jet emission. Such explanation is supported by radio observations of jet precession observed for some sources. The radio-emitting regions, however, are located far from the central engine, and thus the observed time scales in this band can be affected by e.g. a variation of the bulk Lorentz factor along the jet.\r\n\r\nIn this contribution, we derive expected time scales of the jet wobbling using SMBH masses and compare them with the time intervals between flares in long-term (over $\\sim15$ years) X-ray light curves of bright blazars observed by Swift-XRT. We found that for Mrk 421 and 3C 273, the derived time scales are consistent with the observational constraints, while for the other sources we are mostly limited by an uncertainty in the Doppler beaming factor.'

Collaborations

Keywords and Comments
", "

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Subcategory Experimental Results

AstroSat View of Blazar OJ 287: A complete evolutionary cycle of HBL Component from end-phase to disappearance and Re-emergence

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 281

Presenter
Pankaj Kushwaha
Author and Co-Author
Pankaj Kushwaha, K. P. Singh | A. Sinha | S. Chandra | V. R. Chitnis | Main Pal | G. C. Dewangan | A. Gopakumar | S. B. Markoff | S. Doeleman | A. Agrawal

Abstract
'We report three AstroSat observations of BL Lacertae object OJ 287. The three observations caught it in very different flux states that are connected to different broadband spectral states. These observations trace the source spectral evolution from the end-phase of activity driven by a new, additional HBL like emission component in 2017 to its complete disappearance in 2018 and re-emergence in 2020. The 2017 observation shows a comparatively flatter optical-UV and X-ray spectrum. Supplementing it with the simultaneous NuSTAR monitoring indicates a hardening at the high-energy-end. The 2018 observation shows a harder X-ray spectrum and a sharp decline or cutoff in the optical-UV spectrum revealed thanks to the Far-UV data from AstroSat. The brightest of all, the 2020 observation shows a hardened optical-UV spectrum and an extremely soft X-ray spectrum, constraining the low-energy peak of spectral energy distribution at UV energies – a characteristic of HBL blazars. The contemporaneous MeV-GeV spectra from LAT show the well-known OJ 287 spectrum during 2018 but a flatter spectrum during 2017 and a hardening above ~1 GeV during 2020. Modeling broadband SEDs show that 2018 emission can be reproduced with a one-zone leptonic model while 2017 and 2020 observations need a two-zone model, with the additional zone emitting an HBL radiation.'

Collaborations

Keywords and Comments
'radiation mechanisms: non-thermal – galaxies: active – BL Lacertae objects: in-\r\ndividual: OJ 287 – galaxies: jets – gamma-rays: galaxies – X-rays: galaxies.', ''

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

A new GeV-TeV particle component and the barrier of cosmic-ray sea in the CMZ region

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Xiaoyuan Huang
Author and Co-Author
Xiaoyuan Huang | Qiang Yuan | Yizhong Fan,

Abstract
'The Galactic center is widely anticipated to be an important cosmic-ray source and the observations of some Imaging Atmospheric Cherenkov Telescopes did successfully reveal a new component of TeV-PeV cosmic rays in the vicinity of the Galactic center. This work reports the identification of GeV-TeV cosmic rays in the central molecular zone with the γ-ray observations of the Fermi-LAT. The spectrum and spatial gradient of the GeV-TeV source component are consistent with that measured by the Imaging Atmospheric Cherenkov Telescopes. The inferred cosmic-ray energy density is, however, substantially lower than the so-called cosmic-ray sea component. Our finding is in support of the presence of high energy particle accelerator at the Galactic center and strongly suggests a barrier that can effectively suppress the penetration of the particles from the cosmic-ray sea to the central molecular zone.'

Collaborations

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Experimental Results

An Investigation into the Origin of short-term flaring Gamma-ray Emission of TON 599

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 282

Presenter
Jacob Green
Author and Co-Author
Jacob Green,

Abstract
'The FSRQ TON 599 is one of the most luminous $\\gamma$-ray emitting AGN. Data from the Fermi-LAT are used for these analyses. It shows variability on time scales down to minutes during strong flares detected by the Fermi-LAT. A flux above 100 MeV during hourly time intervals could exceed $\\sim 10^{-5}$ photons cm$^-2$ s$^-1$ and the spectrum for the flaring period extends up to 100 GeV with a hard photon index of $\\sim2$.\r\nThis short term variability time scale is the indication of the compactness of the $\\gamma$-ray emission region size (< 10^{16} cm). Thus, this study of TON 599 was undertaken to give an understanding of $\\gamma$-ray emission from AGN. Different scenarios are discussed to explain the short-term variability.'

Collaborations

Keywords and Comments
'AGN; Fermi', ''

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Branch GAD | Gamma Ray Direct

Subcategory Future projects

MeVCube: a CubeSat for MeV astronomy

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
Giulio Lucchetta
Author and Co-Author
Giulio Lucchetta,

Abstract
'Despite the impressive progresses achieved both by X-ray and gamma-ray observatories in the last decades, the energy range between $\\sim 200\\,\\mathrm{keV}$ and $\\sim 50\\,\\mathrm{MeV}$ remains poorly explored. COMPTEL, on-board CGRO (1991-2000), was the last telescope to accomplish a complete survey of the MeV-sky with a relatively modest sensitivity. Missions like AMEGO have been proposed for the future, in order to fill this gap in observation; however, the time-scale for development and launch is about 10 years. On a shorter time-scale, a different approach may be profitable: MeV observations can be performed by a Compton telescope flying on a CubeSat.\r\nMeVCube is a 6U CubeSat concept currently under investigation at DESY, that could cover the enery range between hundreds of keV up to few MeVs with a sensitivity comparable to that of missions like COMPTEL and INTEGRAL. The Compton camera is based on pixelated Cadmium-Zinc-Telluride (CdZnTe) semiconductor detectors, coupled with low-power read-out electronics (ASIC, VATA450.3), ensuring a high detection efficiency and excellent energy resolution. In this work I will show measurements of the performance of a custom design CdZnTe detector and extrapolations of the expected telescope performance based on these measurements as well as simulations.'

Collaborations

Keywords and Comments
'Gamma-rays astrophysics; Compton telescope; CubeSat; CdZnTe detectors', ''

Branch GAD | Gamma Ray Direct

Subcategory Future projects

New Mission Concept: Galactic Explorer with a Coded Aperture Mask Compton Telescope (GECCO)

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
Alexander Moiseev
Author and Co-Author
Alexander Moiseev | for the GECCO Collaboration,

Abstract
'We present a novel concept for a next-generation γ-ray telescope that will cover the hard X-ray - soft γ-ray region. Despite the progress made by the European Space Observatory INTEGRAL, this energy range is still under-explored. GECCO will conduct high-sensitivity measurements of the cosmic γ-radiation in the energy range from 50-100 keV to ∼10 MeV and create intensity maps with high spectral and spatial resolution, focusing on sensitive separation of diffuse and point-source components. These observations will enable the following major objectives for GECCO: \r\na)\tunderstand the nature, composition and fine structure of the inner Galaxy \r\nb)\tlocalize and discern the origin(s) of the positron annihilation 511 keV line, \r\nc)\tresolve Galactic chemical evolution and sites of explosive element synthesis \r\nd)\tprovide identification and precise localization of gravitational wave and neutrino events \r\ne)\ttest as-yet unexplored candidates for the dark matter \r\nThe instrument is based on a novel CdZnTe Imaging calorimeter and a deployable coded aperture mask. The unique feature of GECCO is that it combines the advantages of two techniques – the high-angular resolution possible with coded mask imaging, and a Compton telescope mode providing high sensitivity measurements of diffuse radiation. Expected GECCO performance is as follows: energy resolution <1% at 0.5-5 MeV, angular resolution ∼1 arcmin in the Mask mode (3-4 degree field-of-view, ∼2,000 sq.cm effective area), and 3-5 degrees in the Compton mode (~60 degree field-of-view, ∼500 sq.cm effective area). The continuum sensitivity is expected to be ~ 10−6MeV/sq.cm/s at 1 MeV. GECCO can be considered for a future NASA Explorer mission.'

Collaborations
, GECCO

Keywords and Comments
'Compton telescope; Coded Aperture Mask; CZT detector; Galactic plane', ''

Branch GAD | Gamma Ray Direct

Subcategory Future projects

AMEGO-X: MeV gamma-ray Astronomy in the Multi-messenger Era

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
Henrike Fleischhack
Author and Co-Author
Henrike Fleischhack | for the AMEGO-X team,

Abstract
'Recent detections of gravitational wave signals and neutrinos from gamma-ray sources have ushered in the era of multi-messenger astronomy, while highlighting the importance of gamma-ray observations for this emerging field. AMEGO-X, the All-sky Medium Energy Gamma-Ray Observatory eXplorer, is an MeV gamma-ray instrument that will survey the sky in the energy range from hundreds of keV to one GeV with unprecedented sensitivity. AMEGO-X will detect gamma-ray photons both via Compton interactions and pair production processes, bridging the “sensitivity gap” between hard X-rays and high-energy gamma rays. AMEGO-X will provide important contributions to multi-messenger science and time-domain gamma-ray astronomy, studying e.g. high-redshift blazars, which are probable sources of astrophysical neutrinos, and gamma-ray bursts. I will present an overview of the instrument and science program.'

Collaborations
other (fill field below), AMEGO-X team

Keywords and Comments
'MeV; medium-energy gamma rays; multi-messenger; instrumentation; future missions;', 'This could go into the multi-messenger track as well as the main science driver is multi-messenger science.'

Branch GAD | Gamma Ray Direct

Subcategory Future projects

The future look at the Galaxy with the Galactic Explorer with a Coded Aperture Mask Compton Telescope (GECCO)

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
Elena Orlando
Author and Co-Author
Elena Orlando | the GECCO Collaboration,

Abstract
'In the past 15 years, observations of the Galaxy at high energies by Fermi-LAT, AGILE, INTEGRAL and very recently by NuSTAR and eROSITA have been shown to be very exciting, allowing discoveries of a variety of objects and unexpected breakthroughs. However, from a few hundreds of KeV to several tens of MeV, the Galaxy remains poorly explored. In this energy range the lack of sufficiently sensitive instruments limits potential discoveries and challenges our understanding of the Galactic high-energy processes and sources. \r\nTo solve this issue, GECCO is a new mission concept that will allow high-sensitivity observations of the sky from ~50 KeV to ~10 MeV. It combines a coded aperture mask technique that provides high angular resolution for source detection, and a Compton telescope that provides high-sensitivity measurements of diffuse emissions. Such a combination enables efficient separation between sources and diffuse emissions.\r\nA GECCO-like mission has the potential of answering open questions and leading to new discoveries. Among the most recent challenges regarding the Galaxy, sensitive observations at MeV energies with unprecedented high resolution will open a new window in understanding complicated regions such as the inner Galaxy, the origin of the Fermi Bubbles, the origin of the 511 keV line, and it will provide new insights on element formation in dynamical environments, on possible Galactic winds, and on the mechanisms of propagation of the low-energetic cosmic rays, their sources and their role on the Galaxy evolution.'

Collaborations
other (fill field below), GECCO

Keywords and Comments
'Galactic Science at MeV in particular with GECCO', ''

Branch GAD | Gamma Ray Direct

Subcategory Future projects

Gamma-ray performance study of the HERD payload

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
Luis Farina
Author and Co-Author
Léa Jouvin | Luis Farina, Javier Rico | Nicola Mori | Fabio Gargano | Valerio Formato | Francesco de Palma | cecilia Pizzolotto

Abstract
'The High Energy cosmic-Radiation Detection (HERD) facility has been proposed as a space astronomy payload onboard the future China's Space Station. HERD is planned for operation starting around 2025 for about 10 years In addition to the unprecedented sensitivity for dark matter searches and cosmic-ray measurements up to the knee energy, it should perform gamma-ray monitoring and full sky survey from few hundred MeV up to tens of TeV. We present the first study of the HERD gamma-ray performance obtained with full simulations of the whole detector geometry. HERD will be a cubic detector composed with 5 active faces. We present a study conducted inside the HERD analysis software package, which includes a detailed description of the detector materials. The HERD effective area, the point spread function and the resulting gamma-ray sensitivity have been estimated for different detector configurations, in particular taking into account different detector sides and investigating also some design optimization possibilities like the addition of tungsten layers for enhancing the gamma-ray conversion probability.'

Collaborations
other (fill field below), HERD

Keywords and Comments
'Gamma-ray; satellite; sensitivity; HERD; MC', ''

Branch GAD | Gamma Ray Direct

Subcategory Future projects

The Compton Spectrometer and Imager Project for MeV Astronomy

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
John Tomsick
Author and Co-Author
John Tomsick | For the COSI Collaboration,

Abstract
"The Compton Spectrometer and Imager (COSI) is a 0.2-5 MeV Compton telescope capable of imaging, spectroscopy, and polarimetry of astrophysical sources. Such capabilities are made possible by COSI's germanium cross-strip detectors, which provide high efficiency, high resolution spectroscopy and precise 3D positioning of photon interactions. Science goals for COSI include studies of 511 keV emission from antimatter annihilation in the Galaxy, mapping radioactive elements from nucleosynthesis, determining emission mechanisms and source geometries with polarization, and detecting and localizing multimessenger sources. The instantaneous field of view for the germanium detectors is 25% of the sky, and they are surrounded on the sides and bottom by active shields, providing background rejection as well as allowing for detection of gamma-ray bursts or other gamma-ray flares over most of the sky. We are currently carrying out a Phase A concept study to consider COSI as a Small Explorer (SMEX) satellite mission (see arXiv:1908.04334), and I will discuss the advances COSI-SMEX provides for astrophysics in the MeV bandpass."

Collaborations
other (fill field below), COSI

Keywords and Comments
'MeV gamma-rays; Compton telescopes; positron annihilation; nucleosynthesis; polarization; satellite missions', ''

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Subcategory Future projects

Overview of the GRAMS (Gamma-Ray AntiMatter Survey) Project

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
Tsuguo Aramaki
Author and Co-Author
Tsuguo Aramaki,

Abstract
'GRAMS (Gamma-Ray and\xa0AntiMatter\xa0Survey) is a next-generation proposed balloon/satellite mission that will be the first to target both MeV gamma-ray observations and antimatter-based indirect dark matter searches with a\xa0LArTPC (Liquid Argon Time Projection Chamber)\xa0detector. Astrophysical observations at MeV energies have not yet been well-explored due to the complexity and difficulties of the event reconstruction of Compton scatterings. With a cost-effective, large-scale\xa0LArTPC, a single LDB (Long-Duration Balloon) flight could provide an order of magnitude improved sensitivity compared to previous experiments. Additionally, GRAMS can uniquely explore dark matter parameter space via antimatter measurements. In particular, low-energy antideuterons can be background-free dark matter signatures. In this talk, I will give an overview of the GRAMS project and the detection concepts for MeV gamma rays and antiparticles.'

Collaborations
, GRAMS

Keywords and Comments
'gamma ray; antimatter; antiproton; antideuteron; antihelium; dark matter; primordial black hole', 'This talk is for the GRAMS Collaboration'

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Branch GAD | Gamma Ray Direct

Subcategory Future projects

GRAINE precise γ-ray observations: latest results on 2018 balloon-borne experiment and prospects on next/future scientific experiments

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
Satoru Takahashi
Author and Co-Author
Satoru Takahashi, GRAINE collaboration

Abstract
'We are developing a GRAINE project, 10 MeV – 100 GeV cosmic $\\gamma$-ray observations with a precise (0.08 degree @ 1 – 2 GeV) and polarization sensitive large-aperture-area ($\\sim$10 m^2) emulsion telescope repeated long duration balloon flights. We demonstrated a feasibility and performance of the balloon-borne emulsion $\\gamma$-ray telescope experiment with various test experiments and developments on the ground and balloon-borne experiments in 2011 and 2015. In 2018, a balloon-borne experiment was performed with a 0.38 m^2 aperture area and 17.4 hour flight duration in Australia to demonstrate an overall performance of the telescope with a detection and imaging of a known $\\gamma$-ray source, Vela pulsar. By the flight data analysis, we achieved a firm detection and highest imaging for the Vela pulsar and established the emulsion $\\gamma$-ray telescope with a highest angular resolution in the $\\gamma$-ray telescopes in the energy region. Based on the experiences and achievements, we aim to start scientific observations expanding an aperture area and flight duration repeated balloon flights. In 2022, we have a plan of twice balloon-borne experiments in Australia by JAXA Scientific Ballooning with a 2.5 m^2 aperture area and a flight duration above 15 hours aiming, e.g., to observe galactic center region with a highest imaging resolution. An overview and status of the GRAINE project, especially the latest results on the 2018 balloon-borne experiment and the prospects on the next/future scientific experiments are presented.'

Collaborations
, GRAINE

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Future projects

The Advanced Particle-astrophysics Telescope (APT) Project Status

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
James Buckley
Author and Co-Author
James Buckley,

Abstract
'We describe a future gamma-ray/cosmic-ray mission concept called the Advanced Particle-astrophysics Telescope (APT). The instrument combines a pair tracker and Compton telescope in a large monolithic design. By using scintillating fibers for the tracker and wavelength-shifting fibers to readout CsI detectors, the instrument could achieve more than an order-of-magnitude improvement in both MeV and GeV sensitivity compared to other proposed instruments, while fitting within the cost envelope for an astrophysics probe-class mission. The addition of a single layer silicon-strip detector is currently under study, and could result in a substantial improvement in charge resolution for cosmic-ray studies as well as angular resolution for low-energy gamma-ray events. The ultimate goal of the APT program is the deployment of an observatory in a 10-year mission in a sun-Earth Lagrange orbit, providing an all-sky field of view and an effective area more than 10 times that of the Fermi Gamma-Ray Space Telescope. While the mission would have a broad impact on astroparticle physics, the primary science drivers for the mission include: (1) probing dark matter across the entire natural mass range and annihilation cross section for a thermal WIMP, (2) providing a nearly all-sky instantaneous FoV with prompt sub-degree localization and polarization measurements for gamma-rays transients such as neutron-star mergers and (3) making measurements of rare ultra-heavy cosmic-ray nuclei to distinguish between n-star merger and SNae r-process synthesis of the heavy elements. We will present results of detailed simulation studies, results from the Antarctic APTlite balloon flight and a heavy-ion beam test at CERN, and a proposed balloon experiment: the Antarctic Demonstrator for APT (ADAPT).'

Collaborations
other (fill field below), APT

Keywords and Comments
'Dark Matter; Multi-messenger astronomy; Cosmic-ray Composition; Instrumentation', 'for the APT Collaboration'

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Branch GAD | Gamma Ray Direct

Subcategory Future projects

BurstCube: status and public alerts

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 43 New and Upcoming Instruments for Space-Based Gamma-Ray Astronomy | GAD
Presenter Forum Table

Presenter
Israel Martinez-Castellanos
Author and Co-Author
Israel Martinez-Castellanos | For the BurstCube Team,

Abstract
'BurstCube is a CubeSat Gamma-Ray Burst (GRB) detector expected to launch in 2022, significantly expanding sky coverage in the ~50 keV to 1 MeV energy range and increasing the probability of detecting a gravitational wave counterpart. BurstCube will take advantage of the Tracking and Data Relay Satellite (TDRS) system in order to provide rapid public alerts and localization information, which has proven to be a key to obtain valuable multi-messenger and multi-wavelength information. The BurstCube instrument is comprised of four Cesium Iodide scintillators coupled to arrays of Silicon photo-multipliers, therefore serving as a pathfinder for future missions utilizing this technology for space-based gamma-ray detection. In this presentation we will discuss the current status of the BurstCube instrument assembly, calibration and analysis pipelines. We will also describe the real-time alerts that will be sent out to the community throughout the duration of the mission.'

Collaborations
other (fill field below), BurstCube

Keywords and Comments
'grb; sgrb; gw counterparts; gamma rays; satellite', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Methods

Assessing the signatures imprinted by star-forming galaxies in the cosmic gamma-ray background

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
Ellis Owen
Author and Co-Author
Ellis Owen, Albert Kong | Khee-Gan Lee

Abstract
'In recent years, high-energy gamma-ray emission has been detected from star-forming galaxies in the local universe, including M82, NGC 253, Arp 220 and M33. The bulk of this emission is thought to be of hadronic origin, arising from the interactions of cosmic rays (CRs) with the interstellar medium of their host galaxy. More distant star-forming galaxies would also presumably be bright in gamma-rays, but these would not be resolved as point sources. Instead, they contribute gamma-rays as unresolved sources to the extra-galactic gamma-ray background (EGB). However, despite the wealth of high-quality all-sky EGB data from the Fermi-LAT gamma-ray space telescope collected over more than a decade of operation, the exact contribution of SFGs to the EGB and the signatures their emission would imprint on the gamma-ray sky remains unsettled. In this talk, I will discuss how this can be assessed by modelling the gamma-ray emission from SFG populations above 1 GeV. I will demonstrate that such emission can be characterised by just a small number of key physically-motivated parameters, and outline how source populations would leave anisotropic signatures in the EGB. I will consider model signatures that may be imprinted population classes and discuss how such imprints could yield information about the underlying properties and evolution of SFGs over cosmic time.'

Collaborations

Keywords and Comments
'cosmic rays; gamma-rays:diffuse background; gamma-rays:galaxies; galaxies:starburst; galaxies:star-formation; galaxies:ISM', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Methods

Spectrum of the Isotropic Diffuse Gamma-ray Background

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 283

Presenter
Meenakshi Rajagopal
Author and Co-Author
Meenakshi Rajagopal, Markus Ackermann | Marco Ajello

Abstract
'The isotropic diffuse γ-ray background (IGRB) comprises of all extragalactic diffuse emission that is not resolved into sources and is found to be approximately isotropic on large angular scales. The initial measurement of the IGRB intensity with the Fermi Large Area Telescope (LAT) was performed in 2010 using the first 10 months of sky-survey data. After improvements were made in event selection and characterization of cosmic-ray backgrounds, a second measurement using 50 months of LAT data allowed for a refinement and a better understanding of the IGRB measurement, this time covering an energy range from 100 MeV to 820 GeV. The result was a spectrum defined by a power law with exponential cutoff with a spectral index of 2.32±0.02. A total intensity of (7.2±0.6) × 10−6 cm−2 s−1 sr−1 above 100 MeV was seen with about +15%/-30% systematic uncertainty attributed to Galactic diffuse foregrounds. This systematic uncertainty dominates the measurement uncertainties over most of the observed energy range. In the current analysis, therefore, the primary goal is to refine the measurement of the IGRB, employing 8 years of pass8 Fermi data and the 4FGL source catalog. A reduction of the systematic uncertainties arising from the DGE emission will be achieved through improved modeling of this emission, as well as a careful selection of analysis regions. A few other improvements including, wider energy range (between 50 MeV - >1 TeV), larger dataset, more powerful fitting techniques etc., will also be achieved in the current analysis.'

Collaborations

Keywords and Comments
'gamma-ray; diffuse; isotropic', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Methods

Bispectrum analysis of the unresolved gamma-ray background

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 284

Presenter
Ebo Peerbooms
Author and Co-Author
Ebo Peerbooms,

Abstract
'In recent years, properties of the unresolved gamma ray background (UGRB) have been constrained by measuring the anisotropy in the form of the angular power spectrum (APS). The energy dependence of the anisotropy has been found to be consistent with a broken power law, suggesting the existence of two distinct source classes above and below $\\sim$2 GeV. In this work, we aim to go beyond the angular power spectrum, and use the bispectrum to further constrain the source classes that contribute to the UGRB. As in the case of the APS, for a skymap consisting of unresolved, randomly distributed point sources, we expect the bispectrum to be independent of multipole and therefore to be fully characterised by a single amplitude b_{src}. We adapt the formalism developed in the context of CMB research and apply the resulting analysis pipeline to Fermi-LAT data in the energy range 0.7 GeV – 1 TeV. We verify the robustness of our analysis pipeline by applying it to simulated realizations with a predetermined value of the bispectrum amplitude. Additionally, bispectrum amplitudes obtained from the UGRB data are compared to simulated, purely isotropic realizations of the UGRB in order to test for deviations from Poissonianity across the entire energy range. Finally, we check if the energy-dependence of the bispectrum amplitude is consistent with the same broken power-law is in the case of the APS.'

Collaborations

Keywords and Comments
'bispectrum;IGRB;UGRB;anisotropy;skewness;unresolved gamma-ray background;', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Methods

Decelerated sub relativistic material with energy Injection

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 285

Presenter
Boris Betancourt Kamenetskaia
Author and Co-Author
Boris Betancourt Kamenetskaia | Nissim Fraija | Maria Giovanna Dainotti | Antonio Gálvan-Gámez | Rodolfo Barniol Duran | Simone Dichiara,

Abstract
'We investigate the evolution of the afterglow produced by the deceleration of the non-relativistic material due to its surroundings. The ejecta mass is launched into the circumstellar medium with equivalent kinetic energy expressed as a power-law velocity distribution $E\\propto \\left(\\Gamma\\beta\\right)^{-\\alpha}$. The density profile of this medium follows a power law $n(r)\\propto r^{-k}$, with k the stratification parameter, which accounts for the usual cases of a constant medium ($k=0$) and a wind-like medium ($k=2$). A long-lasting central engine, which injects energy into the ejected material as $E\\propto t^{1-q}$ was also assumed. With our model, we show the predicted light curves associated with this emission for different sets of initial conditions and notice the effect of the variation of these parameters on the frequencies, timescales and intensities. The results are discussed in the Kilonova scenario.'

Collaborations

Keywords and Comments
'mergers; black holes; neutron stars; compact binary stars; radiation mechanism; nonthermal; ISM; GRB', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Methods

A theoretical model of an off-axis GRB jet

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Boris Betancourt Kamenetskaia
Author and Co-Author
Boris Betancourt Kamenetskaia | Nissim Fraija | Maria Giovanna Dainotti | Antonio Gálvan-Gámez | Rodolfo Barniol Duran | Simone Dichiara,

Abstract
'In light of the most recent observations of late afterglows produced by the merger of compact objects or by the core-collapse of massive dying stars, we research the evolution of the afterglow produced by an off-axis top-hat jet and its interaction with a surrounding medium. The medium is parametrized by a power law distribution of the form $n(r)\\propto r^{-k}$, where k is the stratification parameter and contains the development when the surrounding density is constant ($k=0$) or wind-like (k=2). We develop an analytical synchrotron forward-shock model when the outflow is viewed off-axis, and it is decelerated by a stratified medium. Using the X-ray data points collected by a large campaign of orbiting satellites and ground telescopes, we have managed to apply our model and fit the X-ray spectrum of the GRB afterglow associated to SN 2020bvc with conventional parameters. Our model predicts that its circumburst medium is parametrized by a power law with stratification parameter $k=1.5$.'

Collaborations

Keywords and Comments
'mergers; black holes; neutron stars; compact binary stars; radiation mechanism; nonthermal; ISM; GRB', ''

Branch GAD | Gamma Ray Direct

Subcategory Theoretical Methods

Population Studies of Fermi LAT sources

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
Elena Orlando
Author and Co-Author
Elena Orlando | Melissa Rasmussen | Andrew Strong,

Abstract
'The Fermi Large Area Telescope (LAT) has been detecting hundreds of Galactic sources, most of which are pulsars. Many Galactic sources are still undetected or unresolved due to their low flux, below the Fermi LAT sensitivity, or because of foreground and source confusion. Moreover, among the many unassociated sources, which are one third of the detected sources, a large amount may have Galactic origin.\r\nWe present our method of source population synthesis studies for characterizing the general properties of Fermi LAT Galactic gamma-ray sources and for estimating the number of Galactic sources below the Fermi LAT flux sensitivity threshold.\r\nSource density distribution and luminosity function of our Monte-Carlo simulation are constrained by the Galactic sources detected by Fermi LAT. Then, the number of unresolved sources and their contribution to the diffuse emission are estimated by our best model.\r\nThis is a long-term project on analyzing the point source catalog and performing theoretical studies of gamma-ray sources. Apart from being interesting on its own, characterizing the general properties of detected sources will also allow to estimate the contribution to the diffuse emission from undetected and unresolved sources. In turn this will help their detection, impacting also other studies of diffuse gamma rays including studies of the interstellar emission and dark matter. Finally, it will also help in the characterization of unassociated sources.'

Collaborations

Keywords and Comments
'', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Methods

Source classification at GeV energies using neura lnetworks with time variability and locations

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
Chris van den Oetelaar
Author and Co-Author
Chris van den Oetelaar,

Abstract
'The Fermi LAT point source catalog contains 10 years of observational data between 50 MeV to 1 TeV. It contains 5064 point sources mostly consisting of BLLs (1131) and FSRQs (694), while pulsars (239) are the most numerous Galactic population. However, a quarter of detected sources remains unclassified and might hide new source classes. The classification is difficult due to bright, diffuse emission from our own galaxy.Recently a machine learning methods were developed for the first time to localize and to classify point sources in the catalog, with performance comparable to that of traditional techniques. Synthetic yearly catalogs are simulated to produce 10 yearly $\\gamma$-ray images from 2008 to 2018 in 6 energy bins of the sources. The yearly images provide the network with time variability information of the point sources. The time variable images are fed to the new neural network together with the location in the sky of the point source.\r\nThe network then separates the sources into distinct classes. The addition of time dependency and location data should increase the number of classifiable sources compared to the previous network from 3 to 5 (BLLacs, FSRQs, PSRs, PWN+SNR+SPPs, and Fakes), as well as an increase in classification accuracy.'

Collaborations

Keywords and Comments
'machine learning; Fermi LAT; 4FGL catalog; neural network; source classification', ''

Branch GAD | Gamma Ray Direct

Subcategory Theoretical Methods

Classification of Fermi-LAT sources with deep learning

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Silvia Manconi
Author and Co-Author
Silvia Manconi, Michael Kraemer | Anja Butter | Thorben Finke | Felicitas Keil

Abstract
'Machine learning techniques are powerful tools for the classification of unidentified gamma-ray sources. We present a new approach based on dense and recurrent deep neural networks to classify unidentified or unassociated gamma-ray sources in the last release of the Fermi-LAT catalog (4FGL-DR2). Our method uses the actual measurements of the photon energy spectrum and time series as input for the classification, instead of specific, hand-crafted features. We focus on different classification tasks: the separation between extragalactic sources, i.e. Active Galactic Nuclei (AGN), and Galactic pulsars, the further classification of pulsars into young and millisecond pulsars and the sub-classification of AGN into different types. Since our method is very flexible, we generalize it to include multiwavelength data on the energy and time spectra coming from different observatories, as well as to account for uncertainties in the measurements and in the predicted classes. Our list of high-confidence candidate sources labelled by the neural networks provides targets for further multiwavelength observations to identify their nature, as well as for population studies.'

Collaborations

Keywords and Comments
'gamma rays; catalog; machine learning; source classification', ''

Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Simulating cosmic rays and the gamma-ray emission in star-forming galaxies

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 26 Galactic Sources & Winds | MM
Presenter Forum Table

Presenter
Maria Werhahn
Author and Co-Author
Maria Werhahn, Christoph Pfrommer | Philipp Girichidis

Abstract
'Previously, the non-thermal emission from galaxies has only been modeled with single-zone models which is insufficient to explain a multitude of new, spatially resolved multi-messenger data of cosmic ray (CR) spectra, at gamma-rays and in the radio. Instead, we perform high-resolution magneto-hydrodynamic simulations of galaxies using the moving mesh code AREPO with self-consistent CR physics. We aim to understand the underlying physics of CRs and non-thermal emission processes in the Milky Way and in star-forming (SF) galaxies. In post-processing, we calculate steady-state spectra of CRs including all relevant cooling and escape losses. Consistent with Voyager-1 and AMS-02 data, our models show a turn-over of proton spectra below GeV energies due to Coulomb interactions so that electrons start to dominate the total particle spectra and match the shape of the positron fraction up to 10 GeV. Furthermore, from our CR spectra, we calculate multi-frequency spectra, from the radio up to the TeV energy regime, due to all non-thermal emission processes, i.e. synchrotron, bremsstrahlung, inverse Compton (IC) emission and gamma-ray emission from neutral pion decay. This allows us to produce detailed emission maps, luminosities and spectra of our simulated galaxies, that range from dwarfs to Milk-Way analogues to starburst galaxies, at different evolutionary stages. Within our simulations, we can successfully reproduce the observed far infrared (FIR)-gamma-ray and FIR-radio relations. We find that highly SF galaxies are close to the calorimetric limit and hence, their gamma-ray emission is dominated by neutral pion decay. However, in low SF galaxies, escape losses due to diffusion steepen the spectra and in turn, an increasing contribution from IC emission is needed to reproduce the observed gamma-ray spectra.'

Collaborations

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Fermi acceleration and $\gamma-\gamma$ obscuration along the orbit of η Carinae

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 286

Presenter
Matteo Balbo
Author and Co-Author
Matteo Balbo, Roland Walter

Abstract
'$\\eta$Carinae is the first observed $\\gamma$-ray binary system which does not contain compact objects. It is a natural laboratory to study particle acceleration and $\\gamma$-ray emission. The dense wind of the primary star shocks against the fast light wind coming from the companion star, creating the conditions to accelerate particles up to relativistic energies via Fermi mechanism. These particles subsequently dissipate energy as non-thermal radiation. Fermi-LAT and H.E.S.S. detections of $\\eta$Carinae confirmed such hypotheses for the very first time, creating a brand new class of $\\gamma$-ray emitting sources.\r\nHydrodynamic simulations provide a convincing match to the observations if few percent of the wind mechanical energy dissipated in the shock goes into particle acceleration. The intrinsic $\\pi^0$ decay spectrum is a complex convolution of the maximum energy, luminosity, particle drift and obscuration. Accelerated particles cool down mainly via inverse-Compton, synchrotron radiation, and proton-proton collisions. High-energy $\\gamma$-rays interact also with the anisotropic UV photon field emitted by the luminous star, creating $e^\\pm$ pairs and strongly modifying the observed spectrum. Quick variations of the optical depth are expected along the orbit, due to changes in shape, position, and gas density of the shocked regions. Flux variability down to few days timescale could be detected with future $\\gamma$-ray detectors above 40GeV. Detailed studies of the optical depth variability will help: disentangling the intrinsic particle spectral cut-off from that related to $\\gamma$-$\\gamma$ opacity; determining the flux of relativistic protons and positrons injected in the interstellar medium; studying the geometry of the colliding wind region and the magnetic field configuration; spatially constraining the location where relativistic photons are produced and the orientation of the binary system.'

Collaborations

Keywords and Comments
'$\\eta$Carinae; Particle acceleration; colliding wind binary; optical depth; shocks', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Detection of new Misaligned Active Galactic Nuclei in the Fermi-LAT Fourth Source Catalog using machine learning techniques

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 287

Presenter
Luca Deval
Author and Co-Author
Fiorenza Donato | Mattia Di Mauro | Luca Deval,

Abstract
'Active galactic nuclei (AGN) are the most luminous and abundant objects in the γ-ray sky. AGN with jets misaligned along the line-of-sight (MAGN) appear fainter than the brighter blazars, but are expected more numerous. Fermi Large Area Telescope (LAT) detected 40 MAGNs compared to 1943 blazars. The aim of this study is to identify new MAGN candidates in the blazars of uncertain type (BCUs) listed in the Fermi-LAT 10-years Source Catalog using an artificial neural network (ANN). \r\nThe statistical tests applied to the trained ANN reveals that a classification with machine learning techniques is feasible with high accuracy and precision. The trained ANN has been applied to the 1120 BCUs which have been classified into 655 BL Lacs and 314 Flat Spectrum Radio Quasars (FSRQs). Among the re-classified BCUs, the possible MAGN candidates have been determined by applying thresholds on the spectral index and gamma-ray luminosity. Our results led to 36 possible MAGN candidates, which respect the main physical properties of the 40 MAGN already listed in the Fourth Fermi Catalog.'

Collaborations

Keywords and Comments
'AGN; MAGN; Machine learning;', ''

Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

SNR G39.2-0.3, an hadronic cosmic rays accelerator

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Iurii Sushch
Author and Co-Author
Iurii Sushch | Emma de Ona Wilhelmi, Robert Brose | Enrique Mestre | Yang Su | Roberta Zanin

Abstract
'Recent results obtained with gamma-ray satellites have established supernova remnants as accelerators of GeV hadronic cosmic rays, which produce detectable gamma-ray emission through interaction with particles from gas clouds in their surrounding. In particular, the rich medium in which core-collapse SNRs explode provides a large target density to boost hadronic gamma-rays. SNR G39.2-0.3 is one of the brightest SNRs in infrared wavelengths, and its broad multiwavelength coverage allows a detailed modelling of its radiation from radio to high energies. The collection of the available multiwavelength data certainly favours a hadronic origin of the gamma-ray emission. The GeV spectrum obtained from the re-analysis of the Fermi LAT data implies that the present acceleration of protons is limited to below 10 GeV, which in turn points to a drastic slow down of the shock velocity due to the dense wall traced by the CO observations, surrounding the remnant. Further investigation of the gamma-ray spectral shape points to a dynamically old remnant subjected to severe escape of CRs and a decrease of acceleration efficiency. The low-energy (below 1 GeV) peak of the gamma-ray spectrum, which suggests extremely low maximum energy of freshly accelerated protons, is, however, not easily reproduced within typical acceleration and evolution models. We discuss several scenarios that may explain such a spectral shape, one of which is the heavy composition of accelerated particles which is certainly expected for a core-collapse SNR with an environment enriched by heavy nuclei from stellar winds of the progenitor star. We also show that a widely discussed idea of gamma-ray production by compressed and re-accelerated pre-existing Galactic cosmic rays cannot explain the observed emission.'

Collaborations

Keywords and Comments
'SNR; particle acceleration; hadronic interactions; gamma-ray emission', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Morphology of Gamma-ray Halos around Middle-aged Pulsars: Influence of the Pulsar Proper Motion

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 53 PWN and Halos | GAD-GAI
Presenter Forum Table

Presenter
Yi Zhang
Author and Co-Author
Yi Zhang | Ruo-Yu Liu | Songzhan Chen | Xiang-Yu Wang,

Abstract
'Recently, gamma-ray halos of a few degree extension have been detected around two middle-aged pulsars, namely, Geminga and PSR B0656+14, by the High Altitude Water Cherenkov observatory (HAWC). The gamma-ray radiation arise from relativistic electrons that escape the pulsar wind nebula and diffuse in the surrounding medium. The diffusion coefficient is found to be significantly lower than the average value in the Galactic disk. If so, given a typical proper velocity of $400-500{\\,\\rm km /s}$ for a pulsar, the displacement of the pulsars due to the proper motion could be important in shaping the morphology of the pulsar halos. Motivated by this, we study the morphology of pulsar halos considering the proper motion. We find that the morphology of the pulsar halo can be basically classified into three evolutionary phases, depending on the proper velocity, the cooling of the emitting electrons and the diffusion coefficient. Generally, the morphology would appear highly asymmetric at $\\leq 1\\,$TeV while keeps more or less spherical at $\\geq 10\\,$TeV for middle-aged pulsars. The proper motion can induce observable offsets between the position of the pulsar and the center of the halo from GeV up to a few TeV energies provided that the source is located within several kpc from Earth. It is more difficult to produce resolvable offset of the pulsar halo at higher energy due to more rapid cooling of emitting electrons. Our result can provide constraints on the origins of the observed extended sources at very high energies.'

Collaborations

Keywords and Comments
'Gamma-ray; TeV Halo; Pulsar', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

The detectability of fast gamma-ray blazar flares from magnetic reconnection with the Fermi Large Area Telescope

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Maria Petropoulou
Author and Co-Author
Maria Petropoulou, Manuel Meyer | Ian Christie

Abstract
'The physical mechanism for the production of fast gamma-ray variability in blazars remains debated. Plasmoids – magnetized quasi-circular structures of plasma formed self-consistently in reconnecting current sheets – are ideal candidates for the production of broadband variable non-thermal emission. Using state-of-the-art kinetic simulations of magnetic reconnection and radiative transfer calculations, we generate artificial gamma-ray light curves that would be observed with the Fermi Large Area Telescope (LAT). Our goal is to investigate if characteristic features of the theoretical light curves, such as the ultra-rapid gamma-ray flares predicted by the reconnection model, are detectable with the typical Fermi-LAT observations. A comparison with observed luminous and fast gamma-ray flares from flat spectrum radio quasars (FSRQs) reveals that magnetic reconnection events lead to comparable flux levels and variability patterns, especially when the reconnection layer is slightly misaligned with the line of sight. Emission from fast plasmoids moving close to the line of sight could explain fast variability on the time scales of minutes for which evidence has been found in observations of FSRQs. Our results motivate improvements in the existing reconnection model for blazars as well as dedicated searches for fast variability in LAT data as evidence for magnetic reconnection events.'

Collaborations

Keywords and Comments
'AGN; jets; gamma-ray flares; magnetic reconnection', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

The role of unresolved PWNe to the gamma-ray diffuse emission at GeV

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 53 PWN and Halos | GAD-GAI
Presenter Forum Table

Presenter
Giulia Pagliaroli
Author and Co-Author
Giulia Pagliaroli | Vittoria Vecchiotti | Francesco Villante,

Abstract
'We recently performed a population study of the HESS Galactic Plane Survey (HGPS) \r\n considering the specific assumption that most of the bright TeV gamma-ray sources observed by HESS are powered by pulsar activity, such as PWNe or TeV halos. \r\n In this paper, we discuss the implications of the TeV source population for the interpretation of Fermi-LAT data in the GeV domain. \r\n We show that consistency among HGPS and 3FGL catalogues requires that the ratio $r \\equiv \\Phi_{\\rm GeV}/\\Phi_{\\rm TeV}$, where $\\Phi_{\\rm GeV}$ ($\\Phi_{\\rm TeV}$) is the integrated gamma-ray flux emitted by sources in the range 1-100 GeV (1-100 TeV) probed by Fermi-LAT (HESS), is typically $r \\sim 500$. \r\n Considering that the average spectral index of observed sources at TeV energies is $\\gamma \\sim 2.4$, the required value for r can be only obtained by assuming that sources have spectral break at $\\sim 0.1-1.0$ TeV and harder emission spectrum with $\\gamma < 2$ in the GeV domain.\r\n Such spectral shapes are well compatible with the expected gamma-ray emission in young PWNe due to Inverse Compton scattering of high-energy electrons on background radiation fields.\r\n Finally, we show that a relevant fraction of the TeV source population cannot be resolved by Fermi-LAT in the GeV domain. We suggest that unresolved sources can provide a not negligible contribution to the large-scale diffuse emission observed by Fermi-LAT, possibly explaining the spectral hardening of this component toward the galactic center reported by Gaggero et al. 2018, Yang et al. 2016, Acero et al. 2016.'

Collaborations

Keywords and Comments
'gamma-ray sources; PWN; diffuse emission;', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

High-energy and very high-energy gamma-ray emission from the magnetar SGR 1900+14 outskirts

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Vadym Voitsekhovskyi
Author and Co-Author
Bohdan Hnatyk | Vadym Voitsekhovskyi | Roman Hnatyk | Valery Zhdanov,

Abstract
"Hypernova remnants (HNRs) and magnetar wind nebulae (MWNe), supported by new-born millisecond magnetars, as well as magnetar giant flares are promising PeVatron candidates and even potential sources of ultra high energy cosmic rays (UHECRs, E>10^{18} eV). Nonthermal high-energy (HE, E>100 MeV) and very high-energy (VHE, E>100 GeV) γ-ray emission from magnetars' outskirts should be an observed signature of CR acceleration processes. We investigate HE and VHE γ-ray emission from the vicinity of the magnetar SGR 1900+14 as one generated by cosmic rays accelerated in a (still undetected) magnetar-related Supernova remnant and/or MWN. Modelling of the observed HE (the extended *Fermi*-LAT source 4FGL J1908.6+0915e) and VHE (the extended H.E.S.S. source candidate HOTS J1907+091 and the point-like HAWC TeV source 3HWC J1907+085) γ-ray emission, spatially coincident with the magnetar SGR 1900+14, was carried out in the framework of hadronic and leptonic models. We show that the observed γ-ray emission of abovementioned sources may be explained by a magnetar-connected HNR and/or a MWN created by a new-born millisecond magnetar with a large rotational energy E_rot ≈ 10^{52} erg. We analyse also all presently available multi-band observational data concerning the magnetar SGR 1900+14 and its environment and justify their explanation in the model of Hypernova-like explosion of a SGR 1900+14 progenitor."

Collaborations

Keywords and Comments
'Magnetars; particle acceleration; cosmic rays; Supernova remnants; pulsar wind nebulae; gama-rays; nonthermal radiation mechanisms', ''

Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Investigating the millisecond pulsar and dark matter interpretations of the gamma ray excess of the Andromeda Galaxy

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 288

Presenter
Fabian Zimmer
Author and Co-Author
Fabian Zimmer | Oscar Macias,

Abstract
'There has been a recent discovery of an excess in the gamma ray emission from the Andromeda Galaxy (M31) observed with the Fermi Large Area Telescope. The origin of this excess, however, is completely unknown. The goals of this work are (1) to show that the excess is indeed real and not due to improper treatment of the back-/foreground models; (2) to analyze the morphology and spectrum of the signal with robust statistical methods; and (3) to test different source models (either astrophysical or exotic), which could explain this excess.\r\nThe first goal is accomplished by using different combinations of the individual back-/foreground components, constructed to trace hydrogen gas or emission due to Inverse Compton scattering. The region around M31 was excised from these maps and inpainted over with machine learning techniques. With these different templates and multiple inpainting algorithms, these back-/foreground models are used to get to the systematic uncertainties, to ultimately see how significant the excess really is.\r\nWe achieve the second and third goals by testing a variety of spatial and spectral models, both accounting for point-like and extended source signals.\r\nFurthermore, we constructed more sophisticated stellar maps containing old populations of red giants, serving as tracers for pulsars. This serves to contribute to a long-standing debate, whether the signal could come from an unresolved population of millisecond pulsars. Finally, the more exotic but exciting claim, that the signal could come from dark matter annihilation is tested with a variety of spatial density profiles.'

Collaborations

Keywords and Comments
'Gamma Rays; Andromeda; Inpainting; millisecond pulsar', ''

Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

HI absorption and Galactic Center Excess

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 289

Presenter
Chris Gordon
Author and Co-Author
Martin Pohl | Phaedra Coleman | Chris Gordon | Oscar Macias,

Abstract
'Pohl et al. (2008) used a gas-flow model based on a SPH simulation to deconvolve Galactic CO data. They employed an iterative method to successively reduce signal in the line spectrum and place it at the eight best-matching distance intervals, until there is only noise left. In Macias et al. (2018) an analogous deconvolution of HI data was found to provide a better fit to the diffuse gamma-ray emission from the Galactic-center region than do the gas maps of the standard Fermi-LAT data analysis pipeline. The absorption correction was minimal and involved only self-absorption with constant excitation temperature of 170 K. Continuum emission was ignored, which means weak positive signal was deemed optically thin and negative signal had to be disregarded. In the Galactic-center region these simplifications lead to a potentially significant underestimation of the mass of atomic gas, and hence a deficit in the predicted diffuse gamma-ray emission and an artificial indication for new emission components. \r\n\r\nIn this talk we will present an advanced model of atomic gas in the Galaxy and apply it to the analysis of gamma-ray emission from the Galactic center. We account for both line and continuum emission in the radiation transport, which allows the modelling of negative line intensity and traces gas in both emission and absorption. We find good fits to the HI data for a broad range of excitation temperatures. We will also discuss whether the new maps provide a better fit to the Fermi-LAT Galactic-center data and whether the estimates of the Galactic-center excess are affected.'

Collaborations

Keywords and Comments
'Galactic center Excess; Fermi-LAT; HI density distribution', ''

Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

The imprint of protons on the emission of extended blazar jets

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 290

Presenter
Michael Zacharias
Author and Co-Author
Michael Zacharias | Anita Reimer | Andreas Zech,

Abstract
'Blazars – active galaxies with the jet pointing at Earth – emit across all electromagnetic wavelengths. The so-called one-zone model has described well both quiescent and flaring states, however it cannot explain the radio emission. In order to self-consistently describe the entire electromagnetic spectrum, extended jet models are necessary. Notably, kinetic descriptions of extended jets can provide the temporal and spatial evolution of the particle species and the full electromagnetic output. Here, we present the initial results of a recently developed hadronic extended-jet code. As protons take much longer than electrons to lose their energy, they can transport energy over much larger distances than electrons and are therefore essential for the energy transport in the jet. Furthermore, protons can inject additional leptons through pion and Bethe-Heitler pair production, which can explain a dominant leptonic radiation signal while still producing neutrinos. We will present a detailed parameter study and provide insights into the different blazar sub-classes.'

Collaborations

Keywords and Comments
'AGN; kinetic model; extended jet;', ''

Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

The ablation of gas clouds by blazar jets and the long-lasting flare in CTA 102

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 291

Presenter
Michael Zacharias
Author and Co-Author
Michael Zacharias | Jonathan Heil | Markus Böttcher | Felix Jankowsky | Jean-Philippe Lenain | Stefan Wagner | Alicja Wierzcholska,

Abstract
'Long-lasting, very bright multiwavelength flares of blazar jets are a curious phenomenon. The interaction of a large gas cloud with the jet of a blazar may serve as a reservoir of particles entrained by the jet. The size and density structure of the cloud then determine the duration and strength of the particle injection into the jet and the subsequent radiative outburst of the blazar. In this presentation, a comprehensive parameter study is provided showing the rich possibilities that this model offers. Additionally, we use this model to explain the 4-months long, symmetrical flare of the flat spectrum radio quasar CTA 102 in late 2016. During this flare, CTA 102 became one of the brightest blazars in the sky despite its large redshift of z=1.032.'

Collaborations

Keywords and Comments
'AGN; blazars; long-lasting flares', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Dissecting the inner Galaxy with gamma-ray pixel count statistics

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
Silvia Manconi
Author and Co-Author
Silvia Manconi, Fiorenza Donato | Francesca Calore

Abstract
"The nature of the GeV gamma-ray Galactic center excess (GCE) in the data of Fermi-LAT is still under investigation. Different techniques, such as template fitting and photon-count statistical methods, have been applied in the past few years in order to disentangle between a GCE coming from sub-threshold point sources or rather from diffuse emissions, such as the dark matter annihilation in the Galactic halo.\r\nA major limit to all these studies is the modeling of the Galactic diffuse foreground, and the impact of residual mis-modeled emission on the results' robustness.\r\nIn Ref.[1], we combine for the first time adaptive template fitting and pixel count statistical methods in order to assess the role of sub-threshold point sources to the GCE, while minimizing the mis-modelling of diffuse emission components.\r\nWe reconstruct the flux distribution of point sources in the inner Galaxy well below the Fermi-LAT detection threshold, and measure their radial and longitudinal profiles. We find that point sources and diffuse emission from the Galactic bulge each contributes about 10% of the total emission therein, disclosing a sub-threshold point-source contribution to the GCE.\r\n\r\n[1] arXiv:2102.12497"

Collaborations

Keywords and Comments
'Galactic center excess; gamma rays; Fermi-LAT', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

A two-zone emission model for Blazars and the role of Accretion Disk MHD winds

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Stella Boula
Author and Co-Author
Stella Boula | Demosthenes Kazanas | Apostolos Mastichiadis,

Abstract
'Blazars are a sub-category of radio-loud active galactic nuclei with relativistic jets pointing towards the observer. They exhibit non-thermal variable emission, which practically extends over the whole electromagnetic spectrum. Despite the plethora of multi-wavelength observations, the origin of the emission in blazar jets remains an open question. In this work, we construct a two-zone leptonic model: particles accelerate in a small region and lose energy through synchrotron radiation and inverse Compton Scattering. Consequently, the relativistic electrons escape to a larger area where the ambient photon field, which is related to Accretion Disk MHD Winds, could play a central role in the gamma-ray emission. This model explains the Blazar Sequence and the broader properties of blazars, as determined by Fermi observations, by varying only one parameter, the mass accretion rate onto the central black hole. Flat Spectrum Radio Quasars have a strong ambient photon field and their gamma-ray emission is dominated by the more extensive zone, while in the case of BL Lac objects, the negligible ambient photons make the smaller (acceleration) zone dominant.'

Collaborations

Keywords and Comments
'AGN; Blazars; radiation mechanisms; particle acceleration; gamma-rays; Fermi telescope; accretion disk winds', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Gamma-rays from young SNRs in dense circumstellar environments

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Jonathan Mackey
Author and Co-Author
Jonathan Mackey, Robert Brose

Abstract
"Supernova remnants are known to accelerate cosmic rays from their non-thermal emission of radio waves, X-rays, and gamma rays. However, the ability to accelerate cosmic rays up to PeV energies has yet to be demonstrated. The presence of cutoffs in the gamma-ray spectra of several young SNRs led to the idea that PeV energies might only be achieved during the earliest stages of a remnant's evolution. We use the time-dependent particle-acceleration software RATPaC to study the acceleration of cosmic rays in dense circumstellar environments (CSE) of massive stars, where the dense target material could produce gamma-rays bright enough for detection by current and future experiments. We performed spherically symmetric simulations in which we simultaneously solve equations for the transport for cosmic rays, evolution of magnetic turbulence, and hydrodynamical flow of the thermal plasma, in the test-particle limit. We investigated typical CSE conditions for freely-expanding winds around Red Supergiants and Luminous Blue Variables, as well as structured ambient media due to photoionization-confined shells or episodes of enhanced mass loss prior to the SN explosion. Potentially detectable gamma-ray signals can be expected in the Fermi-LAT band weeks to months post-explosion for wind CSE. Likewise, the interaction with dense shells enhances the gamma-ray luminosity, which is accompanied by a re-brightening in thermal X-rays that might be used as trigger for dedicated gamma-ray observations. The maximum achievable energy may be limited even in the presence of strong magnetic fields close to the progenitor star because of enhanced damping of turbulence due to cascading."

Collaborations

Keywords and Comments
'Particle acceleration; supernova remnants', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

BlaVar: A numerical study of long-term multi-wavelength blazar variability

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Markos Polkas
Author and Co-Author
Markos Polkas, Maria Petropoulou Petropoulou | Georgios Vasilopoulos | Apostolos Mastichiadis | Megan Urry | Paolo Coppi | Charles Bailyn

Abstract
'Blazars are characterized by flux variability that is frequency-dependent and manifests in a variety of timescales. Decade-long monitoring of blazars at optical and infrared (OIR) wavelengths with the Small and Moderate Aperture Research Telescope System (SMARTS) in Chile and in gamma-rays with the Fermi Large Area Telescope (LAT) has enabled the systematic study of their multi-wavelength long-term variability. These studies pinpoint that besides extreme short-term variability (minutes to hours), a source can exhibit correlated and uncorrelated inter-band flux variability between different observation periods and/or on different timescales (days to years).\r\n\r\nIn this work, we investigate from a theoretical perspective the long-term variability properties of blazar emission. To do so, we impose variations on the main parameters of the one-zone leptonic model (injection luminosity of relativistic electrons, strength of magnetic field, Doppler factor, and external photon field luminosity) motivated by the Fermi-LAT full-mission light curves of blazars. Using as case studies two bright and well-monitored blazars from the SMARTS sample (PKS2155-304 and 3C273), we compute 10 year-long OIR, X-ray, and gamma-ray model light curves for different varying parameters. We compare the findings of our theoretical investigation with multi-wavelength observations using various measures of variability. While no single-varying parameter simulation can explain all multi-wavelength variability properties, our results motivate future time-dependent studies with coupling between two or more physical parameters to describe the multi-wavelength long-term blazar variability.'

Collaborations

Keywords and Comments
'AGN: gamma-rays : multiwavelength: variability: radiative-transfer', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Multi-wavelength probes of the Fermi GeV excess

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Joanna Berteaud
Author and Co-Author
Joanna Berteaud | Francesca Calore | Pasquale Dario Serpico | Maïca Clavel | Guillaume Dubus | Pierre-Olivier Petrucci,

Abstract
'More than a decade after its discovery, the Fermi GeV excess is still an exciting subject of research. Thus far, an unresolved population of millisecond pulsars (MSPs) in the Galactic bulge shining in gamma rays is the favorite explanation to the excess, but other explanations exist. Data from the Fermi-LAT have been thoroughly studied and, in order to discriminate between the different hypotheses, a multi-wavelength approach is now needed. In this talk, I will present the main rationale and results of [1], where we investigated the sensitivity of current X-ray telescopes to a Galactic bulge MSP population. We created a synthetic population of MSPs based on models fitted to observational data and constructed an empirical connection between gamma- and X-ray emission based on observed source properties. By comparing our mock population to the Chandra sensitivity towards the Galactic center, we concluded that a non negligible amount of MSPs should be detectable in X-rays. Using the latest Chandra source catalog, we selected yet unidentified sources based on spectral observables and optical astrometry with Gaia, and found a significant number of them being potential MSPs candidates. Finally, I will present some new developments aimed to further reduce our X-ray candidate selection, and to make predictions for radio observations.\r\n\r\n[1] arXiv:2012.03580'

Collaborations

Keywords and Comments
'GeV excess; millisecond pulsars; gamma-ray; X-ray; Fermi; Chandra', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Bayesian inference of three-dimensional gas maps: Galactic CO

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 292

Presenter
Philipp Mertsch
Author and Co-Author
Philipp Mertsch | Andrea Vittino,

Abstract
'The three-dimensional distribution of both atomic and molecular gas in the Galaxy is a crucial modelling input, both for the generation of diffuse emission in gamma-rays and the transport of cosmic rays. Here, we present new 3D maps of molecular hydrogen based on the Dame et al. (2001) CO survey compilation. We consider the deprojection as a Bayesian variational inference problem. The posterior distribution of the gas densities allows us to estimate both the mean and uncertainty of the reconstructed density. Unlike most of the previous attempts, we take into account the correlations of gas on a variety of scales which allows curing some of the well-known pathologies, like fingers-of-god effects. Both gas flow models that we adopt incorporate a Galactic bar which induces radial motions in the inner few kiloparsecs and thus offers spectral resolution towards the Galactic centre. We compare our gas maps with those of earlier studies and characterise their statistical properties, e.g. the radial profile of the average surface mass density. We briefly comment on an ongoing deprojection of atomic hydrogen.'

Collaborations

Keywords and Comments
'diffuse emission; gamma-rays; ISM; molecular gas; statistical methods', ''

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Giant cosmic ray halos around M31 and the Milky Way

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Stefano Gabici
Author and Co-Author
Stefano Gabici | Sarah Recchia | Felix Aharonian | Viviana Niro,

Abstract
"Recently, a diffuse emission of 1-100 GeV $\\gamma$-rays has been detected from the direction of Andromeda. The emission is centered on the galaxy, and extends for $\\sim 100-200$ kpc away from its center. Explaining the extended $\\gamma-$ray emission within the framework of standard scenarios for the escape of cosmic rays injected in the galactic disk or in the galactic center is problematic. Here, we argue that a cosmic ray origin (either leptonic or hadronic) of the $\\gamma$-ray emission is possible in the framework of non standard cosmic ray propagation scenarios or in the case of particle acceleration taking place in the galaxy's halo. It would imply the existence of a giant cosmic ray halo surrounding M31, possibly powered by the galaxy nuclear activity, or by accretion of intergalactic gas. Remarkably, if cosmic ray halos, as the one observed around M31, are a common feature of galaxies, including our own, the interactions between cosmic ray protons and the Milky Way circumgalactic gas could also explain the isotropic diffuse flux of neutrinos observed by Icecube."

Collaborations

Keywords and Comments
", "

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Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Cosmic ray acceleration and gamma-ray emission from protostellar jets

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Anabella Araudo
Author and Co-Author
Anabella Araudo, Alexandre Marcowith | Marco Padovani

Abstract
'Synchrotron radio emission from non-relativistic jets powered by massive protostars has been reported, indicating the presence of relativistic electrons and mG magnetic fields. We study diffusive shock acceleration and magnetic field amplification in protostellar jets with speeds between 300 and 1000 km/s. We show that the magnetic field in the synchrotron emitter can be amplified by the non-resonant hybrid (Bell) instability excited by the cosmic-ray streaming. By using the synchrotron data we estimate the magnetic field in the synchrotron emitter and the maximum energy of protons. Protons can achieve maximum energies of about 0.1 TeV and emit GeV gamma rays in their interaction with matter fields. We predict that Fermi can detect gamma rays in IRAS 16547-5247 and IRAS 16848-4603. The detection of this radiation may open a new window to study the formation of massive stars, as well as diffusive acceleration and magnetic field amplification in shocks with velocities of about 1000 km/s.'

Collaborations

Keywords and Comments
'"particle acceleration; gamma rays; astrophysical jets"', ''

Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Using Phase-resolved Spectral and Energy-dependent Light Curve Modelling of the Vela Pulsar to Scrutinize its GeV Emission Mechanism

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems, Microquasars | GAD-GAI
Presenter Forum Table

Presenter
Monica Barnard
Author and Co-Author
Monica Barnard, Alice K. Harding | Tyrel J. Johnson | Christo Venter | Constantinos Kalapotharakos

Abstract
"Recent detection of the Vela pulsar in the GeV band up to $\\sim$100 GeV by both H.E.S.S. and the Fermi Large Area Telescope provides evidence for a curved spectral component in this band, distinct from the TeV pulsed emission seen by H.E.S.S. up to $\\sim$7 TeV. We interpret these GeV pulsations to be the result of curvature radiation due to primary particles in the pulsar magnetosphere, primarily the current sheet. We present predictions of energy-dependent light curves and phase-resolved spectra using an extended slot gap and current sheet model in a force-free magnetosphere, invoking a step function for the accelerating electric field as motivated by kinetic simulations. Our refined calculation of the curvature radius of particle trajectories in the lab frame impacts the particle transport and resulting light curves and spectra. Our model reproduces the decrease of flux of the first peak versus the second one (P1/P2 effect), evolution of the bridge emission, near constant phase positions of peaks, and narrowing of pulses with increasing energy. We isolate the distribution of Lorentz factors and curvature radii of trajectories associated with the first and second $\\gamma$-ray light curve peaks. The median values of these quantities are slightly larger for the second peak, leading to larger spectral cutoffs (i.e., a `harder' second peak), and thus explaining the P1/P2 effect."

Collaborations

Keywords and Comments
'Gamma rays: stars\r\nPulsars: Vela pulsar\r\nMagnetic fields\r\nFermi Large Area Telescope', ''

Branch GAD | Gamma Ray Direct

Subcategory Theoretical Results

Predictions for TeV fluxes from "Spider" Compact Millisecond Pulsar Binaries

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems, Microquasars | GAD-GAI
Presenter Forum Table

Presenter
Zorawar Wadiasingh
Author and Co-Author
Zorawar Wadiasingh | Christian van der Merwe | Christo Venter | Alice K. Harding | Matthew Baring,

Abstract
'Black widow and redback systems are compact binaries in which a rotation-powered millisecond pulsar interacts with its low-mass companion. In such systems, an intrabinary shock can form as a site of particle acceleration and associated nonthermal emission. We model the X-ray and gamma-ray synchrotron and inverse Compton spectral components for select spider binaries, including diffusion, convection, and radiative energy losses in an axially symmetric, steady-state approach. Our new multizone code simultaneously yields energy-dependent light curves and orbital-phase-resolved spectra. Using parameter studies and matching the observed X-ray spectra and light curves, as well as Fermi Large Area Telescope spectra where available, with a synchrotron component, we constrain model parameters. This affords a more robust prediction of the expected high-energy and VHE gamma-ray flux. It also better constrains the multiplicity of electron/positron pairs that have been accelerated up to TeV energies and are necessary to power orbitally-modulated synchrotron emission components between the X-rays and MeV/GeV potentially observed in some systems. We find that nearby MSPs with hot or flaring companions may be promising targets for CTA, and that such spider binaries could contribute to the observed AMS2 energetic positron excess.'

Collaborations

Keywords and Comments
'Millisecond Pulsars; Pulsar binaries; Particle acceleration; Positrons; Pulsar winds; Termination Shock; Pulsar Nebulae', 'This some of it concerns TeV astronomy, it could fit into GAI as well as GAD.'

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The first cross-calibration of Imaging Atmospheric Cherenkov Telescopes with a UAV-based airborne calibration platform

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 132

Presenter
Jacques Muller
Author and Co-Author
Jacques Muller | Anthony M. Brown | Mathieu de Naurois,

Abstract
"The Cherenkov Telescope Array (CTA) will have unprecedented accuracy and sensitivity, affording us the ability to understand the mysteries of the high energy universe. This unprecedented accuracy does however also force us to adapt current calibration procedures, or indeed pioneer new techniques, to ensure the envisaged CTA performance. CTA will infer the energy of the gamma-rays it detects by the amount of Cherenkov radiation it observes. As such, the optical efficiency of the telescopes needs to be monitored and also its wavelength dependent degradation, which might be different for different telescope types, needs to be determined. Based on the results of a feasibility study, a novel cross-calibration method with an unmanned aerial vehicle (UAV) was tested on the H.E.S.S. telescope array, leading to the World's first cross-calibration of an Imaging Atmospheric Cherenkov Telescope (IACT) array with a single light source. In this talk, we present the cross-calibration results from a first campaign in which we determine the relative optical efficiencies of the four HESS-I telescopes by successfully recording light from the UAV-mounted nanosecond pulsed UV light source simultaneously in all four telescopes. In addition, we show that the UAV data can be used to monitor the pointing accuracy at least at the level of tens of arcseconds and we give an outlook on other potential use cases of the UAV such as the monitoring of the atmospheric state."

Collaborations

Keywords and Comments
'Gamma-ray; IACT; calibration; cross-calibration; optical efficiency; UAV;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The search for high altitude sites in South America for the SWGO detector

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 133

Presenter
Michele Doro
Author and Co-Author
Michele Doro | Arthur Moraes | Marcos Santander | Dusan Mandat | Luis Miguel Mendes | Marco Giammarchi, Jakub Vícha | Ibrahim Torres | Fabian Schussler | Andres Sandoval

Abstract
'The Southern Wide-field Gamma-ray Observatory (SWGO) is a project for a new generation of extensive air shower detectors, based on the water Cherenkov technique, to be located in the Southern Hemisphere, where no other instruments of that kind is currently operating in the TeV energy range. The reference configuration of SWGO foresees an array of about 6,000 water Cherenkov tanks deployed over a circle of 320 m diameter, about 80,000 square meter area. In order to reach a sensitivity at energies around and below 1 TeV competitive with current and future detectors, SWGO will be placed at altitude above 4,400 m a.s.l. Preliminary site searches have found several candidate sites in Argentina, Bolivia, Chile and Peru. The major challenge will be the water provision, considering more than 100 kt of water are possibly required. This poster will present the challenges and status of the SWGO site search in South America.'

Collaborations
SWGO,

Keywords and Comments
'EAS; detector; PeV', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

TAIGA-IACT control and monitoring software status

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 134

Presenter
Dmitriy Zhurov
Author and Co-Author
Dmitriy Zhurov | Dmitriy Lukyantsev | Oleg Gress,

Abstract
'The TAIGA-IACTs are part of the hybrid TAIGA experimental complex, located near lake Baikal in Tunka valley, Siberia, Russia. The telescopes have segmented mirrors in Davis-Cotton design with the reflector diameter of 4.3 m and an imaging camera with PMTs in its focus to detect nanosecond flashes of Cherenkov light from EAS. The TAIGA-IACTs are operating in wobble mode. Their operation requires high pointing and tracking accuracy, especially important for long exposure times. The telescope positioning system consists of steppers motors, 17-bit angular encoders and a CCD camera for accurate monitoring of the telescope pointing by stars in its field of view and related calibration procedures. The telescope is controlled by using the custom software based on the EPICS (Experimental Physics and Industrial Control System) package. This report presents an overview of the TAIGA-IACT control and monitoring software, pointing accuracy and the relevant calibration procedures.'

Collaborations
TAIGA,

Keywords and Comments
'IACT; telescope; control; monitoring; software', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The Architecture of ASTRI Mini Array Cherenkov Camera Software Supervisor

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 135

Presenter
Mattia Corpora
Author and Co-Author
Mattia Corpora | Alessandro Grillo | Pierluca Sangiorgi | Milvia Capalbi | Osvaldo Catalano | Giuseppe Sottile | Federico Russo | Gino Tosti | Andrea Bulgarelli | Fabrizio Lucarelli | Nicolò Parmiggiani | Joseph Hilary Schwarz | Salvatore Scuderi,

Abstract
'The ASTRI Mini-Array (MA) is an INAF project to construct and operate an experiment to study gamma-ray sources emitting up to the TeV spectral band. The ASTRI MA consists of an array of nine Imaging Atmospheric Cherenkov Telescopes that will be deployed at the Observatorio del Teide (Tenerife, Spain). These telescopes will be an evolution of the two-mirror ASTRI-Horn telescope, successfully tested since 2014 at the Serra La Nave Astronomical Station of the INAF Observatory of Catania. Each telescope will be equipped with the new version of the ASTRI Silicon Photo-Multiplier (SiPM) Cherenkov Camera.\r\nThe ASTRI-MA will be monitored and controlled by a Supervisory Control And Data Acquisition (SCADA) system which consists of different software subsystems. One of these is the Cherenkov Camera Supervisor (CCS) that controls each Cherenkov Camera.\r\nIts main functionality is to realize an interface between each Camera and the central SCADA software.\r\nThe CCS provides the services to control and monitor the Camera through the Alma Common Software (ACS). This is a framework based on object-oriented CORBA middleware, which gives the infrastructure for the exchange of messages between distributed objects and system wide services. The CCS is based on the Open Platform Communications - Unified Architecture (OPC-UA) protocol, a platform-independent service-oriented architecture.\r\nThis work presents the design and the technologies used by the ASTRI Camera team to implement the CCS. It describes architecture and functionalities starting from the definition of the use cases and the system requirements.'

Collaborations
other (fill field below), ASTRI Mini Array

Keywords and Comments
", "

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The Online Observation Quality System for the ASTRI Mini Array.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 136

Presenter
Nicolò Parmiggiani
Author and Co-Author
Nicolò Parmiggiani | Andrea Bulgarelli | Leonardo Baroncelli | Antonio Addis | Valentina Fioretti | Ambra Di Piano | Milvia Capalbi | Osvaldo Catalano | Vito Conforti | Michele Fiori | Fulvio Gianotti | Fabrizio Lucarelli | Maria Concetta Maccarone | Tere,

Abstract
'The ASTRI Mini-Array is an international collaboration led by the Italian National Institute for Astrophysics (INAF), aiming to construct and operate an array of nine Imaging Atmospheric Cherenkov Telescopes to study gamma-ray sources at very high energy (TeV) and perform Stellar intensity interferometry observations. \r\n\r\nThis contribution describes the design and the technologies used by the ASTRI team to implement the Online Observation Quality System (OOQS). \r\n\r\nThe main objective of the OOQS is to perform data quality analyses in real-time during Cherenkov and Intensity Interferometry observations to provide feedback to both the Array Control System and the Operator. The OOQS perform the analysis of a set of key data quality parameters and can generate alarms to other sub-systems for a fast reaction to solve critical conditions in real-time. The results from the data quality analyses are saved into the Quality Archive for further investigations. The main challenge addressed by the OOQS design is the high data rate (up to 3Gbit/s) produced by each telescope and acquired by the Array Data Acquisition System that sends it to the OOQS. \r\n\r\nIn the current OOQS design, developed on the basis of the definition of specific use cases and requirements, the Redis NoSQL database manages the data throughput generated by the telescopes, and the Slurm workload scheduler executes in parallel the high number of data quality analyses. The Operator can visualise the OOQS results (e.g. camera plots, histograms, tables and more) through a Graphical User Interface as soon as they are produced.'

Collaborations
other (fill field below), ASTRI Mini Array

Keywords and Comments
'online data quality; gamma-ray; Cherenkov telescope; data quality; real-time analysis', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Intensity interferometry with the MAGIC telescopes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 137

Presenter
Carlos Delgado
Author and Co-Author
Carlos Delgado | For the MAGIC Collaboration, Nicolas Produit | Roland Walter | Daniel Guberman | Luca Zampieri | Michele Fiori | Miguel Polo | Carlos Diaz | Salvatore Mangano

Abstract
'Due to their large mirror size, fast response to single photons, sensitivity and telescope baselines in the order of 100 m, Imaging Atmospheric Cherenkov Telescopes are ideally suited to make intensity interferometry observations. In 2019 a test readout setup was installed in the two 17-m diameter MAGIC telescopes to allow performing interferometry measurements with them. The first on-sky measurements were able to detect correlated intensity fluctuations consistent with the stellar diameters of three different stars: Adhara ($\\epsilon$ CMa), Benetnasch ($\\eta$ UMa) and Mirzam ($\\beta$ CMa). After the upgrade of the setup in 2021, MAGIC is now equipped with a high duty cycle intensity interferometer, already in operation. A technical description of the interferometer and first results of several known and yet unknown stellar diameter measurements are presented.'

Collaborations
MAGIC,

Keywords and Comments
'photodetection;interferometry;Cherenkov Telescopes', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Detection methods for the Cherenkov Telescope Array at very-short exposure times

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Ambra Di Piano
Author and Co-Author
Ambra Di Piano | Andrea Bulgarelli | Valentina Fioretti | Nicolò Parmiggiani | Leonardo Baroncelli | Giulia Stratta | Giovanni De Cesare | Antonio Stamerra | Francesco Longo | Alicia López-Oramas | for the CTA Consortium,

Abstract
'The Cherenkov Telescope Array (CTA) will be the next generation ground-based observatory for very-high-energy gamma-ray astronomy, with the deployment of tens of highly sensitive and fast-reacting Cherenkov telescopes. It will cover a wide energy range (20 GeV - 300 TeV) with unprecedented sensitivity. Our study is focused on real-time detection at very-short timescales (from 1 to 100 seconds). We built and characterised an analysis and detection pipeline and tested it via the verification of the Wilks' theorem for false-positives. The performance was evaluated in terms of sky localisation accuracy, detection significance and detection efficiency for different observing and analysis configurations. Our goal is to determine the feasibility of the analysis methods at very-short exposure times. We also investigated the sensitivity degradation which is expected in a real-time analysis context and compared it to the requirement of being better than half of the CTA sensitivity. In this work, we present a general overview of the pipeline and the performance obtained for the use-case of a blind-search and detection following an external alert, such as from a gamma-ray burst or a gravitational wave event.'

Collaborations
CTA,

Keywords and Comments
'very-short exposure times; blind detection; transients; real-time analysis;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Robust constraints on Lorentz Invariance Violation from H.E.S.S., MAGIC and VERITAS data combination

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 57 New Physics | CRD-CRI-DM-GAD-GAI-NU-MM-SH
Presenter Forum Table

Presenter
Christelle Levy
Author and Co-Author
Christelle Levy | Julien Bolmont | Sami Caroff | Markus Gaug | Alasdair Gent | Agnieszka Jacholkowska | Daniel Kerszberg | Tony Lin | Manel Martinez | Leyre Nogués | Nepomuk Otte | Cédric Perennes | Michele Ronco | Tomislav Terzić,

Abstract
'Gamma-Ray bursts, flaring active galactic nuclei and pulsars are distant and energetic astrophysical sources, detected up to tens of TeV with Imaging Atmospheric Cherenkov Telescopes (IACTs). Due to their high variability, they are the most suitable sources for energy-dependent time-delay searches related to Lorentz Invariance Violation (LIV) predicted by some Quantum Gravity (QG) models. However, these studies require large datasets. A working group between the three major IACTs ground experiments - H.E.S.S., MAGIC and VERITAS - has been formed to address this issue and combine for the first time all the relevant data collected by the three experiments in a joint analysis.\r\nThis presentation will review the new standard combination method. The likelihood technique used to deal with data from different source types and instruments will be presented, as well as the way systematic uncertainties are taken into account. The method has been developed and tested using simulations based on published source observations from the three experiments. From these simulations, the performance of the method will be assessed and new light will be shed on time delays dependencies with redshift.'

Collaborations
H.E.S.S., MAGIC; VERITAS;

Keywords and Comments
'LIV; Time delays; QG; AGN; GRB; Pulsar; Likelihood; Combined analysis; H.E.S.S.; MAGIC; VERITAS; IACT;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The Application of 20 inch PMT in LHASSO-WCDA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 138

Presenter
Xiaohao You
Author and Co-Author
Xiaohao You | Bo Gao | Mingjun Chen,

Abstract
'In the Large High Altitude Air Shower Observatory (LHAASO), the main physics objective of the Water Cherenkov detector array (WCDA) is able to survey the gamma-ray sky continuously in the energy range from 100 GeV to PeV. The water Cherenkov detector array, covering an area of about 78,000 m2 area, is constituted by 3120 detector units divided into 3 separate ponds. Each unit of the first 150x150 m2 pond are placed 8 inch PMT while the second and third pond are placed 20 inch PMTs. The newly developed 20 inch PMT uses microchannel-plate (MCP) instead of the traditional dynodes enables better energy resolution, good detector response etc. Here plans to give you a full view about the test result of 20 inch MCP-PMT before and after water proof potting with electronics, including TTS, peak-to-valley ratio, and the geomagnetic effect on PMT.'

Collaborations
Lhaaso,

Keywords and Comments
'20 inch MCP_PMT; water proof potting;geomagnetic field effect', ''

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Subcategory Experimental Methods & Instrumentation

Application of Pattern Spectra and Convolutional Neural Networks to the Analysis of Simulated Cherenkov Telescope Array Data

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Jann Aschersleben
Author and Co-Author
Jann Aschersleben, Reynier Peletier | Manuela Vecchi | Michael Wilkinson | for the CTA Consortium

Abstract
'The Cherenkov Telescope Array (CTA) will be the next generation gamma-ray observatory with more than 100 telescopes located in the northern and southern hemispheres. It will be the major global instrument for very high energy astronomy over the next decade, offering one order of magnitude better flux sensitivity than current generation ground-based gamma-ray telescopes. Each telescope will provide a snapshot of gamma-ray induced particle showers by capturing their Cherenkov emission at ground level. The simulation of such events provides images that can be used as training data for Convolutional Neural Networks (CNNs) to determine the energy and direction of the initial gamma rays. Compared to other state-of-the-art algorithms, analyses based on CNNs promise to further enhance the performance to be achieved by CTA.\r\nPattern spectra are commonly used tools for image classification and provide the distributions of the shapes and sizes of various objects comprising an image. The use of relatively shallow CNNs on pattern spectra would automatically select relevant combinations of features within an image, taking advantage of the 2D nature of pattern spectra. In this work, we will generate pattern spectra from simulated gamma-ray events instead of using the raw images themselves in order to train our CNN for energy and arrival direction reconstruction. This is different from other relevant learning and feature selection methods that have been tried in the past. Thereby, we aim to reduce the depth of our neural network to obtain a significantly faster and less computationally intensive algorithm, with minimal loss of performance.'

Collaborations
CTA,

Keywords and Comments
'CTA;gamma ray;machine learning;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

A single photoelectron calibration system for the NectarCAM camera of the Cherenkov Telescope Array Medium-Sized Telescopes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 139

Presenter
Pooja Sharma
Author and Co-Author
Pooja Sharma, Barbara Biasuzzi | Jonathan Biteau | Martin Bourgaux | Sami Caroff | Giulia Hull | Michaël Josselin | Kevin Pressard | Patrick Sizun | Tiina Suomijärvi | Thi Nguyen Trung | for the CTA NectarCAM project

Abstract
"This contribution aims to introduce the single photoelectron system designed to calibrate the camera of the Medium-Sized Telescopes of the Cherenkov Telescope Array (CTA). This system will allow us to measure accurately the gain of the camera's photodetection chain and to constrain the systematic uncertainties on the energy reconstruction of gamma rays detected by CTA. The system consists of a white painted screen, a fishtail light guide, a flasher and an XY motorization to allow movement. The flashes, guided by the fishtail, mimic the Cherenkov radiation and illuminate the focal plane under the screen homogeneously. Then, through the XY motorisation, the screen is moved across the entire focal plane of the NectarCAM camera, which consists of 1855 photo-multiplier tubes. In this contribution, we present the calibration system and the study on its optimum scan positions required to cover the full camera effectively. Finally, we will show the results of the calibration data analysis and discuss the performance of the system."

Collaborations
CTA,

Keywords and Comments
'Cherenkov Telescope Array; NectarCAM; Medium-Sized Telescopes; single photoelectron calibration system', 'The abstract has been verified and accepted by the CTA publication and conference committee (SAPO).'

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

CTbend: A Baysian open-source framework to model pointing corrections of Cherenkov telescopes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 140

Presenter
Gerrit Spengler
Author and Co-Author
Gerrit Spengler | Ullrich Schwanke | Dmitriy Zhurov,

Abstract
'The pointing of Cherenkov telescopes is subject to imperfections which are, e.g. related to\r\nthe bending of the mechanical structure. These imperfections must be measured, modeled and finally corrected for to\r\nachieve an optimal telescope pointing precision. The measurement of pointing deviations is typically\r\nperformed while the telescope points to different stars and a CCD camera\r\nmonitors the offsets of the star images to the center of the focal plane. Outlier in these\r\nmeasurements can propagate into the pointing model and lead to imprecise model predictions.\r\nCTbend is a simple and standalone open-source framework which uses a Baysian\r\nanalysis with an outlier resilient likelihood function to model the pointing of Cherenkov\r\ntelescopes with parametric standard models like TPoint.\r\nThe framework is in the following described on the basis of simulated data.'

Collaborations

Keywords and Comments
'Cherenkov telescope; pointing model; Baysian statistics', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The Monitoring, Logging, and Alarm system for the Cherenkov Telescope Array

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 141

Presenter
Alessandro Costa
Author and Co-Author
Alessandro Costa | Federico Incadona | Kevin Munari, Stefano Germani | Igor Oya | Bruno Pietro | Alessandro Grillo | Eva Sciacca | Ugo Becciani | Mario Raciti

Abstract
'We present the current development of the Monitoring, Logging and Alarm subsystems in the framework of the Array Control and Data Acquisition System (ACADA) for the Cherenkov Telescope Array (CTA). The Monitoring System (MON) is the subsystem responsible for monitoring and logging the overall array (at each of the CTA sites) through the acquisition of monitoring and logging information from the array elements. The MON allows us to perform a systematic approach to fault detection and diagnosis supporting corrective and predictive maintenance to minimize the downtime of the system. We present a unified tool for monitoring data items from the telescopes and other devices deployed at the CTA array sites. Data are immediately available for the operator interface and quick-look quality checks and stored for later detailed inspection.\r\nThe Array Alarm System (AAS) is the subsystem that provides the service that gathers, filters, exposes, and persists alarms raised by both the ACADA processes and the array elements supervised by the ACADA system. It collects alarms from the telescopes, the array calibration, the environmental monitoring instruments and the ACADA systems. The AAS sub-system also creates new alarms based on the analysis and correlation of the system software logs and the status of the system hardware providing the filter mechanisms for all the alarms. Data from the alarm system are then sent to the operator via the human machine interface.'

Collaborations
CTA, ASTRI Mini Array

Keywords and Comments
'monitoring; logging; alarms; Cherenkov Telescope; CTA', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Source-morphology-independent background estimation for extended gamma-ray sources

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Ruo Yu Shang
Author and Co-Author
Ruo Yu Shang,

Abstract
'We present a new background estimation method for a search for largely extended TeV gamma-ray sources with instruments using the imaging atmospheric Cherenkov technique. This novel method does not rely on the assumption of source morphology and uses the cosmic-ray-like events (events that fail gamma-hadron-separation cuts using shower-shape parameters) collected from the given field to estimate the gamma-ray-like background of the same field. We show that the use of cosmic-ray-like events allows an effective reduction of the systematic error on background subtraction. This report explains the methodology, presents the validation of the background method using the gamma-ray-free VERITAS (Very Energetic Radiation Imaging Telescope Array System) dark field data, and includes comparisons with conventional background methods. This new method is suitable for largely extended gamma-ray sources whose angular sizes exceed the capacity of the conventional background methods.'

Collaborations
VERITAS,

Keywords and Comments
'Gamma-ray astronomy; extended gamma-ray sources', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Excess estimation in On/Off measurements including single-event variables

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 142

Presenter
Giacomo D'Amico
Author and Co-Author
Giacomo D'Amico, Michele Doro | Tomislav Terzić | Jelena Strišković | Marcel Strzys | Juliane van Scherpenberg

Abstract
'Signal estimation in the presence of background noise is a common problem in many scientific disciplines. An “On/Off” measurement is when the background itself is imprecisely measured, which is the case for instance of observations performed in astronomy. The ‘frequentist’ and Bayesian approaches for signal estimation in “On/Off” measurements are reviewed and compared, focusing on the weakness of the former and on the advantages of the latter in correctly addressing the Poissonian nature of the problem. We propose a new method for estimating the signal rate based on the Bayesian formalism. It uses information on single-event variables and their distribution for the signal and background population. Events are thereby weighted according to their likelihood of being a signal or a background event and background suppression can be achieved without performing data selection cuts. Simulating “On/Off” measurements from imaging atmospheric Cherenkov observations, we conclude that this new method is capable of increasing the resolution of the signal estimation, in particular for background dominated observations.'

Collaborations

Keywords and Comments
'Excess estimation; On/Off measurements; Bayesian; inference; statistic', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Analysis of the Cherenkov Telescope Array first Large Size Telescope real data using convolutional neural networks

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Mathieu de Bony de Lavergne
Author and Co-Author
Thomas Vuillaume | Mikael Jacquemont | Mathieu de Bony de Lavergne | David Sanchez | Vincent Poireau | Gilles Maurin | Alexandre Benoit | Patrick Lambert | Giovanni Lamanna, for the CTA LST project

Abstract
'The Cherenkov Telescope Array (CTA) is the future ground-based gamma-ray observatory and will be composed of two arrays of imaging atmospheric Cherenkov telescopes (IACTs) located in the Northern and Southern hemispheres respectively. The first CTA prototype telescope built on-site, the Large Size Telescope (LST-1), is under commissioning in La Palma and has already taken data on numerous known sources. \r\nIACTs detect the faint flash of Cherenkov light indirectly produced after a very energetic gamma-ray photon has interacted with the atmosphere and generated an atmospheric shower. Reconstruction of the characteristics of the primary photons is usually done using a parameterization up to the third order of the light distribution of the images.\r\nIn order to go beyond this classical method, new approaches are being developed using state-of-the-art methods based on convolutional neural networks (CNN) to reconstruct the properties of each event (incoming direction, energy and particle type) directly from the telescope images. While promising, these methods are notoriously difficult to apply to real data due to differences (such as different levels of night sky background) between Monte Carlo (MC) data used to train the network and real data.\r\nThe GammaLearn project, based on these CNN approaches, has already shown an increase in sensitivity on MC simulations for LST-1 as well as a lower energy threshold. In this work, we apply the GammaLearn network to real data acquired by LST-1 and compare the results to the classical approach that uses random forests trained on extracted image parameters. The improvements on the background rejection, event direction, and energy reconstruction are discussed in this contribution.'

Collaborations
CTA,

Keywords and Comments
'CTA; analysis; machine learning', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Analysis optimisation for more than 10 TeV gamma-ray astronomy with IACTs

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Iryna Lypova
Author and Co-Author
Iryna Lypova, Stefan Ohm | Stefan Klepser | David Berge | Stefan Wagner

Abstract
'The High Energy Stereoscopic System (H.E.S.S.) is one of the currently operating Imaging Atmospheric Cherenkov Telescopes. H.E.S.S. operates in the broad energy range from a few tens of GeV to more than 50 TeV reaching its best sensitivity around 1 TeV. In this contribution, we present an analysis technique, which is optimised for the detection at the highest energies accessible to H.E.S.S. and aimed to improve the sensitivity above 10 TeV. It includes the employment of improved event direction reconstruction and gamma-hadron separation. For the first time, also extensive air showers with event offsets up to 4.5 degrees from the camera center are considered in the analysis, thereby increasing the effective Field-of-View of H.E.S.S. from 5 to 9 degrees. Key performance parameters of the new high-energy analysis are presented and its applicability demonstrated for representative hard-spectrum sources in the Milky Way.'

Collaborations
H.E.S.S.,

Keywords and Comments
'High energy optimisation', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

GPU Accelerated optical light propagation in CORSIKA8

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 143

Presenter
Dominik Baack
Author and Co-Author
Dominik Baack,

Abstract
"Optical photons, created from fluorescence or Cerenkov emission in atmospheric cascades induced through high energetic cosmic rays are of major interest for several experiments. Experiments like CTA require a significant amount of computing time and funds for the simulation with CORSIKA.\r\n\r\nSince individual photons don't interact they can be simulated without any order as in the traditional sequential approach and on the contrary leads to reduced utilization of modern hardware infrastructure. The calculations on each photon have low complexity, compared to the other aspects of the simulation. This, as well as the fact that besides the photon itself nearly no additional data is needed, favors a data-parallel approach in which several photons are propagated. The new CORSIKA 8 framework enables the implementation and verification of these methods.\r\n\r\nWith the use of dedicated high parallel acceleration hardware like GPUs the possible benefits with this data-parallel approach are even higher. First results and comparisons based on different algorithms and precision levels are shown."

Collaborations
CORSIKA-8,

Keywords and Comments
'GPU; Simulation; CORSIKA; performance; Chrenkov Radiation; Fluorescence;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Development of a Detector Prototype for future High Energy Gamma Ray Experiments

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 144

Presenter
Abaz Kryemadhi
Author and Co-Author
Abaz Kryemadhi | Matthew Farrar | Brandon Weindorf | Aeowyn Kendall | Al Mokris,

Abstract
'Development of instruments capable of detecting gamma rays across vast ranges of energies is important for understanding different astrophysical objects. Instruments are constrained by cost, power, autonomous operation and sensitivity over wide range of energies. Photomultiplier tubes have been the main photon detection technology for these experiments because they can be manufactured in large sizes hence higher light yields. The drawbacks of these devices is their higher voltage of operation, bulky size, and a limited number of vendors producing them. Silicon photomultipliers (SiPMs) are the solid-state equivalents which operate at lower voltage and there is an increase in the number of vendors producing them. The main drawbacks of SiPMs is their small surface area and higher dark rate. In order to circumvent their small area we have constructed a Cherenkov detector prototype with variety of wavelength shifters (WLS) in combination with SiPMs to increase light collection efficiency and report on the detector performance.'

Collaborations
other (fill field below), Small R & D collaboration

Keywords and Comments
'"Cherenkov; Silicon Photomultipliers; Wave Length Shifters; Light collection"', "

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Subcategory Experimental Methods & Instrumentation

Gamma/hadron discrimination using a small-WCD with four PMTs

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 145

Presenter
Ruben Conceição
Author and Co-Author
Ruben Conceição | Pedro Assis | Filipe Assunção | Alena Bakalová | Ulisses Barres de Almeida | Clécio R. Bom | João Correia | Alessandro De Angelis | Luciana Dias | Borja S. Gonzaléz | Alberto Guillén | Giovanni La Mura | Nuno Lourenço | Penousal Machado,

Abstract
"The Southern Wide-field Gamma-ray Observatory (SWGO) is the next-generation gamma-ray observatory, currently in a three-year R&D phase. The experiment is expected to have a large array of water Cherenkov detectors (WCD) placed at a high elevation (> 4.4 km a.s.l.) in South America. Here we present a WCD concept with reduced surface area and height stations comprising four PMTs at the bottom. We show that it is possible to reach an excellent gamma/hadron discrimination by analysing the data gathered by this station with machine learning techniques. Such performance can be achieved by analysing the shower patterns at the ground or through the PMTs signal time structure to tag muons. Moreover, it is shown that the station's performance does not depend on the array configuration (dense or sparse) nor on the shower inclination (theta < 40 deg). Such a concept reduces the cost associated with the transport of massive amounts of water to high elevation sites while keeping a high physics performance. Therefore, it could be a good candidate station for SWGO, enabling it to reach good sensitivities from low energies (~100 GeV) up to the PeV region, covering large ground surface areas (few square km)."

Collaborations
SWGO,

Keywords and Comments
'Detector concept; Gamma-ray wide-field observatory; Gamma/hadron discrimination; Machine Learning', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Lake Deployment of Southern Wide-field Gamma-ray Observatory (SWGO) Detector Units

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 146

Presenter
Hazal Goksu
Author and Co-Author
Hazal Goksu | For the SWGO Collaboration,

Abstract
'Southern Wide-field Gamma-ray Observatory (SWGO) will be a next-generation high altitude gamma-ray survey observatory in the southern hemisphere consisting of an array of water cherenkov detectors. With its energy range, wide field of view, large duty cycle, and location it will complement the other existing and planned gamma-ray observatories. In this contribution, we will describe the lake concept for SWGO, an alternative to the HAWC-like separate detector unit design, and the LHAASO-style artificial ponds. In the lake concept, instead of having tanks filled with water, bladders filled with clean water are deployed near the surface of a natural lake, where each bladder is a light-tight stand-alone unit containing one or more photosensors. We will give an overview of the advantages and challenges of this design concept and describe the first results obtained from prototyping.'

Collaborations
SWGO,

Keywords and Comments
'wcd; gamma-ray survey;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Monitoring Gamma-Ray Burst VHE emission with the Southern Wide-field-of-view Gamma-ray Observatory

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 54 Gamma-Ray Bursts in the VHE regime | GAI
Presenter Forum Table

Presenter
Giovanni La Mura
Author and Co-Author
Giovanni La Mura | Ulisses Barres de Almeida | Ruben Conceição | Alessandro De Angelis | Francesco Longo | Mário Pimenta | Elisa Prandini | Edna Loredana Ruiz Velasco,

Abstract
'It has been established that Gamma-Ray Bursts (GRB) can produce Very High Energy radiation (VHE, E > 100 GeV), opening a new window on the investigation of particle acceleration and radiation properties in the most energetic domain. We expect that next-generation instruments, such as the Cherenkov Telescope Array (CTA), will mark a huge improvement in their observation. However, constraints on the target visibility and the limited duty cycle of Imaging Atmospheric Cherenkov Telescopes (IACT), limit their ability to react promptly to transient events and to characterize them as a population. Here we use a grid of instrument performance estimates, based on the Extensive Air Shower (EAS) array concept proposed by the Southern Wide Field-of-view Gamma-ray Observatory (SWGO) Collaboration, to evaluate the possibility to detect and track VHE emission from GRBs. Observations by the Fermi Large Area Telescope (Fermi-LAT) at high energy (HE, E > 10 GeV), identified some events with a distinct spectral component, which can represent a substantial fraction of the emitted energy and even arise in early stages of the process. Using models based on these properties, we estimate the possibilities that a wide field of view and large effective area ground-based monitoring facility has to probe VHE emission from GRBs. We show that the ability to monitor VHE transients with a nearly continuous scanning of the sky grants an opportunity to access simultaneous electromagnetic counterparts to gravitational waves and relativistic particles sources up to cosmological scales, in a way that is not available to IACTs.'

Collaborations
SWGO,

Keywords and Comments
'GRB; detectors; Extensive air shower', 'for the SWGO Collaboration'

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Status of the VERITAS Stellar Intensity Interferometry (VSII) System

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 147

Presenter
David Kieda
Author and Co-Author
David Kieda | for the VERITAS Collaboration,

Abstract
'The VERITAS Imaging Air Cherenkov Telescope array IACT) was augmented in 2019 with high-speed focal plane electronics to allow the use of VERITAS for Stellar Intensity Interferometry (SII) observations. Since that time, a number of improvements have been made to increase the sensitivity of VSII and increase the speed of nightly data processing. This poster will describe the use of IACT arrays for performing ultra-high resolution (sub-milliarcsecond) astronomical observations. The poster presentation will include a description of the VERITAS-SII focal plane, data acquisition, and data analysis systems. The poster concludes with an evaluation of the VSII observatory's system's current sensitivity, and plans for a future upgrade of the VSII instrument.'

Collaborations
VERITAS,

Keywords and Comments
'Intensity Interferometry; stellar diameters; IACT arrays; stellar envelopes; limb darkening', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

New methods to reconstruct Xmax and the energy of gamma-ray air showers with high accuracy in large wide-field observatories

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Ruben Conceição
Author and Co-Author
Mário Pimenta | Ruben Conceição | Laura Peres | Bernardo Tomé,

Abstract
"A new method to reconstruct the slant depth of the maximum of the longitudinal profile (XmaxXmax\u200b) of high-energy showers initiated by gamma-rays as well as their energy (E0\u200b) are presented. The method were developed for gamma rays with energies ranging from a few hundred GeV to around 10 TeV. An estimator of Xmax is obtained, event-by-event, from its correlation with the distribution of the particles' arrival time at the ground, or the signal at the ground for lower energies. An estimator of E0\u200b is obtained, event-by-event, using a parametrization that has as inputs the total measured energy at the ground, the amount of energy contained in a region near to the shower core and the estimated Xmax\u200b. Resolutions about 40 (20) g/cm2 and about 30(20)% for, respectively, Xmax\u200b and E0\u200b at 1 (10) TeV energies are obtained, considering vertical showers. The obtained results are auspicious and can lead to the opening of new physics avenues for large wide field-of-view gamma-ray observatories. The dependence of the resolutions with experimental conditions is discussed."

Collaborations

Keywords and Comments
'Very high energy gamma-ray; Wide-field observatory; Energy reconstruction', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Monitoring the pointing of the Large Size Telescope prototype using star reconstruction in the Cherenkov camera

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 148

Presenter
Luca Foffano
Author and Co-Author
Luca Foffano | Alessandro Carosi | Mykhailo Dalchenko | Domenico della Volpe | Matthieu Heller | Teresa Montaruli, for the CTA LST project

Abstract
'The first Large Size Telescope (LST-1) proposed for the forthcoming Cherenkov Telescope Array (CTA) has recently started to operate in La Palma. The large structure of LST-1 - with a 23 m mirror dish diameter - imposes a strict control of its deformations that could affect the pointing accuracy and its overall performance. According to CTA specifications that are conceived to resolve e.g. the fine structure of galactic sources, the LST post-calibration pointing accuracy should be better than 14 arcseconds. To fulfill this requirement, the telescope pointing precision is monitored with two dedicated CCD cameras located at the dish center. The analysis of their images allows us to disentangle different systematic deformations of the structure.\r\nIn this work, we investigate a complementary approach with lower precision but offering the possibility to monitor the pointing of the telescope during the acquisition of Cherenkov data. After properly cleaning the events from the Cherenkov showers, the reconstructed positions of the stars imaged in the camera FoV are compared to their nominal expected positions in catalogues. This provides a direct measurement of the telescope pointing, that can be used to cross-check the other methods and as a real-time monitoring of the optical properties of the telescope and of the pointing corrections applied by the bending models. Additionally, this method benefits from not relying on specific hardware or dedicated observations.\r\nIn this contribution we will illustrate this analysis and show results based on sky data of LST-1.'

Collaborations
CTA, LST

Keywords and Comments
'Gamma rays: instrumentation; Cherenkov telescopes: data quality monitoring; Cherenkov telescopes: pointing', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Plans and Tests for Stereoscopic and Monoscopic Operation of Four IACTs of the TAIGA Hybrid Experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 149

Presenter
Pavel Volchugov
Author and Co-Author
Andrey Grinyuk | Evgeny Postnikov | Pavel Volchugov,

Abstract
'The 2nd TAIGA imaging air Cherenkov telescope (IACT) has successfully been put into operation in the Tunka Valley in fall 2020. Currently two more telescopes are under construction and completion. The ability to use the telescopes in the so-called stereo mode of image analysis by taking into account the unusually large distance between them (from 320 m to 500 m), well exceeding the inter-telescope distances in conventional IACT stereo systems, is being explored and discussed. \r\nThe results of the dedicated Monte Carlo are compared with the experiment data from the 1st and the 2nd TAIGA-IACTs.'

Collaborations
TAIGA,

Keywords and Comments
'IACT; Tunka; hybrid; stereo; Monte Carlo; simulation; image analysis', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Technological options for the Southern Wide-field Gamma-ray Observatory (SWGO) and current design status

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 150

Presenter
Felix Werner
Author and Co-Author
Felix Werner, Lukas Nellen | for the SWGO Collaboration

Abstract
'The Southern Wide-field Gamma-ray Observatory (SWGO) Collaboration is in the process of designing and prototyping a wide field of view, high duty cycle complement to CTA and the existing ground-based particle detectors of the Northern Hemisphere (HAWC and LHAASO). In this contribution, we will compare the various technological options for designing the detector and present an overarching system design accommodating them. We will introduce a feasible reference configuration that is used for the first large-scale simulations and cost estimates, and show ongoing prototyping work focused on reaching a maintenance-free and cost-effective detector.'

Collaborations
SWGO,

Keywords and Comments
'', ''

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Subcategory Experimental Methods & Instrumentation

STACEX: a RPC-based detector for a multi-messenger Southern observatory in the GeV-PeV range

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table

Presenter
Gonzalo Rodriguez Fernandez
Author and Co-Author
Gonzalo Rodriguez Fernandez | Marco Tavani | Ciro Bigongiari | Valentina Fioretti | Giuseppe Di Sciascio | Antonio Addis | Giovanni Piano | Rinaldo Santonico,

Abstract
'Recent findings by the LHAASO experiment are opening a new window, that of the PeV sky, to the observation of the electromagnetic spectrum.\r\nSeveral astronomical objects emitting gamma-rays at energies well above 100 TeV have been observed with the LHAASO-KM2 array of scintillators and muon detectors, clearly demonstrating the feasibility of gamma-ray astronomy up to PeV energies.\r\nAn all-sky gamma-ray detector in the Southern Hemisphere, operating in the GeV-PeV range, could complement LHAASO observations, monitor the inner Galaxy and the Galactic Center looking for PeVatrons.\r\nAs shown by LHAASO, a water-Cherenkov based detector is not well suited to measure the energy spectrum up to the PeV range, nor to reach the advisable 100 GeV threshold.\r\nThe ARGO-YBJ experiment, operated for many years at 4300 m a.s.l. with an energy threshold of about 300 GeV, demonstrated, on the contrary, the capability of a carpet of Resistive Plate Chambers (RPCs) to fully reconstruct showers starting from the GeV range up to about 10 PeV.\r\nIn this contribution we propose a hybrid detector made of a layer of RPCs on top of a water Cherenkov pond devoted to the detection of muons for the selection of gamma-induced showers.\r\nWe present the layout and discuss the expected performance.'

Collaborations
other (fill field below), STACEX

Keywords and Comments
'STACEX;gamma-rays;RPCs;PeVatrons', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Reconstruction of extensive air shower images of the Large Size Telescope prototype of CTA using a novel likelihood technique

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Gabriel Emery
Author and Co-Author
Gabriel Emery | Mykhailo Dalchenko | Luca Foffano | Teresa Montaruli | For the CTA LST project,

Abstract
'Ground-based gamma-ray astronomy requires reconstructing extensive air showers initiated by gamma rays impinging on the atmosphere. Imaging atmospheric Cherenkov telescopes collect the Cherenkov light induced by secondary charged particles in extensive air showers, creating an image of the shower in a camera. This image is parametrized and used to evaluate the type, energy and arrival direction of the primary particle that initiated the shower. This contribution shows the results of a novel reconstruction method based on likelihood maximization. The method is applied to observations of the Crab Nebula acquired with the Large Size Telescope prototype (LST-1) deployed at the Northern site of the Cherenkov Telescope Array. The novelty with respect to previous likelihood reconstruction methods lies in the definition of a likelihood per single camera pixel, accounting not only for the total measured charge, but also for its development over time. It considers the waveform acquired by each pixel involved in the reconstruction of the shower. This reconstruction, which considers also the response characteristics of the sensor in the camera pixel, leads to improved reconstruction of shower images and consequently allows for the recovery of the primary particles properties with an improved accuracy.'

Collaborations
CTA,

Keywords and Comments
'CTA; LST; Image reconstruction; Crab Nebula', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Prototype Schwarzschild-Couder Telescope for the Cherenkov Telescope Array: Commissioning the Optical System

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 151

Presenter
Deivid Ribeiro
Author and Co-Author
Deivid Ribeiro | for the CTA SCT Project,

Abstract
'The Schwarzschild-Couder Telescope (SCT) is a candidate for medium-sized telescopes of the Cherenkov Telescope Array (CTA). CTA will enable improvements in multi-wavelength and multi-messenger observations due to higher angular resolution and increased sensitivity, capable of detecting Crab-like gamma-ray point sources nearly 100 times faster than current arrays. A prototype SCT (pSCT) has been constructed at the Fred Lawrence Whipple Observatory. The pSCT uses a dual-mirror design with a 9.7 m primary mirror and 5.4 m segmented secondary mirror. It has a wide field of view (8 degrees), and allows a compact, high-resolution SiPM camera (0.067 deg per imaging pixel), and substantially improves the off-axis performance giving better angular resolution across all of the field of view with respect to single-mirror telescopes. The novel optical system requires a submillimeter-precision custom alignment system, which was successfully achieved with an on-axis PSF of 2.8 arcmin prior to first-light detection of the Crab Nebula in 2020. Future commissioning work aims to meet the on-axis PSF design goal of 2.6 arcmin, measurement and improvement of the off-axis PSF and development of techniques to maintain alignment stability over telescope structural deformations from pointing and temperature variations. In this contribution, we report on the commissioning status, the alignment procedures, and alignment results during the ongoing commissioning phase of the optical system of the prototype SCT to meet remaining design specifications.'

Collaborations
CTA,

Keywords and Comments
'Atmospheric Cherenkov telescopes; Telescopes; Optical alignment; Optical instrument design; Alignment procedures; Mirrors; Point spread functions; Silicon photomultipliers', ''

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Subcategory Experimental Methods & Instrumentation

Commissioning of the camera of the first Large Size Telescope of the Cherenkov Telescope Array

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 152

Presenter
Takayuki Saito
Author and Co-Author
Takayuki Saito | Carlos Delgado | Oscar Blanch Bigas, Manuel Artero | Juan Abel Barrio | Franca Cassol | Carlos Diaz Ginzo | Daniela Hadasch | Dirk Hoffmann | Julien Houles | Yusuke Inome | Maurizio Iori | Lea Jouvin | Yukiho Kobayashi | Daniel Kerszberg | Hidetoshi Kubo | Gustavo Martinez | Daniel Mazin | E

Abstract
'The first Large Size Telescope (LST-1) of the Cherenkov Telescope Array has been operational since October 2018 at La Palma, Spain, and its camera has been under commissioning. The camera of LST consists of 265 modules, each of which is equipped with 7 PMTs. An analog trigger system is implemented where PMT signals from 3 modules (21 pixels) are summed up before a discriminator. Upon the triggers, the events are readout with a high speed DAQ system with a 60 Gbps bandwidth. In addition, the dedicated system that provides a ~2 ns width UV laser pulse, whose intensity is monitored with a 1% precision, is used to monitor and calibrate the camera performance on a daily basis. \r\n In this contribution we report on the results obtained during the camera commissioning. The commissioning process of the camera required to perform tasks such as flatfielding of PMT gains with a 2% homogeneity, timing calibration for the analog sum trigger with a few ns precision, synchronization of the clock and the trigger propagation within 1 ns accuracy. Moreover, the requirement for the DAQ system was to acquire data at a trigger rate higher than 15 kHz. A deep understanding of the night sky background light and its impact on the trigger and the signal readout were also essential.'

Collaborations
CTA,

Keywords and Comments
'IACT; photodetection; camera;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

SiPM Based Imaging Camera for 4m Class Telescope

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 153

Presenter
Varsha Chitnis
Author and Co-Author
Varsha Chitnis | S. S. Upadhya | K. S. Gothe | S. Duhan | S. K. Rao | B. B. Singh | M. Ranjan | N. K. Parmar | A. Chatterjee | R. L. Deshmukh | P. Dorjey | N. Dorji | A. P. K. Kutty | B. K. Nagesh | V. A. Nikam | S. R. Patel | A. Roy | M. N. Saraf | A.,

Abstract
'In last few years, SiPMs have emerged as a viable alternative to PMTs used in the imaging atmospheric Cherenkov telescopes. In addition to their higher photon detection efficiency, SiPMs provide attractive features like possible increase in observation duty cycle owing to their safe operation under partial moonlight conditions. Design and development of 256 pixel based SiPM camera for a 4m class Cherenkov telescope is currently at an advanced stage. This camera is proposed to cover a field of view of 5 deg X 5 deg, with a pixel size of ~ 0.3 deg. The camera being developed, is planned to be mounted in the focal plane of one of the vertex elements of TACTIC telescope system which is currently operational at Mt Abu, in the north-western part of India. The associated camera electronics will also be mounted in focal plane of telescope behind the SiPM pixels. The camera will have modular structure, with each module consisting of 16 pixel sensors and the associated front end electronics. The signal generated from the pixels on registration of a Cherenkov event will be passed to “back-end” electronics for trigger generation, digitization @1GSPS and the subsequent data recording. A 16-pixel prototype module has already been developed and tested in our laboratory. A “mini-camera” consisting of 64 pixels has also been assembled and is currently at advanced stage of testing. After completion of the successful testing of the “mini-camera”, field tests at the telescope site will be conducted. Salient features of the SiPM based camera, results from the tests conducted by us and status report will be presented.'

Collaborations

Keywords and Comments
'Gamma Ray Telescope; Atmospheric Cherenkov Technique; VHE gamma Rays', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Camera Calibration of the CTA-LST prototype

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 154

Presenter
Yukiho Kobayashi
Author and Co-Author
Yukiho Kobayashi, Akira Okumura | Franca Cassol | Hideaki Katagiri | Julian Sitarek | Pawel Gliwny | Seiya Nozaki | Yuto Nogami | For the CTA LST project

Abstract
'The Cherenkov Telescope Array (CTA) is the next-generation gamma-ray observatory that is expected to reach one order of magnitude better sensitivity than that of current telescope arrays. The Large Size Telescopes (LSTs) have an essential role in extending the energy range down to 20 GeV. The prototype LST (LST-1) proposed for CTA was built in La Palma, the northern site of CTA, in 2018. LST-1 is currently in its commissioning phase and moving towards scientific observations. The LST-1 camera consists of 1855 photomultiplier tubes (PMTs) which are sensitive to Cherenkov light. PMT signals are recorded as waveforms sampled at 1 GHz rate with Domino Ring Sampler version 4 (DRS4) chips. Fast sampling is essential to achieve a low energy threshold by minimizing the integration of background light from the night sky. Absolute charge calibration can be performed by the so-called F-factor method, which allows calibration constants to be monitored even during observations. A calibration pipeline of the camera readout has been developed as part of the LST analysis chain. The pipeline performs DRS4 pedestal and timing corrections, as well as the extraction and calibration of charge and time of pulses for subsequent higher-level analysis. The performance of each calibration step is examined, and especially charge and time resolution of the camera readout are evaluated and compared to CTA requirements. We report on the current status of the calibration pipeline, including the performance of each step through to signal reconstruction, and the consistency with Monte Carlo simulations.'

Collaborations
CTA,

Keywords and Comments
", "

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Subcategory Experimental Methods & Instrumentation

VERITAS throughput calibration

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 155

Presenter
Mireia Nievas Rosillo
Author and Co-Author
Mireia Nievas Rosillo, the VERITAS Collaboration

Abstract
'Imaging Air Cherenkov Telescopes are continuously exposed to varying weather conditions that have short and long-term effects on their response to Cherenkov light from extensive air showers. This work presents the implementation of a throughput calibration method for the VERITAS telescopes taking into account changes in the optical response and detector performance over time. Different methods to measure the total throughput of the instrument, sum of optical response and detector performance, are discussed as well as the effect of its evolution on energy thresholds, effective collection areas, and energy reconstruction. The application of this calibration in the VERITAS reconstruction process is discussed, including the validation using Monte Carlo simulations and observations of the Crab Nebula'

Collaborations
VERITAS,

Keywords and Comments
'Cherenkov light; throughput measurements; signal calibration; instrument response functions; VERITAS; photodetection', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

A data-driven evaluation of Fermi-LAT extrapolation schemes to the VHE regime.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 156

Presenter
Mireia Nievas Rosillo
Author and Co-Author
Mireia Nievas Rosillo | Tarek Hassan,

Abstract
'After 10 years of operations of the Large Area Telescope (LAT), a high-energy pair-creation telescope onboard the Fermi satellite, the Fermi Collaboration has produced two major catalogs: the 4FGL and the 3FHL. These catalogs represent the best sample of potential very high energy (VHE) emitters that may be studied by Imaging Atmospheric Cherenkov Telescopes (IACTs). Several methods are used to extrapolate the Fermi-LAT spectra to TeV energies, generally using simple analytical functions. The recent success of IACTs has motivated the creation of catalogs listing the discoveries of these experiments. Among these initiatives, gamma-cat excels as an open-access tool to archive high-level results in the VHE field, such as catalogs, spectra and light curves. By using these resources, we present a data-driven methodology to test the reliability of different VHE extrapolation schemes used in the literature and evaluate their accuracy reproducing real VHE observations.'

Collaborations

Keywords and Comments
'VHE; AGN; extrapolations; Fermi-LAT; spectra', ''

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Subcategory Experimental Methods & Instrumentation

Simulation Studies of MACE Gamma Ray Telescope : Estimation of Integral Sensitivity, Angular Resolution and Energy Resolution

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 157

Presenter
Chinmay Borwankar
Author and Co-Author
Chinmay Borwankar, Nilay Bhatt | Subir Bhattacharyya | Mridul Sharma

Abstract
'The **MACE** (Major Atmospheric Cherenkov Experiment) is an Imaging Atmospheric Cherenkov Telescope (IACT) located in Hanle, India. It has highest altitude of 4270 m among all the IACTs in the world. The high altitude of MACE along with its large reflector having diameter of 21 m is expected to yield wide energy coverage of ~20 GeV to ~20 TeV. We have carried out detailed Monte Carlo simulations of the MACE response to gamma and cosmic ray showers in this energy range for various zenith angles between 0$^{\\circ}$ to 60$^{\\circ}$. We estimated the variation of integral flux sensitivity, angular resolution and energy resolution as a function of energy, at various zenith angles. We find that the energy threshold of the MACE remains steady between ~30 GeV to ~50 GeV over the zenith angle range of 0$^{\\circ}$ to 40$^{\\circ}$ with integral flux sensitivity of ~2 % Crab. The Angular resolution of the MACE improves from 0.21$^{\\circ}$ near the energy threshold to 0.07$^{\\circ}$ at energy of > 1 TeV for zenith angle range of 0$^{\\circ}$ to 40$^{\\circ}$. The expected energy resolution of the MACE in the zenith angle range of 0$^{\\circ}$ to 40$^{\\circ}$ varies from ~40% near energy threshold to ~20% for energies above 1 TeV. The MACE will detect Crab like point source within few minutes at all zenith angles, with best detection time of ~80 seconds occurring at zenith angle of 25$^{\\circ}$.'

Collaborations
other (fill field below), MACE

Keywords and Comments
'IACT ; Cherenkv Telescope ; Gamma ray astronomy', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Cross-calibration and combined analysis of the CTA-LST prototype and the MAGIC telescopes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 158

Presenter
Yoshiki Ohtani
Author and Co-Author
Yoshiki Ohtani, Alessio Berti | Davide Depaoli | Federico Di Pierro | David Green | Lea Heckmann | Moritz Hütten | Tomohiro Inada | Ruben Lopez-Coto | Elisabetta Medina | Abelardo Moralejo | Daniel Morcuende | Giorgio Pirola | Marcel Strzys | Yusuke Suda | Ievgen Vovk

Abstract
'The Cherenkov Telescope Array (CTA) will be the next generation gamma-ray observatory, which will consist of three kinds of telescopes of different sizes. Among those, the Large Size Telescope (LST) will be the most sensitive in the low energy range starting from 20 GeV. The prototype LST (LST-1) proposed for CTA was inaugurated in October 2018 in the northern hemisphere site, located in La Palma (Spain), and is currently in its commissioning phase.\r\n MAGIC is a system of two gamma-ray Cherenkov telescopes of the current generation, located approximately 100 m away from LST-1, that have been operating in stereoscopic mode since 2009. Since MAGIC and LST-1 can observe the same air shower events initiated by gamma rays, we can compare the brightness of the showers, estimated energies, and other parameters event by event, which can be used to cross-calibrate the telescopes. Ultimately, by performing combined analyses of the events triggering the three telescopes, we can reconstruct the shower geometry more accurately, leading to better energy and angular resolutions, and a better discrimination of the background showers initiated by cosmic rays. \r\nFor that purpose, as a part of the commissioning of LST-1, we performed joint observations of established gamma-ray sources with MAGIC and LST-1. Also, we have been developing Monte Carlo simulations, and an analysis pipeline for such joint observations which finds event coincidence in the offline analysis based on their timestamps. In this talk, we present the results of the inter-telescope cross-calibration, and the expected performance of joint observations.'

Collaborations
CTA, MAGIC

Keywords and Comments
'IACT; CTA; LST; MAGIC; cross-calibration;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The high-energy upgrade of the HAWC observatory: operation, calibration and performance.

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table

Presenter
Armelle Jardin-Blicq
Author and Co-Author
Armelle Jardin-Blicq | Harm Schoorlemmer | for the HAWC Collaboration,

Abstract
'The High Altitude Water Cherenkov (HAWC) observatory has been upgraded with a sparse array of water-Cherenkov detectors called the outrigger array. It is surrounding the HAWC densely-packed main array, and increases the instrumented area by a factor of 4. The outrigger array aims to improve the performance of HAWC above 10 TeV by better constraining the parameters of high-energy air showers. In this contribution, we present the calibration strategy, the monitoring of the operation of the array, and its performance.'

Collaborations
HAWC,

Keywords and Comments
'Very-high-energy gamma rays -- Water-Cherenkov detector -- Instrumentation -- Calibration', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Event rates of UHE photons cascading in the geomagnetic field at CTA-North

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 159

Presenter
Kevin Almeida Cheminant
Author and Co-Author
Kevin Almeida Cheminant | Dariusz Góra | for the CREDO Collaboration,

Abstract
'Photons in the EeV range and beyond are expected from top-down models of UHECR production and from the GZK effect. As they reach the Earth, they have a non-zero probability of converting into an electron/positron pair in the geomagnetic field and producing an electromagnetic shower above the atmosphere. In this paper, we present a new method to search for cascading UHE photons with gamma-ray telescopes based on Monte-Carlo simulations and multivariate analyses. Considering the future CTA-North experiment in La Palma, Spain, we show that such a method provides an efficient cosmic-ray background rejection with little loss of cascading UHE photon events. We also estimate that if gamma-ray bursts photon emission extends to the EeV regime, the number of expected events in 30 hours of observation time can go up to 0.17.'

Collaborations
other (fill field below), Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'cosmic ray ensembles; ultra-high energy photon; CTA; GRB', 'The main results covered by this article will be summarised in a highlight talk to be presented by a representative speaker of the CREDO Collaboration, if only the Conference Organizers agree that such a talk is given (an appropriate request will be sent

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Standardized formats for gamma-ray analysis applied to HAWC observatory data

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 160

Presenter
Laura Olivera-Nieto
Author and Co-Author
Laura Olivera-Nieto | Vikas Joshi | Harm Schoorlemmer | for the HAWC Collaboration | Axel Donath,

Abstract
'A wide range of data formats and proprietary software have traditionally been used in gamma-ray astronomy, usually developed for a single specific mission or experiment. However, in recent years there has been a shift towards making astronomical data open and accessible. Within the gamma-ray community this has translated to the creation of a common data format across different gamma-ray observatories: the "gamma-astro-data-format" (GADF). Based on a similar premise, open-source analysis packages, such as Gammapy, are being developed and aim to provide a single, robust tool which suits the needs of many experiments at once. In this contribution we show that data from the HAWC observatory can be made compatible with the GADF and present the first GADF-based production of event lists and instrument response functions for a wide-field instrument. We use these data products to reproduce with excellent agreement the published HAWC reference spectrum using Gammapy. Having a common data format and analysis tools facilitates joint analysis between different experiments and effective data sharing. This will be especially important for next-generation instruments, such as the proposed Southern Wide-field Gamma-ray Observatory (SWGO) and the planned Cherenkov Telescope Array (CTA).'

Collaborations
HAWC,

Keywords and Comments
'HAWC; gamma-astro-data-format; wide-field; data format; open source; Gammapy;', 'Axel Donath is not a member of the HAWC collaboration and should be listed after "for the HAWC Collaboration".'

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The Small Size Telescopes for the Southern Site of the Cherenkov Telescope Array

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 161

Presenter
Richard White
Author and Co-Author
Richard White | for the CTA SST Project,

Abstract
'The Cherenkov Telescope Array (CTA) will use three telescope sizes to efficiently detect cosmic gamma rays in the energy range from several tens of GeV to hundreds of TeV. The Small Sized Telescopes (SSTs) will form the largest section of the array, covering an area of many square kilometres on the CTA southern site in Paranal, Chile. Up to 70 SSTs will be implemented by an international consortium of institutes and teams as an in-kind contribution to the CTA Observatory. The SSTs will provide unprecedented sensitivity to gamma rays above 1 TeV and the highest angular resolution of any instrument above the hard X-ray band. CTA has recently finalised the technology that will be used for the SSTs: the telescopes will be a dual-mirror design with a primary reflector of ~4 m diameter, equipped with an SiPM-based camera with full waveform readout from ~2000 channels covering a ~9 degree field of view. Thanks to the aplanatic and small plate-scale Schwarzschild-Couder configuration of the optics, the camera can be compact (diameter ~50 cm, mass ~50 kg) and low cost. In this contribution, we describe the experience gained operating telescope and camera prototypes during the CTA preparatory phase, and the development of the final SST design, including the technologies involved and the implementation plan for series production.'

Collaborations
CTA,

Keywords and Comments
'IACT; technology; SiPMs;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Matched Runs Method to Study Extended Regions of Gamma-ray Emission

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Binita Hona
Author and Co-Author
Binita Hona | for the VERITAS Collaboration,

Abstract
'Imaging atmospheric Cherenkov telescopes, such as the Very Energetic Radiation Imaging Telescope Array System (VERITAS), are uniquely suited to resolve the detailed morphology of extended regions of gamma-ray emission. However, standard VERITAS data analysis techniques have insufficient sensitivity to gamma-ray sources spanning the VERITAS field of view (3.5°), due to difficulties with background estimation. For analysis of such spatially extended sources with 0.5° to greater than 2° radius, we developed the Matched Runs Method. This method derives background estimations for observations of extended sources using matched separate observations of known point sources taken under similar observing conditions. Our technique has been validated by application to archival VERITAS data. Here we present a summary of the Matched Runs Method and multiple validation studies on different gamma-ray sources using VERITAS data.'

Collaborations
VERITAS,

Keywords and Comments
", "

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Reconstruction of stereoscopic CTA events using deep learning with CTLearn

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Tjark Miener
Author and Co-Author
Tjark Miener, Daniel Nieto Castaño | Aryeh Brill | for the CTA Collaboration

Abstract
'The Cherenkov Telescope Array (CTA), conceived as an array of tens of imaging atmospheric\r\nCherenkov telescopes (IACTs), is an international project for a next-generation ground-based\r\ngamma-ray observatory, aiming to improve on the sensitivity of current-generation instruments\r\nby an order of magnitude and provide energy coverage from 20 GeV to more than 300 TeV.\r\nArrays of IACTs probe the very-high-energy gamma-ray sky. Their working\r\nprinciple consists of the simultaneous observation of air showers initiated by\r\nthe interaction of very-high-energy gamma rays and cosmic rays with the atmosphere.\r\nCherenkov photons induced by a given shower are focused onto the camera plane\r\nof the telescopes in the array, producing a multi-stereoscopic record of the event. This\r\nimage contains the longitudinal development of the air shower, together\r\nwith its spatial, temporal, and calorimetric information. The properties of\r\nthe originating very-high-energy particle (type, energy and incoming direction)\r\ncan be inferred from those images by reconstructing the full event using machine\r\nlearning techniques. In this contribution, we present a purely deep-learning\r\ndriven, full-event reconstruction of simulated, stereoscopic IACT events\r\nusing CTLearn. CTLearn is a package that includes modules for loading\r\nand manipulating IACT data and for running deep learning models,\r\nusing pixel-wise camera data as input.'

Collaborations
CTA,

Keywords and Comments
", "

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The TAIGA - an advanced hybrid detector complex for astroparticle physics, cosmic ray physics and gamma-ray astronomy

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table

Presenter
Nikolay Budnev
Author and Co-Author
Nikolay Budnev | Razmik Mirzoyan | Leonid Kuzmichev,

Abstract
'The physical motivations and performance of the TAIGA (Tunka Advanced Instrument for cosmic ray physics and Gamma Astronomy) project are presented. The TAIGA observatory addresses ground-based gamma-ray astronomy at energies from a few TeV to several PeV, as well as cosmic ray physics from 100 TeV to several EeV and astroparticle physics. The pilot TAIGA complex locates in the Tunka valley, ~50 km West from the southern tip of the lake Baikal. It includes integrating air Cherenkov TAIGA-HiSCORE array with 120 wide-angle optical stations distributed over on area 1 square kilometer about and three the 4-m class Imaging Atmospheric Cherenkov Telescopes of the TAIGA-IACT array. The latter array has a shape of triangle with side lengths of about 300m, 400m and 500m. The expected integral sensitivity of the 1 km^2 TAIGA detector will be about 2,5 × 10^{-13} TeV cm^{-2} sec^{-1} for detection of E ≥ 100 TeV gamma-rays in 300 hours of source observations. The combination of the wide angle Cherenkov array and IACTs could offer a cost effective-way to build a really large (up to 10 km^2) array for very high energy gamma-ray astronomy. The reconstruction of a given EAS energy, incoming direction and the core position, based on the TAIGA-HiSCORE data, allows one to increase the distance between the relatively expensive IACTs up to 600-800 m. These, together with the surface and underground electron/Muon detectors will be used for selection of gamma-ray induced EAS. Present status of the project, together with the current array description and the first experimental results and plans for the future will be reported.'

Collaborations
TAIGA,

Keywords and Comments
'TAIGA; hybrid Cherenkov array; high energy gamma-ray astronomy; cosmic rays physics; EAS parameter reconstruction; gamma/hadron EAS separation', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Study of water Cherenkov detector to determine air shower arrival directions with accuracy

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 162

Presenter
Atsushi Shiomi
Author and Co-Author
Atsushi Shiomi | Hiroki Nakada | Yusaku KATAYOSE | Munehiro Ohnishi | Takashi K. Sako | Hibino Kinya,

Abstract
'In recent years, a few groups have reported detections of gamma rays in the 100 TeV region from astronomical objects in the galaxy using extensive air shower arrays.\r\nThese observations have certainly taken a new step in the research of cosmic-ray acceleration mechanisms.\r\nSeveral spread TeV gamma-ray sources have been observed in the galaxy.\r\nTo study the acceleration mechanisms, it is important to investigate a correlation between gamma-ray source and molecular cloud and to identify the exact gamma-ray emission region.\r\nIn extensive air shower experiments, an arrival direction of a cosmic ray is determined by estimating the shape of its air shower front based on a detected secondary particle density distribution and detection time.\r\nHere, we report a study on shapes of water Cherenkov detector to determine arrival directions of air showers with good accuracy.'

Collaborations

Keywords and Comments
'WCD; 100 TeV gamma-ray; air shower', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Current status of ALPACA for exploring sub-PeV gamma-ray sky in Bolivia

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table

Presenter
Takashi Sako
Author and Co-Author
Takashi Sako, for the ALPACA collaboration

Abstract
'ALPACA is a project to construct an air shower array near the Chacaltaya mountain at an altitude of 4,740m in Bolivia. A 83,000 m^2 surface area is covered by 400 scintillating counters of 100cmx100cmx5cm (thick). In addition to this conventional surface array, underground muon detectors covering total 4,000 m^2 allow clear identification of muon components in air showers. Using this array ALPACA will explore sub-PeV gamma-ray sky first time in the Southern hemisphere. The prime target of ALPACA is to reveal PeV cosmic-ray accelerators presumably existing in the galactic plane, including the galactic center. In early 2021, a prototype array ALPAQUITA consisting of 97 surface counters and 1000 m^2 muon detectors is under construction and planned to start data taking in 2021. The next extension to the 200 counters and 4000 m^2 muon detectors named half ALPACA is scheduled in 2022. In this contribution, a general introduction to ALPACA, the current status of ALPAQUITA with its infrastructure, and extension plan after 2022 are presented.'

Collaborations
other (fill field below), ALPACA

Keywords and Comments
'Air shower array; gamma-ray astronomy; sub-PeV gamma ray; galactic sources', 'T.Sako (myself) and T.K.Sako in the same collaboration and same institute are different persons. Please do not confuse.'

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Towards a fast simulation of a water Cherenkov detector for gamma ray and cosmic ray experiments.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 163

Presenter
Analisa Gabriela Mariazzi
Author and Co-Author
Patricia Hansen | Diego Gabriel Melo | Analisa Gabriela Mariazzi | Lukas Nellen,

Abstract
'The secondary particles produced during the interaction of primary gamma rays or cosmic rays in the atmosphere can be measured using Water Cherenkov Detectors (WCD).\r\nDetailed simulations of the WCD signals produced by the interactions of the secondaries inside the detector are computationally time consuming, so a fast simulator is desirable.\r\nIn this work, we use complete and detailed simulations of a water Cherenkov detector based on Geant4 to obtain a parametrization of the average signal response for different types of secondary particles as a function of the particle energy and incident angle. This parametrization is used to generate approximate signals which match the signals generated by the full detector simulation.'

Collaborations

Keywords and Comments
'Gamma rays; Cosmic rays; Water cherenkov detector; Geant4 Simulation', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

“Star coverage”, a simple tool to schedule an observation when FOV rotation matters

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 164

Presenter
Simone Iovenitti
Author and Co-Author
Simone Iovenitti, Giorgia Sironi

Abstract
'During a tracking observation, every telescope with an alt-azimuthal mount shows a rotation in the field of view (FoV) due to the diurnal motion of the Earth. The angular extension of the rotation depends mainly on the time-length of the observation, but also on the latitude and the telescope’s pointing direction, as it is determined by the evolution of the parallactic angle of the target.\r\nIn many cases, the rotation of the FoV can be exploited to assess some optomechanical properties of the telescope, e.g. the alignment of the optical elements or the motors’ precision during the tracking. As a consequence, it could happen that a proper simulation of the FoV rotation, considering the observable range of the telescope, is crucial to program an observation aiming at the calibration of the whole system.\r\nWe present a tool to simulate the apparent rotation of the FoV, calculating the actual “star coverage” exploitable for scientific goals. Given the FoV and the pointing direction, the software calculates the angular extension of the rotation, considering only the stars observable by the telescope below the magnitude limit. This tool will be adopted to schedule the pointing calibration runs of the innovative ASTRI-Horn Cherenkov telescope, developed by INAF for gamma-ray ground-based astronomy, but with the potentiality to produce sky images as an ancillary output, using the so-called Variance method. By exploiting the FoV rotation with the Variance method, the critical assessment of the camera axis can be successfully performed.'

Collaborations
other (fill field below), ASTRI

Keywords and Comments
'FoV rotation; simulation; stars; variance; calibration; observation; schedule;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The Cherenkov Telescope Array transient and multi-messenger program

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 165

Presenter
Alessandro Carosi
Author and Co-Author
Alessandro Carosi | Alicia López-Oramas | Francesco Longo,

Abstract
'The Cherenkov Telescope Array (CTA) is a next generation ground-based very-high-energy gamma-ray observatory that will allow for observations in the >10 GeV range with unprecedented photon statistics and sensitivity. This will enable the investigation of the yet-marginally explored physics of short-time-scale transient events. CTA will thus become an invaluable instrument for the study of the physics of the most extreme and violent objects and their interactions with the surrounding environment. The CTA Transient program includes follow-up observations of a wide range of multi-wavelength and multi-messenger alerts, ranging from compact galactic binary systems to extragalactic events such as gamma-ray bursts (GRBs), core collapse supernovae and bright AGN flares. In recent years, the first firm detection of GRBs by current Cherenkov telescope collaborations, the proven connection between gravitational waves and short GRBs, as well as the possible neutrino-blazar association with TXS 0506+056 have shown the importance of coordinated follow-up observations triggered by these different cosmic signals in the framework of the birth of multi-messenger astrophysics. In the next years, CTA will play a major role in these types of observations by taking advantage of its fast slewing (especially for the CTA Large Size Telescopes), large effective area and good sensitivity, opening new opportunities for time-domain astrophysics in an energy range not affected by selective absorption processes typical of other wavelengths. In this contribution we highlight the common approach adopted by the CTA Transients physics working group to perform the study of transient sources in the very-high-energy regime.'

Collaborations
CTA,

Keywords and Comments
'', 'for the Transients Working Group on behalf of the CTA Consortium'

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

A simulation study on the performance of the ALPAQUITA experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 166

Presenter
Sei Kato
Author and Co-Author
Sei Kato | for the ALPACA collaboration,

Abstract
'Aiming at exploring the southern gamma-ray sky in the highest energy range, we are proceeding with the ALPACA project. Also, as the prototype experiment of ALPACA, the ALPAQUITA experiment is in preparation, and its detector is now under construction. ALPAQUITA consists of a surface air shower array and an underground water Cherenkov muon detector. To get the most out of ALPAQUITA, we work on a detailed Monte Carlo simulation and evaluate the ALPAQUITA performance. As a result, we find that ALPAQUITA achieves an angular resolution of $\simeq$0.2° and an energy resolution of $\simeq$25% for gamma rays in the 100 TeV range. \r\n Moreover, using the muon detector alongside the surface array, the ALPAQUITA sensitivity to gamma rays is enhanced by a factor of $\simeq$10 in the 100 TeV range compared to using only the surface array. The aforementioned enables us to detect several southern gamma-ray sources with ALPAQUITA beyond 100 TeV in one calendar year observation. \r\n This presentation comprehensively introduces the ALPAQUITA performance and current observational situation of gamma-ray sources detectable with ALPAQUITA.'

Collaborations
, the ALPACA collaboration

Keywords and Comments
'southern gamma-ray astronomy; VHE gamma rays; international project;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Autonomous Environmental and Scientific SWGO site Characterization Instrument

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 167

Presenter
Ladislav Chytka
Author and Co-Author
Ladislav Chytka | Dusan Mandat | Miroslav Pech | Staník Daniel | Jakub Vícha | Petr Travnicek | Martina Boháčová | Petr Tobiška | for the SWGO Collaboration,

Abstract
'The project Southern Wide-field Gamma-ray Observatory (SWGO) aims to build an array of air-shower detectors in the Southern hemisphere. Preliminary site searches identified suitable sites in Argentina, Bolivia, Chile and Peru. Site environment (including weather, seismic activity and also the electric field) is one of the key aspects to be considered in the site selection and should be based on reliable and comparable measurements.\r\nWe describe an environmental monitoring device to equip several candidate sites proposed for the SWGO. The individual monitoring sensors, control unit and the data storage together with the power system and data transfer concepts are specified. We present also the results of a long term cross-calibration campaign and a climate chamber evaluation of the proposed devices.'

Collaborations
SWGO,

Keywords and Comments
'SWGO; Aerosite; environmental characterization', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Bayesian Deep Learning for Shower Parameter Reconstruction in Water Cherenkov Detectors

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Clecio R. Bom
Author and Co-Author
Clecio R. Bom, Luciana O. Dias | Ruben Conceição | Bernardo Tomé | Ulisses Barres de Almeida | Arthur Moraes | Mário Pimenta | Ronald Shellard | Márcio P. Albuquerque

Abstract
'Deep Learning methods are among the state-of-art of several computer vision tasks, intelligent control systems, fast and reliable signal processing and inference in big data regimes. It is also a promising tool for scientific analysis such as gamma/hadron discrimination.\r\nWe present an approach based on Deep Learning for the regression of shower parameters, namely its core position and energy at the ground, using water Cherenkov detectors. We design our method using simulations. In this contribution, we explore the recovery of the shower's center coordinates. We evaluate the limits of such estimation near the borders of the arrays, including the when the center is outside the detector's range. We also address the feasibility of recovering other parameters, such as ground energy. We used Bayesian Neural Networks and derived and quantified systematic errors arising from Deep Learning models and optimized the network design. The method could be easily adapted to estimate other parameters.'

Collaborations

Keywords and Comments
'Machine Learning; Deep Learning', ''

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Subcategory Experimental Methods & Instrumentation

Time and charge calibration of the LHAASO electromagnetic particle detectors

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 168

Presenter
Binyu Pang
Author and Co-Author
Binyu Pang | Hongkui Lv | Xiangdong Sheng | Jia Liu | Xiaopeng Zhang | for the LHAASO Collaboration,

Abstract
'The one square kilometer array (KM2A), a sub-array of LHAASO experiment, consists of 5195 ED and 1188 MD detectors, has been built over three-quarters scale and began operation since December 2020. Its main scientific goal is to study gamma ray sources at energies above 100 TeV. In this work, an offline self-calibration method was used to calibrate the KM2A-ED array to guarantee the key performances of the array such as angular resolution and pointing accuracy within 0.1° during long-term operation. Half of the KM2A array has been operated since December 2019 and the three-quarters has been operated since December 2020. The experimental results of the 1/2 and 3/4 arrays show that this method can be used to determine the detector time offset with an accuracy of 0.5ns and the particle number with an accuracy of a few percent. Furthermore, we monitor the calibration parameters in real time and update the calibration results regularly to ensure the data quality of the detector. As a result, the observation of moon shadow is used to further check the reliability of calibration results.'

Collaborations
Lhaaso,

Keywords and Comments
", "

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The identification of proton and gamma components in cosmic-rays based on deep learning algorithm

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
F Zhang
Author and Co-Author
F Zhang, Y.C Hao | F.R Zhu | J Hou | C He

Abstract
'The Large High Altitude Air Shower Observatory (LHAASO), is a multi-component experiment located at Daocheng (4410 m a.s.l.), Sichuan province, P.R. China. The identification of gamma rays from protons is an important foundation and premise for gamma ray research. In this paper, we use deep learning algorithm to extract the key features of events directly based on a large amount of original information, and explore the identification power of gamma rays from protons of LHAASO experiment. The Convolutional Neural Network(CNN), Deep Neural Networks(DNN) and Graph Neural Networks\xa0(GNN) are trained and tested based on a large number of simulation events respectively. Compared with the traditional methods, we have found that the trained CNN, DNN and GNN models all have improvements in the effect of proton and gamma discrimination.'

Collaborations
Lhaaso,

Keywords and Comments
", "

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The precision of the IACT mechanical mounts of the TAIGA observatory

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 169

Presenter
Artur Borodin
Author and Co-Author
Dmitriy Zhurov | Andrey Grinyuk | Artur Borodin | Leonid Tkachev | Anatoliy Pan | Yaroslav Sagan,

Abstract
'The TAIGA (Tunka Advanced Instrument for cosmic ray physics and Gamma Astronomy) observatory is located in the Tunka valley (~50 km west from the southern shore of Lake Baikal) at an altitude of 675m a.s.l. The TAIGA observatory aims to address gamma-ray astronomy at energies from a few TeV to several PeV and CR physics from 100 TeV to several EeV. Its main feature is the complementary, hybrid approach to distinguish CR events from those of gamma rays. Currently TAIGA consists of ~80 wide-angle air Cherenkov detectors (HiSCORE stations), three ~4m diameter IACTs and several hundred surface and underground muon detectors, grouped in three jointly operating arrays. The exceptional feature of the TAIGA IACT array is it’s topology that allows one to aim for the optimal cost/performance by scanning the optimal inter-telescope distances from 300m up to 600m. The IACTs have alt-azimuth type mounts and 576-pixel imaging cameras in the foci, covering 9.6° aperture in the sky. The segmented reflectors of ~10m² area follow the Davis-Cotton design. The largest diameter of the hexagonal shape reflector is 4.3m and the focal length is 4.75 m. The rigid telescope mount provides a maximum displacement of EAS image below 2mm (i.e. ≤ 0.024°) in the photodetector plane. The main parameters of IACTs are of a crucial importance for their efficient operation and will be presented in this report.'

Collaborations
TAIGA,

Keywords and Comments
'Gamma astronomy; Imaging TAIGA-IACT array; telescope parameters measurement', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Performance of the new FlashCam-based camera in the 28m telescope of H.E.S.S.

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table

Presenter
Baiyang Bi
Author and Co-Author
Baiyang Bi, Jacqueline Catalano | Jim Hinton | Thomas Kihm | Miquel Barcelo | Olaf Reimer | Stefan Funk | German Hermann | Sebastian Diebold | Frank Garrecht | Thomas Schanz | Christian Föhr | Ruben Kankanyan | Oleg Kalekin | Heiko Salzmann | Gerd Pühlhofer | Ira Jun

Abstract
'In October 2019 the central 28m telescope of the H.E.S.S. experiment has been upgraded with a new camera. The camera is based on the FlashCam design which has been developed in view of a possible future implementation in the medium-sized telescopes of the Cherenkov Telescope Array (CTA), with emphasis on cost and performance optimization and on reliability. The fully digital design of the trigger and readout system makes it possible to operate the camera at high event rates and to precisely adjust and understand the trigger system. The novel design of the front-end circuit achieves a dynamic range of over 3,000 photoelectrons with only one electronics readout circuit per pixel. Here we report on the performance of the camera during more than one year of operation in the field, including operational stability and optimization of calibration algorithms.'

Collaborations
H.E.S.S.,

Keywords and Comments
'H.E.S.S.; FlashCam; Performance', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Prototype Open Event Reconstruction Pipeline for the Cherenkov Telescope Array

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Maximilian Nöthe
Author and Co-Author
Maximilian Nöthe | Karl Kosack | Lukas Nickel | Michele Peresano,

Abstract
'The Cherenkov Telescope Array (CTA) is the next-generation gamma-ray observatory\r\ncurrently under construction.\r\nIt will improve over the current generation of imaging atmospheric Cherenkov telescopes (IACTs)\r\nby at least one order of magnitude in sensitivity and be able to observe the whole\r\nsky from a northern site in La Palma, Spain, and a southern one in Paranal, Chile.\r\n\r\nCTA will also be the first open gamma-ray observatory.\r\nAccordingly, the data analysis pipeline is developed as open-source software.\r\nThe event reconstruction pipeline accepts raw data of the telescopes and processes it to\r\nproduce suitable input for the higher-level science tools.\r\nIts primary tasks include estimating the physical properties of each recorded\r\nshower and providing the corresponding instrument response functions.\r\n\r\nCtapipe is a framework providing algorithms and tools to facilitate raw data calibration,\r\nimage extraction, image parameterization and event reconstruction.\r\nIts main focus is currently the analysis of simulated data but it has also been successfully applied\r\nfor the analysis of data obtained with the first CTA prototype telescopes, such as the Large Size Telescope 1.\r\n\r\nPyIRF is a library to calculate IACT instrument response functions,\r\nneeded to obtain physics results like spectra and light curves,\r\nfrom the reconstructed event lists.\r\n\r\nBuilding on these two, protopipe is a prototype for the event reconstruction pipeline for CTA.\r\nRecent developments in these software packages will be presented.'

Collaborations
CTA,

Keywords and Comments
'', 'for the CTA Consortium'

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Using Machine Learning for gamma/hadron separation with HAWC

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Tomás Capistrán
Author and Co-Author
Tomás Capistrán | Kwok Lung Fan | James Linnemann | Ibrahim Torres | Pablo Miguel Saz Parkinson | Philip Yu | for the HAWC Collaboration,

Abstract
'Background showers triggered by hadrons represent over 99.9% of all particles arriving at ground-based gamma-ray observatories. An important stage in the data analysis of these observatories, therefore, is the removal of hadron-triggered showers from gamma showers. Currently, the High-Altitude Water Cherenkov (HAWC) gamma-ray observatory employs an algorithm that is a single cut in two variables, unlike other ground-based gamma-ray observatories (e.g. HESS, VERITAS) which employ a large number of variables to separate the primary particles. In this work, we explore machine learning techniques (Boosted Decision Trees and Neural Networks) to identify the primary particles that were detected by HAWC. Our new gamma/hadron separation techniques were tested on data from the Crab nebula, the standard reference in Very High Energy astronomy, showing an improvement compared to the standard HAWC background rejection method.'

Collaborations
HAWC,

Keywords and Comments
'Machine Learning; G/H separation; High Energy', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Gammapy: a Python Package for Gamma-Ray Astronomy

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Axel Donath
Author and Co-Author
Axel Donath | Régis Terrier, Fabio Acero | Luca Giunti | Jalel Eddine Hajlaoui | Bruno Khelifi | Cosimo Nigro | Maximilian Noethe | Laura Olivera-Nieto | Fabio Pintore | Quentin Remy | José Enrique Ruiz | Atreyee Sinha | For the Gammapy collaboration

Abstract
'Gammapy is a community-developed, open source Python package for gamma-ray Astronomy, which is built on the scientific Python ecosystem Numpy, Scipy and Astropy. It provides methods for the analysis of gamma-ray data of many instruments including Imaging Atmospheric Cherenkov Telescopes, Water Cherenkov, as well as space based observatories.\r\n\r\nStarting from event lists and a description of the specific instrument response functions (IRF) stored in open FITS based data formats, Gammapy implements the reduction of the input data and instrument response to binned WCS, HEALPix or region based data structures. Thereby it handles the dependency of the IRFs with time, energy as well as position on the sky. It offers a variety of background estimation methods for spectral, spatial and spectro-morphological analysis. Counts, background and IRFs data are bundled in datasets and can be serialised, rebinned and stacked.\r\n\r\nGammapy supports to model binned data using Poisson maximum likelihood fitting. It comes with built-in spectral, spatial and temporal models as well as support for custom user models, to model e.g. energy dependent morphology of gamma-ray sources. Multiple datasets can be combined in a joint-likelihood approach to either handle time dependent IRFs, different classes of events or combination of data from multiple instruments. Gammapy also implements methods to estimate flux points, including likelihood profiles per energy bin, light curves as well as flux and signficance maps in energy bins.\r\n\r\nIn this contribution we present an overview of the most recent features and user interface of Gammapy along with example analyses using H.E.S.S, Fermi-LAT and simulated CTA data.'

Collaborations
, Gammapy

Keywords and Comments
'gammapy; software; likelihood fitting; github; source detection; gamma ray; awesome; model fitting; maximum likelihood; spectral analysis; data analysis; python; astropy;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Monte Carlo Simulations and Validation of NectarCAM, a Medium Sized Telescope Camera for CTA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 170

Presenter
Thomas Armstrong
Author and Co-Author
Thomas Armstrong, Jean-Francois Glicenstein | Jean-Philippe Lenain | Thomas Tavernier | Ullrich Schwanke | Heide Costantini

Abstract
'The upcoming Cherenkov Telescope Array (CTA) ground-based gamma-ray observatory will open up our view of the very high energy Universe, offering an improvement in sensitivity of an order of magnitude over previous experiments. NectarCAM is one of the proposed cameras for the Medium-Sized Telescopes (MST) which have been designed to cover the core energy range of CTA, from 100 GeV to 10 TeV. The final camera will be capable of GHz sampling and provide a field of view of 8 degrees with its 265 modules of 7 photomultiplier each (for a total of 1855 pixels). In order to validate the performance of NectarCAM, a partially equipped prototype has been constructed consisting of only the inner 61 modules. It has so far undergone testing at the integration test-bench facility in CEA Paris-Saclay (France) and on a prototype of the MST structure in Adlershof (Germany). To characterize the performance of the prototype, Monte Carlo simulations were conducted using a detailed model of the 61 module camera in the CORSIKA/sim_telarray framework. This contribution provides an overview of this work including the comparison of trigger and readout performance in the lab and trigger and image parameterization performance during on-sky measurements.'

Collaborations
CTA,

Keywords and Comments
", "

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Design and performance of the prototype Schwarzschild-Couder Telescope camera

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 171

Presenter
Leslie Taylor
Author and Co-Author
Leslie Taylor | for the CTA SCT Project,

Abstract
"The Cherenkov Telescope Array (CTA) is the next-generation ground-based observatory for very-high-energy gamma-ray astronomy. An innovative 9.7 m aperture, dual-mirror Schwarzschild-Couder Telescope (SCT) design is a candidate design for CTA Medium-Sized Telescopes. A prototype SCT (pSCT) has been constructed at the Fred Lawrence Whipple Observatory in Arizona USA. Its camera is currently partially instrumented with 1600 pixels covering a field of view of 2.7 degrees. The small plate scale of the optical system allows densely packed silicon photomultipliers to be used, which combined with high-density trigger and waveform readout electronics enable the high-resolution camera. The camera's electronics are capable of imaging air shower development at a rate of one billion samples per second. We describe the commissioning and performance of the pSCT camera, including trigger and waveform readout performance, calibration, and absolute GPS time stamping. We also present the upgrade to the camera, which is currently underway. The upgrade will fully populate the focal plane, increasing the field of view to 8 degrees, and lower the front end electronics noise, enabling a lower trigger threshold and improved reconstruction and background rejection."

Collaborations
CTA,

Keywords and Comments
'IACT; CTA; SCT; gamma rays;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Measurement and long monitoring of the water transparency in LHAASO-WCDA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 172

Presenter
Huicai Li
Author and Co-Author
Huicai Li | Mingjun Chen | Bo Gao | Cheng LIU | Xiaohao You | Kai li,

Abstract
'As one of the major components of the LHAASO project, WCDA, a water Cherenkov detector array with an area of 78,000 m2, contains 350,000 tons of purified water, dividing into 3120 detector cells. The water transparency and its stability are critical for a successful long-term operation of the project. In this paper, with the help of the distribution of single cosmic muon signals , the methods of water transparency measurement and monitoring have being applied to the project, and the results are presented.'

Collaborations
Lhaaso,

Keywords and Comments
'LHAASO-WCDA; Cosmic muon; Water transparency', ''

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Subcategory Experimental Methods & Instrumentation

Operation of the LHAASO-WCDA

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table 173

Presenter
Cheng LIU
Author and Co-Author
Mingjun Chen | Bo Gao | Minhao Gu | Shicong Hu | Huicai Li | Cheng LIU | Zhiguo Yao | Xiaohao You,

Abstract
'The Water Cherenkov Detector Array (WCDA) is one of the major component of the Large High Altitude Air Shower Observatory (LHAASO). WCDA, divided into 3 separate arrays, will make the survey observation on the gamma-ray sky of 100 GeV - 30TeV. The first array (150m×150m), denoted as WCDA-1, has already be operated in April, 2019 and one more array of the same size, referred to as WCDA-2, has also been in operation since November 2019. The third array, WCDA-3, with a size of 300m ×110m, is being tested and the full array of WCDA will be in operation this year. This paper will describe the operation status of the LHAASO-WCDA since April 2019.'

Collaborations
Lhaaso,

Keywords and Comments
'LHAASO-WCDA; Gamma Ray; operation;', 'On behalf of the LHAASO Collaboration'

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Subcategory Experimental Methods & Instrumentation

Time calibration of the LHAASO-WCDA detectors

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 174

Presenter
Bo Gao
Author and Co-Author
Bo Gao | Zhiguo Yao | Jinyan Liu | Min Zha | Huicai Li | Mingjun Chen | Hanrong wu,

Abstract
'The LHAASO (Large High Altitude Air Shower Observatory) is a multi-purpose experiment for measuring the high energy gamma rays and cosmic rays. One of the major detectors is the 78,000 m2 WCDA (Water Cherenkov Detector Array), equipped with 3120 PMTs, which aims to survey the gamma-ray sky continuously in a wide energy range, from 100 GeV to 30 TeV. Precisely calibrating the time offsets of each detector cell is essential to obtain a good angular resolution for observing the gamma ray sources. A dedicated system composed of LED light sources and fibers guided lights to every cell is used for time offset calibration of the whole array. Besides, Cosmic-ray shower events are analyzied for caliculating the time offsets and the charge-time correlations. Finally the observation to the Crab Nebula is visited to fix the pointing error brought by above calibration and calculations. Above calibration procedure and the final calibration results are presented in this talk.'

Collaborations
Lhaaso,

Keywords and Comments
'LHAASO-WCDA; time calibration; LED calibration system; time offsets', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Performance of a proposed event-type based analysis for CTA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 175

Presenter
Tarek Hassan Collado
Author and Co-Author
Tarek Hassan Collado | Orel Gueta | Gernot Maier | Maximilian Nöthe | Michele Peresano | Ievgen Vovk | for the CTA Consortium,

Abstract
'The Cherenkov Telescope Array (CTA) will be the next-generation observatory in the very-high-energy (20 GeV to 300 TeV) gamma-ray astroparticle physics field. Classically, data analysis in the field maximizes sensitivity by applying quality cuts on the data acquired. These cuts, optimized using Monte Carlo simulations, select higher quality events from the initial dataset. Subsequent steps of the analysis typically use the surviving events to calculate one set of instrument response functions (IRFs). An alternative approach is the use of event types, as implemented in experiments such as the Fermi-LAT. In this approach, events are divided into sub-samples based on their reconstruction quality, and a set of IRFs is calculated for each sub-sample. The sub-samples are then combined in a joint analysis, treating them as independent observations. This leads to an improvement in performance parameters such as sensitivity, angular and energy resolution. Data loss is reduced since lower quality events are included in the analysis as well, rather than discarded. In this study, machine learning methods will be used to classify events according to their expected angular reconstruction quality. We will report the impact on CTA high-level performance when applying such an event-type classification with respect to the standard procedure.'

Collaborations
CTA,

Keywords and Comments
'Cherenkov Telescope Array; Analysis; Performance estimation; Monte Carlo; Simulations', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The use of convolutional neural networks for processing images from multiple IACTs in the TAIGA experiment

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Stanislav Polyakov
Author and Co-Author
Stanislav Polyakov | Alexander Kryukov | Evgeny Postnikov,

Abstract
'TAIGA experiment uses hybrid detection system for cosmic and gamma rays that currently includes three imaging atmospheric Cherenkov telescopes (IACTs). Previously we used convolutional neural networks to select gamma ray events and estimate the energy of the gamma rays based on an image from a single telescope. Subsequently we adapted these techniques to use data from multiple telescopes, increasing the quality of selection and the accuracy of estimates. All the results have been obtained with the simulated data of TAIGA Monte Carlo software.'

Collaborations

Keywords and Comments
'deep learning; convolutional neural networks; gamma astronomy; extensive air shower; TAIGA; stereoscopic mode', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Muons as a tool for background rejection in imaging atmospheric Cherenkov telescope arrays

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 176

Presenter
Laura Olivera-Nieto
Author and Co-Author
Laura Olivera-Nieto | Alison Mitchell | Jim Hinton,

Abstract
'The presence of muons in air-showers initiated by cosmic ray protons and nuclei is well established as a powerful tool to separate such showers from those initiated by gamma-rays. However, so far this approach has been exploited only for ground level particle detecting arrays. In this contribution, we explore the feasibility of using Cherenkov light from muons as a background rejection tool for imaging atmospheric Cherenkov telescope arrays at the highest energies. We adopt an analytical model of the Cherenkov light from individual muons to allow rapid simulation of a large number of showers in a hybrid mode. This allows exploration of the very high background rejection power regime at acceptable cost in terms of computing time. We find that for very large telescopes (~20 m diameter), efficient identification of muons would provide a major improvement with respect to standard background rejection techniques at energies above several tens of TeVs.'

Collaborations

Keywords and Comments
'IACTs; muon; background rejection;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The charge calibration of LHAASO-WCDA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 177

Presenter
Shicong hu
Author and Co-Author
Shicong hu | Yong Huang | Chuandong Gao | Zongkang Zeng | Huicai Li | Bo Gao | Xiurong Li | Cheng LIU | Min Zha | Zhiguo Yao,

Abstract
'Water Cherenkov detector array (WCDA), one of major parts of LHAASO project, has been partly operated since April 2019. Each detector cell of the first pool (WCDA-1) has one 8" PMT and one 1.5" PMT. 20" PMT and 3" PMT are hung in each cell of WCDA-2 and WCDA-3. In order to achieve an optimal energy reconstruction, and cosmic ray background suppression for the air showers, we develop an off-line method to calibrate number of photoelectron (NPE) of signals. By matching signals caught by different kinds of PMT, we bridge their linear measurement range to obtain equivalent NPE of signals up to 200000PEs. Besides, detector monitoring and various measurements show the PMT among cells are slightly different in quantum efficiency and collection efficiency, and the light attenuation and depth of water in the pool are also varying with time, especially in the very beginning of the operation. Above inhomogeneity and instability influences the detection efficiency of cells on secondary air shower particles. Based on previous research, the single particle peak mainly formed by muon signals are used to calibrate the detection efficiency difference as well as long term variation of all the detector cells. A possibly more flexible efficiency calibration method of Constant Rate Scaling (CRS) is also under study. The analysis method and the calibration results as well as its long term stability of the first two pools are presented in this talk.'

Collaborations
Lhaaso,

Keywords and Comments
'LHAASO-WCDA; charge calibration', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Status update of MACE Gamma-ray telescope

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table

Presenter
Kuldeep Yadav
Author and Co-Author
Kuldeep Yadav,

Abstract
'MACE (Major Atmospheric Cherenkov Experiment) is an imaging atmospheric Cherenkov telescope which has recently been installed by the HiGRO (Himalayan Gamma-Ray Observatory) collaboration at Hanle (32.80N, 78.90E, 4270m asl) in Ladakh region of North India. The telescope has a 21m diameter large light collector consisting of indigenously developed 1424 square shaped diamond tuned spherical aluminum mirror facets of size ~ 0.5m X 0.5m. MACE is the second largest Cherenkov telescope at the highest altitude in the northern hemisphere. The imaging camera of the telescope consists of 1088 photo multiplier tubes with a uniform pixel resolution of ~0.125o covering a field of view of ~4.0o x 4.0o. The main objective of the MACE telescope is to study gamma-ray sources mainly in the unexplored energy region 20 -100 GeV and beyond with high sensitivity. In this paper, we describe the key design features and current status of MACE including results from the trial observations of the telescope.'

Collaborations
other (fill field below), HiGRO

Keywords and Comments
'', 'For HiGRO Collaboration'

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Development of hybrid reconstruction techniques for TAIGA

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Michael Blank
Author and Co-Author
Michael Blank | Martin Tluczykont | Alaa Kuotb Awad | Dieter Horns | Andrea Porelli | For the TAIGA Collaboration,

Abstract
'The TAIGA-experiment aims to implement a hybrid detection technique of Extensive Air Showers (EAS) at TeV to PeV energies, combining the wide angle Cherenkov timing array HiSCORE with Imaging Air Cherenkov Telescopes (IACTs). The detector currently consists of 89 HiSCORE stations and two IACTs, distributed over an area of about 1 km².\r\nOur goal is to introduce a new reconstruction technique, combining the good angular and shower core resolution of HiSCORE with the gamma-hadron separation power of the imaging telescopes. With the second IACT in operation, three different event types can be explored: IACT stereo, full hybrid (IACT stereo + stations) and mono hybrid (IACT mono + HiSCORE), the latter being the operational goal of TAIGA.\r\nThe status of the development of the full hybrid reconstruction and its verification using real data and simulation are presented.'

Collaborations
TAIGA,

Keywords and Comments
'Gamma rays; EAS; hybrid; timing array; IACT;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Studies of Gamma Ray Shower Reconstruction Using Deep Learning

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Tomas Bylund
Author and Co-Author
Tomas Bylund, Gašper Kukec Mezek | Mohanraj Senniappan | Yvonne Becherini | Michael Punch

Abstract
'The ALTO project aims to build a particle detector array for very high energy gamma ray observations optimized for soft spectrum sources. The accurate reconstruction of gamma ray events, in particular their energies, using a surface array is an especially challenging problem at the low energies ALTO aims to optimize for. In this contribution, we leverage Convolutional Neural Networks (CNNs) to improve reconstruction performance at lower energies (< 1 TeV) as compared to the SEMLA analysis procedure, which is a more traditional method using mainly manually derived features.\r\nWe present performance figures using different network architectures and training settings, both in terms of accuracy and training time, as well as the impact of various data augmentation techniques.'

Collaborations

Keywords and Comments
'gamma-rays; very-high energies; atmospheric showers; machine learning; analysis methods', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

The upgraded Data Acquisition System of the H.E.S.S. telescope array

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 178

Presenter
Sylvia Jiechen Zhu
Author and Co-Author
Sylvia Jiechen Zhu | Tim Holch | Thomas Murach | Stefan Ohm | Matthias Fuessling | Mathieu de Naurois | Fabian Krack | Klemens Mosshammer | Rico Lindemann,

Abstract
'The High Energy Stereoscopic System (H.E.S.S.) is an array of five Imaging Atmospheric Cherenkov Telescopes located in the Khomas Highland of Namibia. H.E.S.S. observes gamma rays above tens of GeV by detecting the Cherenkov light that is produced when Very High Energy gamma rays interact with the Earth’s atmosphere. The H.E.S.S. Data Acquisition System (DAQ) coordinates the nightly telescope operations, ensuring that the various components communicate properly and behave as intended. It also provides the interface between the telescopes and the people on shift who guide the operations. The DAQ comprises both the hardware and software, and since the beginning of H.E.S.S., both elements have been continuously adapted to improve the data-taking capabilities of the array and push the limits of what H.E.S.S. is capable of. Most recently, this includes the upgrade of the entire computing cluster hosting the DAQ software, and the accommodation of a new camera on the large 28m H.E.S.S. telescope. We discuss the performance of the upgraded DAQ and the lessons learned from these activities.'

Collaborations
H.E.S.S.,

Keywords and Comments
'DAQ; data acquisition system; hardware; cluster; computing', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

FACT - Database-based Analysis and Spectrum Calculations

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 179

Presenter
Bernd Schleicher
Author and Co-Author
Bernd Schleicher | Axel Arbet-Engels | Dominik Baack | Matteo Balbo | Noah Biederbeck | Adrian Biland | Thomas Bretz | Jens Buss | Daniela Dorner | Laura Eisenberger | Dominik Elsaesser | Dorothee Hildebrand | Roman Iotov | Karl Mannheim | Dominik Neise,

Abstract
'The First G-APD Cherenkov Telescope (FACT) is a telescope located at the Observatory Roque de los Muchachos on the Canary island La Palma. It uses the imaging air Cherenkov technique to detect gamma rays. With the help of the silicon based photosensors of the camera, FACT is a perfect instrument to monitor a small sample of sources with a high cadence. The automatic operation of the telescope allows an increase of the duty cycle of the instrument. The SQL database is part of the automatic analysis chain, which is used to store the data event-wise basis. This way of storing the data has a lot of advantages. It provides easy web-access to all taken data with no need of creating different user accounts for the analysers and without using special software or powerful hardware. The data selection is done via simple queries to the database. This allows very flexible and powerful queries with for example user defined time binning or background suppression. By using observed and simulated events, the complete analysis chain can be done up to calculating the measured energy spectrum. This could also be implemented to the Quick Look Analysis to provide the information during the night with a low latency.'

Collaborations
, FACT

Keywords and Comments
'First G-APD Cherenkov Telescope; FACT; Imaging Air Cherenkov Technique; Analysis; Database;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Expected performance of the ALTO particle detector array designed for 200 GeV - 50 TeV gamma-ray astronomy.

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table

Presenter
Mohanraj Senniappan
Author and Co-Author
Mohanraj Senniappan, Yvonne Becherini | Michael Punch | Satyendra Thoudam | Tomas Bylund | Gašper Kukec Mezek | Jean-Pierre Ernenwein

Abstract
'ALTO/COMET is an R&D project aiming to design a very-high-energy (VHE) gamma-ray observatory sensitive to energies above ~200 GeV. The science goals include continuous observation of soft-spectrum VHE gamma-ray sources such as Active Galactic Nuclei and transients such as Gamma-Ray Bursts. With these objectives, ALTO/COMET is designed to have a low energy threshold with a wide field-of-view of about 2 sr, at a high altitude, and combines particle detectors with air-Cherenkov detectors. In this contribution, we focus on the ALTO particle detector array performance only. Water Cherenkov detectors are used for the detection of secondary particles in atmospheric air showers while scintillators serve as muon counters. A detailed study is presented through air-shower, detector and trigger simulations, followed by the reconstruction of the event parameters and the extraction of the signal (gamma-rays) from the background (cosmic-rays). In addition, the experience obtained from the prototype operation will be presented.'

Collaborations

Keywords and Comments
'very-high-energy gamma-rays; soft-spectrum; signal over background discrimination;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Effect of SiPM correlated noise and Photon Detection Efficiency into Imaging Atmospheric Cherenkov Telescopes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 180

Presenter
Andrii Nagai
Author and Co-Author
Andrii Nagai | Teresa Montaruli | Domenico della Volpe | Matthieu Heller | Mykhailo Dalchenko | David Medina Miranda,

Abstract
'Silicon Photomultiplier SiPM detectors have become the preferred photosensors for many applications in high-energy particle and astroparticle physics, LIDAR and medical imagining. Due to robustness, low working voltage, ability to work during moon light and high photon detection efficiency the SiPM devices are good choice for cameras of Imaging Atmospheric Cherenkov Telescopes (IACTs) as pioneering works of FACT and SST-1M demonstrated. However, the overvoltage (difference between applied and breakdown voltages) effects almost all device parameters like gain, PDE, uncorrelated and correlated noise. In particular, by increasing the overvoltage the high PDE of 60% can be reached. On the other had high overvoltage leads to higher correlated noise what affects image reconstruction.\r\n In this work we study the effect of SiPM correlated noise and PDE into IACT in therm of charge resolution. With the goal to find the optimal overvoltage value which provides the best balance between PDE and correlated noise. The study was done with Monte Carlo simulation (i.e. sim_telarray – simulation of the imaging atmospheric Cherenkov technique) and validated with measurements at laboratory with calibrated light sources (one to mimic Cherenkov light and another for night sky background NSB). The studies were performed for SiPM devices produced by Hamamatsu: S13360-3050, S14520-3050 and FBK HD-NUV. The studies were performed at different NSB levels from 3MHz up to 1 GHz of photons per sensor at room temperature (T = 25 C).'

Collaborations

Keywords and Comments
'SiPM; Cherenkov Telescopes; Cross-talk; photon detection efficiency; night sky background', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Fundamental Paricle Physics with SWGO

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 181

Presenter
Andrea Albert
Author and Co-Author
Andrea Albert,

Abstract
'The Southern Wide-field Gamma-ray Observatory (SWGO) is a proposed experiment that will continuously monitor the TeV gamma-ray sky. Similar to the High Altitude Water Cherenkov (HAWC) Observatory, is will have a wide field of view, nearly 100% duty cycle, and will therefore observe ~2/3 of the sky every day. It will use water cherenkov detectors and be located in the southern hemisphere. SWGO is planned to be the most sensitive gamma-ray observatory in the southern hemisphere above ~10 TeV. SWGO will be able to perform several searches for physics beyond the standard model. Specifically we will discuss searches for Axion Like Particles and Lorentz Invariance Violation.'

Collaborations
SWGO,

Keywords and Comments
'', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Science verification of the new FlashCam-based camera in the 28m telescope of H.E.S.S.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 182

Presenter
Gerd Pühlhofer
Author and Co-Author
Gerd Pühlhofer, Konrad Bernlöhr | Baiyang Bi | German Hermann | Jim Hinton | Ira Jung | Fabian Leuschner | Vincent Marandon | Alison Mitchell | Dan Parsons | Simon Sailer | Heiko Salzmann | Simon Steinmassl | Felix Werner | for the H.E.S.S. collaboration

Abstract
'In October 2019, the central 28m telescope of the H.E.S.S. experiment has been upgraded with a new camera. The camera is based on the FlashCam design which has been developed in view of a possible future implementation in the medium-sized telescopes of the Cherenkov Telescope Array (CTA). We report here on the results of the science verification program that has been performed after commissioning of the new camera, to show that the camera and software pipelines are working up to expectations.'

Collaborations
H.E.S.S.,

Keywords and Comments
'H.E.S.S.; Cherenkov camera; FlashCam; Science verification', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Simulations performance for an array of refractive air-Cherenkov telescopes HAWC's Eye in hybrid setup with the HAWC Observatory

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table

Presenter
José Serna-Franco
Author and Co-Author
José Serna-Franco, Ruben Alfaro | Jan Audehm | Thomas Bretz | Oscar Chaparro | Giang Do | Maria Magdalena Gonzalez | Arturo Iriarte | Frank Manlowski | Miguel Martínez | Jesús Martínez-Castro | Yunior Perez | Florian Rehbein | Merlin Schaufel | Franziska Tischbein | Ibrahi

Abstract
'Preliminary results from the analysis of first data from hybrid observation campaigns using a compact light-weight Refractive Imaging Air-Cherenkov Telescope (RIACT), named HAWC's eye, and the High-Altitude Water Cherenkov (HAWC) Observatory have shown that some features of the air-shower detection in HAWC, as the angular resolution, could be enhanced. Therefore an array of such devices could be an interesting upgrade for modern and future experiments such as the HAWC Observatory or the Southern Wide-field Gamma-ray Observatory (SWGO). In this work, we show results of simulated observations of extensive air-showers in different configurations of an array of 55 HAWC's Eye RIACTs in simultaneous detection with the HAWC Observatory. We have produced an extensive library of simulated primary particles as γ-rays and hadrons in an energy range from 100 GeV to 100 TeV at an altitude of 4100 m. a.s.l. The features and performance of such an array are discussed in this work.'

Collaborations
HAWC,

Keywords and Comments
"IACT; gamma-ray; hybrid observation; HAWC; HAWC's Eye; simulations", "

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Identifying muon rings in VERITAS data using convolutional neural networks trained on Muon Hunters 2-classified images

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Kevin Flanagan
Author and Co-Author
Kevin Flanagan, Darryl Wright | Hugh Dickinson | Patrick D. Wilcox | Michael Laraia | Stephen Serjeant

Abstract
"Muons from extensive air showers appear as rings in images taken with Cherenkov telescopes, such as VERITAS. These muon ring images are used for the calibration of the VERITAS telescopes, however this calibration process can be improved with a more efficient muon-identification algorithm. Convolutional neural networks (CNNs) are used in many state-of-the-art image-recognition systems and are ideal for this purpose. However, by training a CNN on a dataset labelled by existing algorithms, the performance of the CNN would be limited by the suboptimal muon-identification efficiency of the original algorithms. Muon Hunters 2 is a citizen science project that asks users to label grids of VERITAS telescope images, stating which images contain muon rings. Each image is labelled 10 times by independent volunteers, and the votes are aggregated and used to assign a 'muon' or 'non-muon' label to the corresponding image. An analysis was performed using an expert-labelled dataset in order to determine the optimal vote fraction cut-offs for assigning labels to each image for CNN training. This was optimised so as to identify as many muon images as possible while avoiding false positives. The performance of this model will be presented and compared to existing muon identification algorithms employed in the VERITAS data analysis software. Using any extra images identified for calibration may require improvements to the light-distribution correction algorithm for muon rings with non-zero impact parameters."

Collaborations
VERITAS,

Keywords and Comments
'IACT; Cherenkov radiation; muon ring; machine learning; calibration; citizen science', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

A maximum-likelihood-based technique for detecting extended gamma-ray sources with VERITAS

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Alisha Chromey
Author and Co-Author
Alisha Chromey | For the VERITAS Collaboration,

Abstract
'Gamma-ray observations ranging from hundreds of MeV to tens of TeV are a valuable tool for studying particle acceleration and diffusion within our galaxy. Supernova remnants, pulsar wind nebulae, and star-forming regions are the main particle accelerators in our local Galaxy. Constructing a coherent physical picture of these astrophysical objects requires the ability to distinguish extended regions of gamma-ray emission, the ability to analyze small-scale spatial variation within these regions, and methods to synthesize data from multiple observatories across multiple wavebands. Imaging Atmospheric Cherenkov Telescopes (IACTs) provide fine angular resolution (<0.1 degree) for gamma-rays above 100 GeV. Typical data reduction methods rely on source-free regions in the field of view to estimate cosmic-ray background. This presents difficulties for sources with unknown extent or those which encompass a large portion of the IACT field of view (3.5 degrees for VERITAS). Maximum-likelihood-based techniques are well-suited for analysis of fields with multiple overlapping sources, diffuse background components, and combining data from multiple observatories. Such methods also offer an alternative approach to estimating the IACT cosmic-ray background and consequently an enhanced sensitivity to largely extended sources. In this proceeding, we report on the current status and performance of a maximum likelihood technique for the IACT VERITAS. In particular, we focus on how our method’s framework employs a dimension for gamma-hadron separation parameters in order to improve sensitivity on extended sources.'

Collaborations
VERITAS,

Keywords and Comments
", "

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

A 3D likelihood analysis for KM2A data

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Xiaoyuan Huang
Author and Co-Author
Xiaoyuan Huang | Kaikai Duan,

Abstract
'The square kilometer array (KM2A) is the main array of the Large High Altitude Air Shower Observatory (LHAASO), which is the most sensitive gamma-ray detector for energies above a few tens of TeV. We are developing a software pipeline based on the experimental data, Monte-Carlo simulations and the pointing track of the arrays. The pipeline is able to perform 3D (sky images at different energies) fits of KM2A data, similar to those used for Fermi-LAT and DAMPE gamma-ray analysis. This 3D likelihood analysis could fit source models of arbitrary morphology to the sky images, and get energy spectra information and detection significances simultaneously. The analysis with this software could give consistent results with those using traditional method.'

Collaborations
Lhaaso,

Keywords and Comments
'', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Methods & Instrumentation

Convolutional Neural Networks for Low Energy Gamma-Ray Air Shower Identification with HAWC

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Ian Watson
Author and Co-Author
Ian Watson | For the HAWC Collaboration,

Abstract
'A major task in ground-based gamma-ray astrophysics analyses is to separate events caused by gamma rays from the overwhelming hadronic cosmic-ray background. In this talk we are interested in improving the gamma ray regime below 1 TeV, where the gamma and cosmic-ray separation becomes more difficult. Traditionally, the separation has been done in particle sampling arrays by selections on summary variables which distinguish features between the gamma and cosmic-ray air showers, though the distributions become more similar with lower energies. The structure of the HAWC observatory, however, makes it natural to interpret the charge deposition collected by the detectors as pixels in an image, which makes it an ideal case for the use of modern deep learning techniques, allowing for good performance classifers produced directly from low-level detector information.'

Collaborations
HAWC,

Keywords and Comments
'Particle Identification; Deep Learning', ''

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Subcategory Experimental Methods & Instrumentation

Deep-learning-driven event reconstruction applied to simulated data from a single Large-Sized Telescope of CTA

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Pietro Grespan
Author and Co-Author
Pietro Grespan, Mikael Jacquemont | Ruben Lopez-Coto | Tjark Miener | Daniel Nieto | Thomas Vuillaume

Abstract
'When very-high-energy gamma rays interact high in the Earth’s atmosphere, they produce cascades of particles that induce flashes of Cherenkov light. Imaging atmospheric Cherenkov telescopes (IACTs) detect these flashes and convert them into shower images that can be analyzed to extract the properties of the primary gamma ray. The dominant background for IACTs is comprised of images produced by cosmic hadrons, with typical noise-to-signal ratios of several orders of magnitude. The standard technique adopted to differentiate between images initiated by gamma rays and those initiated by hadrons is based on classical machine learning algorithms, such as Random Forests, that operate on a set of handcrafted parameters extracted from the images. Likewise, the inference of the energy and the arrival direction of the primary gamma ray is performed using those parameters. State-of-the-art deep learning techniques based on convolutional neural networks (CNNs) have the potential to enhance the event reconstruction performance, since they are able to autonomously extract features from raw images, exploiting the pixel-wise information washed out during the parametrization process.\r\n\r\nHere we present the results obtained by applying deep learning techniques to the reconstruction of simulated events from a single, next-generation IACT, the Large-Sized Telescope (LST) of the Cherenkov Telescope Array. We use CNNs to separate gamma-ray-induced events from hadronic events and to reconstruct the properties of the former, showing that they perform better than the standard reconstruction technique. Three independent implementations of CNN-based event reconstruction models have been utilized in this work, producing consistent results.'

Collaborations
CTA,

Keywords and Comments
'deep learning; LST; CTA; large-sized telescope; cnn; convolutional neural networks; simulation; montecarlo;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Search for Very High Energy Emission from the millisecond pulsar PSR J0218+4232

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 184

Presenter
Sidika Merve Colak
Author and Co-Author
Sidika Merve Colak, Brent Limyansky | Pablo Miguel Saz Parkinson | Alessia Spolon | on behalf of the MAGIC and Fermi-LAT Collaborations

Abstract
'PSR J0218+4232 is a millisecond pulsar (MSP) with high magnetic field strength at the light-cylinder radius (B_{LC} ~ 3.2 × 10^{5} G), making it one of the best candidates for VHE gamma-ray emission. It was one of the first MSPs detected by Fermi-LAT at high energy. The source is possibly an aligned rotator with large unpulsed component(~50%) in radio and X-rays.\r\nFor this study, we have analyzed 11.5 years of Fermi-LAT data and 90 hours of MAGIC observations (MJD 58424 - 58791). Fermi-LAT analysis shows evidence for pulsed emission above 25GeV. MAGIC observations were performed with a sub-100GeV optimized Sum-Trigger II system. Due to the unpulsed component, we searched for pulsed emission by using a new background subtraction approach. We did not find any evidence for pulsed or unpulsed VHE emission. Lack of VHE emission detection with our instruments is compatible with our theoretical modeling.'

Collaborations
MAGIC, Fermi-LAT

Keywords and Comments
'pulsars; gamma-rays; PSR J0218+4232', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Performance of the Cherenkov Telescope Array in the presence of clouds

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 185

Presenter
Mario Pecimotika
Author and Co-Author
Mario Pecimotika, Julian Sitarek | Dijana Dominis Prester | Dario Hrupec | Gernot Maier | Dorota Sobczyńska | Saša Mićanović | Michał Szanecki | Katarzyna Adamczyk | Orel Gueta | Lovro Pavletić

Abstract
'The Cherenkov Telescope Array (CTA) is the future ground-based observatory for gamma-ray astronomy at very-high energies. The atmosphere is an integral part of every Cherenkov telescope. Different atmospheric conditions, such as clouds, can reduce the fraction of Cherenkov photons produced in air showers that reach ground-based telescopes, which may affect the performance. Decreased sensitivity of the telescopes may lead to misconstructed energies and spectra. This study presents the impact of various atmospheric conditions on the CTA performance. The atmospheric transmission in a cloudy atmosphere in the wavelength range from 200 nm to 1000 nm was simulated for different cloud bases and different optical depths using the MODerate resolution atmospheric TRANsmission (MODTRAN) code. MODTRAN output files were used as inputs for generic Monte Carlo simulations. Analysis was performed using the MAGIC Analysis and Reconstruction Software (MARS) adapted for CTA. As expected, the effects of clouds are most evident at low energies, near the energy threshold. Even in the presence of dense clouds, high energy gamma rays may still trigger the telescopes if the first interaction occurs lower in the atmosphere, below the cloud base. A method to analyze very-high energy data obtained in the presence of clouds is presented. The systematic uncertainties of the method are evaluated. These studies help to gain more precise knowledge about the CTA response to cloudy conditions and gives insights on how to proceed with data obtained in such conditions. This may prove crucial for alert based observations and time-critical studies of transient phenomena.'

Collaborations
CTA,

Keywords and Comments
'Cherenkov telescopes; clouds; CTA; MODTRAN; Monte Carlo simulations', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

VHE gamma-ray spectral hint of two-zone emitting region in Mrk 501

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Josefa Becerra González
Author and Co-Author
Josefa Becerra González | David Paneque | Christoph Wendel | Koji Noda | Kazuma Ishio | Fabrizio Tavecchio | Karl Mannheim | Andrea Tramacere,

Abstract
'Markarian 501 (Mrk 501) is one of the brightest very high energy (VHE, E> 100 GeV) gamma-ray blazars. It is located in our neighborhood, at redshift z\u2004=\u20040.034. During a multi-wavelength campaign in July 2014, Mrk 501 displayed the highest X-ray activity observed by the Neil Gehrels Swift X-ray telescope (XRT) since its launch. The X-ray spectra displayed during this flaring episode were very hard, and showed variability on nightly timescales. On 2014 July 19, in coincidence with the peak of the X-ray activity, a hint of a narrow feature at ~3 TeV was observed with the MAGIC telescopes. Such feature makes the VHE spectrum inconsistent with the classical analytic functions used to describe the measured VHE spectra (power law, log-parabola, and log-parabola with exponential cutoff) at more than 3σ. A double-log-parabola fit is preferred w.r.t. a single one at more than 4σ confidence level. Three different scenarios that could produce such an effect are discussed: (a) a pileup in the electron energy distribution; (b) a two-zone Synchrotron Self-Compton (SSC) emission model; and (c) a pair cascade model. In this contribution we will present the observational details and a general overview of the possible physical mechanisms of this unprecedented observation.'

Collaborations
MAGIC, Fermi-LAT

Keywords and Comments
'galaxies: active / BL Lacertae objects: individual: Mrk 501 / gamma rays: galaxies / X-rays: galaxies', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Multiwavelength observations in 2019-2020 of a new very-high-energy gamma-ray emitter: the flat spectrum radio quasar QSO B1420+326

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Filippo D'Ammando
Author and Co-Author
Filippo D'Ammando, Roberto Angioni | Monica Orienti | for the Fermi-LAT Collaboration | Julian Sitarek | Seiya Nozaki | Elina Lindfors | Giacomo Bonnoli | Vandad Fallah Ramazani | for the MAGIC Collaboration | Svetlana Jorstad

Abstract
'The flat-spectrum radio quasar QSO B1420+326 underwent an enhanced gamma-ray flux state seen by Fermi-LAT at the turn of 2019/2020. Compared to the low state both the position and luminosity of the two spectral energy distribution peaks changed by at least two orders of magnitude. The high state resulted in the discovery of the very-high-energy (>100 GeV) gamma-ray emission from the source by the MAGIC telescopes. The organized multiwavelength campaign allow us to trace the broadband emission of the source through different phases of the flaring activity. The source was observed by 20 instruments in radio, near-infrared, optical, ultra-violet, X-ray and gamma-ray bands.\r\nWe use dedicated optical spectroscopy results to estimate the accretion disk and the dust torus luminosity. The optical spectroscopy shows a prominent FeII bump with flux evolving together with the continuum emission and a MgII line with varying equivalent width. The gamma-ray flare was accompanied by a rotation of the optical polarization vector and emission of a new superluminal radio knot. We model spectral energy distributions in different flare phases in the framework of combined synchrotron-self-Compton and external Compton scenario in which the\r\nshape of the electron energy distribution is determined from cooling processes.'

Collaborations
Ferrmi-LAT, MAGIC

Keywords and Comments
'Gamma rays: galaxies; Galaxies: jets; Radiation mechanisms: non-thermal; quasars: individual: QSO B1420+326', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

MAGIC observations of the nearby short GRB 160821B

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 186

Presenter
Koji Noda
Author and Co-Author
Koji Noda | Lara Nava | Susumu Inoue | Satoshi Fukami | Michele Palatiello | Alessio Berti | Francesco Longo,

Abstract
'Gamma-ray bursts (GRBs), the most luminous explosions in the universe, have at least two types known. One of them, short GRBs, have been thought to originate from binary neutron star (BNS) mergers. The discovery of GW170817 together with a GRB was the first and only direct proof of the hypothesis, and thus the properties of the short GRBs are poorly known yet. Aiming to clarify the underlying physical mechanisms of the short GRBs, we analyzed GRB 160821B, one of the nearest short GRBs known at z=0.162, observed with the MAGIC telescopes. A hint of a gamma-ray signal is found above 0.5 TeV at a significance of >3 sigma during observations from 24 seconds until 4 hours after the burst, as presented in the past.\r\nRecently, multi-wavelength data of its afterglow emission revealed a well-sampled kilonova component from a BNS merger, and the importance of GRB 160821B increased concerning GRB-GW studies. Accordingly, we investigated GRB afterglow models again, using the revised multi-wavelength data. We found that the straightforward interpretation with one-zone synchrotron self-Compton model from the external forward shock is in tension with the observed TeV flux, contradicting the suggestion reported previously.\r\nIn this contribution we discuss the implication from the TeV observation, including alternative scenarios where the TeV emission can be enhanced. We also give a brief outlook of future GeV-TeV observations of short GRBs with imaging atmospheric Cherenkov telescopes, which could shed more light on the GRB-BNS merger relation.'

Collaborations
MAGIC, Fermi-LAT

Keywords and Comments
'GRB; short GRB; kilonova; very high energy gamma rays; IACT', 'on behalf of the MAGIC and Fermi/LAT Collaborations'

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Observation of burst activity from SGR1935+2153 associated to first galactic FRB with H.E.S.S.

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Dmitriy Kostiunin
Author and Co-Author
Dmitriy Kostiunin | Halim Ashkar | Fabian Schussler | Gavin Rowell | for the H.E.S.S. Collaboration,

Abstract
'Fast radio bursts (FRB) are enigmatic powerful single radio pulses with durations of several milliseconds and high brightness temperatures suggesting coherent emission mechanism. For the time being a number of extragalactic FRBs have been detected in the high-frequency radio band including repeating ones. The most plausible explanation for these phenomena is magnetar hyperflares. The first observational evidence of this scenario was obtained in April 2020 when an FRB was detected from the direction of the Galactic magnetar and soft gamma repeater SGR1935+2154. The FRB was preceded with a number of soft gamma-ray bursts observed by Swift-BAT satellite, which triggered the follow-up program of the H.E.S.S. imaging atmospheric Cherenkov telescopes (IACTs). H.E.S.S. has observed SGR1935+2154 over a 2 hour window few hours prior to the FRB detection by STARE2 and CHIME. The observations overlapped with another X-ray burst from the magnetar detected by INTEGRAL and Swift-BAT, thus providing first observations of a magnetar in a flaring state in the very-high energy domain. We present the analysis of these observations, discuss the obtained results and prospects of the H.E.S.S. follow-up program for soft gamma repeaters and anomalous X-ray pulsars.'

Collaborations
H.E.S.S.,

Keywords and Comments
'IACT; VHE gamma ray; FRB; magnetars; SGR; HESS', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

LMC N132D: a mature supernova remnant with a youthful spectrum

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Jacco Vink
Author and Co-Author
Jacco Vink | Rachel Simoni | Nukri Komin | Prokhorov Dmitry | for the H.E.S.S. collaboration,

Abstract
'Supernova remnant LMC N132D is a remarkably luminous gamma-ray emitter at ~ 50 kpc with an age of $\\sim$2500 years. It belongs to the small group of oxygen-rich SNRs, which includes Cassiopeia A and Puppis A. N132D is interacting with a nearby molecular cloud. By adding 102 hours of new observations with the High Energy Stereoscopic System (H.E.S.S.) to the previously published data with exposure time of 150 hours, we achieve the significant detection of N132D at a 5.7 sigma level in the very high energy (VHE) domain. The gamma-ray spectrum is compatible with a single power law extending above 10 TeV. We set a lower limit on an exponential cut-off energy at 8 TeV with 95% CL. The multi-wavelength study supports a hadronic origin of VHE gamma-ray emission indicating the presence of sub-PeV cosmic-ray protons. The detection of N132D is remarkable since the TeV luminosity is higher than that of Cassiopeia A by more than an order of magnitude. Its luminosity is comparable to, or even exceeding the luminosity of RX J1713.7-3946 or HESS J1640-465. Moreover, the extended power-law tail in the VHE spectrum of N132D is surprising given both the exponential cut-off at 3.5 TeV in the spectrum of its 340-year-old sibling, Cassiopeia A, and the lack of TeV emission from a Fermi-LAT 2FHL source (E>50 GeV), Puppis A. We discuss a physical scenario leading to the enhancement of TeV emission via the interaction between N132D and a near molecular cloud.'

Collaborations
H.E.S.S.,

Keywords and Comments
'Supernova remnants; N132D; cosmic rays; molecular clouds; gamma-rays; H.E.S.S.', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Revisiting the PeVatron candidate MGRO J1908+063 with an updated H.E.S.S. analysis

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 26 Galactic Sources & Winds | MM
Presenter Forum Table

Presenter
Dmitriy Kostiunin
Author and Co-Author
Dmitriy Kostiunin | Lars Mohrmann | Emma de Ona Wilhelmi | Vikas Joshi | Stefan Ohm | Alison Mitchell | for the H.E.S.S. Collaboration,

Abstract
'Detecting and studying galactic gamma-ray sources emitting very-high energy photons sheds light on the acceleration and propagation of cosmic rays presumably created in these sources. Currently, there are few sources emitting photons with energies exceeding 100 TeV. In this work we revisit the unidentified source MGRO J1908+063, initially detected by Milagro, using an updated H.E.S.S. dataset and analysis pipeline. The vicinity of the source contains a supernova remnant and pulsars as well as molecular clouds. This makes the identification of the primary source(s) of local cosmic rays as well as the nature of the gamma emission challenging, especially in light of the recent HAWC detection of the high energy tail of its spectrum. Exploiting the better angular resolution and spectral coverage of H.E.S.S. as compared to HAWC, we investigate the morphology of the source as well as its spectral properties and model different scenarios of gamma-ray production.'

Collaborations
H.E.S.S.,

Keywords and Comments
'pevatrons; galactic gamma rays; pulsars; supernova remnant; tev halos', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Detection of extended TeV emission around the Geminga pulsar with H.E.S.S.

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 53 PWN and Halos | GAD-GAI
Presenter Forum Table

Presenter
Alison Mitchell
Author and Co-Author
Alison Mitchell | Sami Caroff | Jim Hinton | Lars Mohrmann | for the HESS collaboration,

Abstract
'Highly extended gamma-ray emission around the Geminga pulsar was discovered by Milagro and verified by HAWC. Despite many observations with Imaging Atmospheric Cherenkov Telescopes (IACTs), detection of gamma-ray emission on angular scales exceeding the IACT field-of-view has proven challenging. However, recent developments in analysis techniques have enabled the detection of significant emission around Geminga in archival data with H.E.S.S.. \r\nIn 2019, further data on the Geminga region were obtained with an optimised observation strategy. Following the previous announcement of the detection of significant TeV emission around Geminga in archival data, in this contribution we present the detection with this newly acquired, independent dataset. New analysis results will be presented, and emphasis given to the technical challenges involved in observations of highly extended gamma-ray emission with IACTs.'

Collaborations
H.E.S.S.,

Keywords and Comments
'PWN; gamma-ray halo; Geminga; background estimation', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Understanding the origin of the extended gamma-ray emission and the physical nature of HESS J1841-055 using observations at TeV energies with the MAGIC telescopes

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
David Green
Author and Co-Author
Lab Saha | Alicia López-Oramas | David Green, on behalf of the MAGIC Collaboration

Abstract
'With the improved sensitivity with respect to the previous generation, current space-borne and ground-based gamma-ray telescopes have made the number of gamma-ray sources detected at GeV-TeV energies increase many folds over the last decade. Many of the detected extended gamma-ray sources are not associated with any known sources at other wavelengths. Understanding the nature of these sources and the origin of the observed high energy gamma-ray emission remains a great challenge. Using the MAGIC telescopes, we have observed one such unassociated gamma-ray source, named HESS J1841-055, at TeV energies. In this talk, we present our detailed investigation on this source using MAGIC data and other multi-waveband information on nearby sources. We discuss the interpretation of this source as a cosmic-ray accelerator.'

Collaborations
MAGIC,

Keywords and Comments
'Gamma-rays; Unindetified gamma-ray source; HESS J1841-055; Supernova remnants; PWN; Pulsar wind nebulae; Extended gamma-ray source; Ground-based Telescopes; TeV energies; Non-thermal radiation sources', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Monitoring the magnetar SGR 1935+2154 with the MAGIC telescopes

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Alicia López-Oramas
Author and Co-Author
Alicia López-Oramas | John Hoang | Tarek Hassan | Susumu Inoue | for the MAGIC collaboration, Filippo Ambrosino | Alice Borghese | Francesco Coti Zelati | Jason Hessels | Benito Marcote | Alessandro Papitto | Mark Snelders

Abstract
'The Galactic magnetar SGR 1935+2154 was associated with a bright, millisecond-timescale fast radio burst (FRB) which occurred in April 2020, during a flaring episode. This was the first time an FRB was unequivocally associated with a Galactic source, and the first FRB for which the nature of the emitting source was identified. Moreover, it was the first FRB with a counterpart at another wavelength correlated in time, an atypical, hard X-ray burst, which provides clear evidence for accompanying non-thermal processes. The MAGIC Telescopes are Imaging Air Cherenkov Telescopes (IACTs) sensitive to very-high-energy (VHE, E>100 GeV) gamma rays. Located at the center of the camera lies the MAGIC Central pixel, a single fully modified photosensor-to-readout chain to measure millisecond-duration optical signals, displaying a maximum sensitivity at a wavelength of 350 nm. This allows MAGIC to operate simultaneously both as VHE gamma-ray and a fast optical telescope. The MAGIC telescopes have monitored SGR 1935+2154 in a multiwavelength campaign involving X-ray, radio and optical facilities. In this contribution, we will show the results on the search for the VHE counterpart of the first SGR-FRB source in this multiwavelength context, as well as the search for fast optical bursts with the MAGIC Central Pixel.'

Collaborations
MAGIC,

Keywords and Comments
'magnetar; very-high-energy; gamma-rays; IACT; multiwavelenght; FRB', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Prospects for Galactic transient sources detection with the Cherenkov Telescope Array

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Alicia López-Oramas
Author and Co-Author
Alicia López-Oramas | Andrea Bulgarelli | Sylvain Chaty | Masha Chernyakova | Roman Gnatyk | Bohdan Hnatyk | Dimitrios Kantzas | Sera Markoff | Samuel McKeague | Sandro Mereghetti | Enrique Mestre | Ambra Di Piano | Giovanni Piano | Patrizia Romano | Ifta,

Abstract
'Several types of Galactic sources, like magnetars, microquasars, novae or pulsar wind nebulae flares, display transient emission in the X-ray band. Some of these sources have also shown emission at MeV and even at few GeV energies, although none of these Galactic transients have ever been detected in the very-high-energy (VHE; E>100 GeV) regime by any Imaging Air Cherenkov Telescope (IACT).\xa0The Galactic Transient task force inside the Transient Working group of the Cherenkov Telescope Array (CTA) Consortium investigates the chances of detecting the VHE counterpart of these sources and the prospects for studying them with Target of Opportunity (ToO) observations. In this contribution, we will show some of the results exploring the capabilities of CTA to detect and observe Galactic transients assuming different array configurations and observing strategies.'

Collaborations
CTA,

Keywords and Comments
'Galactic; transients; microquasars; PWN; magnetars; particle acceleration', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Recent results on LIV studies using MAGIC telescopes from the observation of GRB 190114C

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 57 New Physics | CRD-CRI-DM-GAD-GAI-NU-MM-SH
Presenter Forum Table

Presenter
Giacomo D'Amico
Author and Co-Author
Giacomo D'Amico | For the MAGIC Collaboration, Daniel Kerszberg | Manel Martinez | Cédric Perennes | Javier Rico | Tomislav Terzić

Abstract
'On January 14, 2019, the most energetic photons ever observed from a gamma-ray burst were recorded by the Major Atmospheric Gamma Imaging Cherenkov (MAGIC) telescopes, detecting GRB 190114C at TeV energies. We used this unique observation to probe an energy dependence of the speed of light in vacuo for photons, as predicted by several quantum gravity models. From a set of conservative assumptions on the possible intrinsic spectral and temporal evolution, competitive lower limits on the quadratic leading order modification of the speed of light were obtained. We performed the first Lorentz invariance violation test ever performed on a gamma-ray burst signal at TeV energies, which will serve as a stepping stone to future studies.'

Collaborations
MAGIC,

Keywords and Comments
'LIV; GRB; gamma rays; MAGIC; Lorentz invariance violation; GRB 190114C', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

MAGIC results on Galactic binaries

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems, Microquasars | GAD-GAI
Presenter Forum Table

Presenter
Edgar Molina
Author and Co-Author
Edgar Molina, Daniela Hadasch | John Hoang | Alicia López-Oramas | for the MAGIC Collaboration

Abstract
'There are a number of binary systems in our Galaxy, typically consisting of a compact object and a non-degenerate companion star, that produce X-ray and gamma-ray emission. Depending on the energy at which their emission peaks, they are called either X-ray or gamma-ray binaries. Two main scenarios have been proposed to explain the observed radiation, one involving matter accretion and jet launching by the compact object (microquasar scenario), and another one in which the compact object is a pulsar that interacts with the star through their winds (pulsar wind scenario). This contribution will be an overview of the latest results on Galactic binary systems obtained with the MAGIC telescopes at energies above 100 GeV. Among them, we will present results on the X-ray binary MAXI J1820+070, which underwent a very bright X-ray flare in 2018 that aroused the interest of several multi-wavelength facilities. Additionally, we will pay special attention to the gamma-ray binary HESS J0632+057, for which a large data set (combined with VERITAS and H.E.S.S.) covering 15 years of observations allowed for the first time determination of the source gamma-ray flux modulation above 350 GeV. We will put these observations in a multi-wavelength context and discuss their physical implications for the different observed sources.'

Collaborations
MAGIC,

Keywords and Comments
'binaries', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Shedding light on the highest energy emission from GRBs with MAGIC observations

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 54 Gamma-Ray Bursts in the VHE regime | GAI
Presenter Forum Table

Presenter
Alessio Berti
Author and Co-Author
Alessio Berti | Zeljka Bosnjak | Stefano Covino | Satoshi Fukami | Susumu Inoue | Francesco Longo | Davide Miceli | Razmik Mirzoyan | Elena Moretti | Lara Nava | Koji Noda | David Paneque | Antonio Stamerra | Yusuke Suda | Ievgen Vovk | on behalf of the,

Abstract
'On 14th January 2019, the MAGIC collaboration achieved the first significant detection at TeV energies of a gamma-ray burst (GRB), namely GRB 190114C. This observation sets the first experimental proof of very high energy (VHE, >~100 GeV) gamma-ray emission in GRBs, after more than 50 years from the first GRB detection and many searches with Cherenkov telescopes in the last decades. The data collected by MAGIC and by more than 20 other ground-based and space-borne instruments, spanning 17 orders of magnitude in energy, revealed a new GeV-TeV emission component in the GRB afterglow. This unprecedented multi-wavelength dataset, including VHE data for the first time, allowed a detailed study of the broadband emission. A one-zone synchrotron-self Compton scenario with internal $\\gamma$-$\\gamma$ absorption could be used to describe the broadband emission, using parameters compatible with those found in previous studies of GRB afterglows below the GeV energy range. This detection opened a new era in the studies of GRBs, leading to new questions such as the universality of TeV emission in different types of GRBs. In this contribution we will present the GRB follow-up program performed by the MAGIC collaboration, which started more than 15 years ago. We will highlight the results on GRB 190114C, discuss the implications for GRB physics, and report the latest developments and the prospects for future observations of GRBs with the MAGIC telescopes.'

Collaborations
MAGIC,

Keywords and Comments
'GRB; TeV GRB; very high energy gamma rays; SSC; IACT', 'on behalf of the MAGIC Collaboration'

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Very-high-energy gamma-ray emission from GRB 201216C detected by MAGIC

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 54 Gamma-Ray Bursts in the VHE regime | GAI
Presenter Forum Table

Presenter
Satoshi Fukami
Author and Co-Author
Satoshi Fukami, Alessio Berti | Serena Loporchio | Yusuke Suda | Lara Nava | Željka Bošnjak | Katsuaki Asano | Francesco Longo | on behalf of the MAGIC Collaboration

Abstract
'Gamma-ray bursts (GRBs) are the most energetic phenomena in the universe. Many aspects of GRB physics are still under debate, such as the origin of their gamma-ray emission above the GeV energy range. \r\nIn 2019, MAGIC detected TeV gamma rays from the long GRB 190114C, whose emission can be well explained by synchrotron-self Compton emission by relativistic electrons. However, it is still unclear whether such a process is common in GRBs, given the reduced number of GRBs detected until now at the very high energies (VHE). \r\nGRB 201216C is a long GRB and is the second one detected by MAGIC in this energy range. After receiving the alert provided by Swift-BAT, MAGIC automatically slewed to the GRB position, starting observations 56 seconds after the GRB onset. In the offline analyses of the collected data, we confirmed the detection of gamma-ray emission with a significance above 5 sigma. \r\nFollowing measurements from optical facilities, the redshift of this GRB was estimated to be z=1.1. This makes GRB 201216C the most distant object ever detected by ground-based gamma-ray telescopes. \r\nIn this contribution we will show the analysis results of the MAGIC data, also in comparison with past detected GRBs in the same energy range. Finally, accounting for available multi-wavelength observations, we will comment on the possible origin of the VHE emission detected by MAGIC.'

Collaborations
MAGIC,

Keywords and Comments
'GRB', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

The young massive stellar cluster Westerlund 1 in gamma rays as seen with H.E.S.S.

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Lars Mohrmann
Author and Co-Author
Lars Mohrmann | for the H.E.S.S. Collarboration, Romed Rauth | Andreas Specovius | Christopher van Eldik | Stefan Ohm

Abstract
'Massive stellar clusters have recently been hypothesised as candidates for the acceleration of hadronic cosmic rays up to PeV energies. Previously, the H.E.S.S. Collaboration has reported about very extended gamma-ray emission around Westerlund 1, the most massive young stellar cluster in the Milky Way. In this contribution we present an updated analysis that employs a new analysis technique and is based on a much larger data set, allowing us to constrain better the morphology and the energy spectrum of the emission. The analysis technique used is a three-dimensional likelihood analysis, which is especially well suited for largely extended sources. The origin of the gamma-ray emission will be discussed in light of recent multi-wavelength observations.'

Collaborations
H.E.S.S.,

Keywords and Comments
'HESS; stellar cluster; PeVatron; Gammapy', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Search for enhanced TeV gamma ray emission from Giant Molecular Clouds using H.E.S.S.

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Atreyee Sinha
Author and Co-Author
Atreyee Sinha | Yves Gallant | Markus Holler | Sabrina Casanova,

Abstract
'Large scale diffuse gamma ray emission, originating from cosmic-ray interactions in the interstellar medium, has now been detected at very high energies (VHE) by various instruments (High Energy Stereoscopic System (H.E.S.S.; 2014), Milagro (Abdo et al. 2008), and the ARGO-YBJ (Bartoli 2015). The gamma ray emission from giant molecular clouds (GMCs) is a direct tracer of the cosmic ray density and the matter density inside the clouds. Detection of enhanced TeV emission from GMCs, i.e., an emission significantly larger than what is expected from the average Galactic cosmic rays illuminating the cloud, can imply a variation in the local cosmic ray density, due to, for example, the presence of a recent accelerator inside the cloud.\r\n\r\nSuch gamma-ray observations can be crucial in probing the cosmic ray distribution across our Galaxy, but are complicated to perform with present generation Imaging Atmospheric Cherenkov Telescopes (IACTs). The limited field of view (FoV) and the strong hadronic background of IACTs make the detection of large scale structures challenging. Moreover, such studies require a proper modelling of the large scale diffuse emission component as well.\r\n\r\nIn this contribution, we use HESS data collected over 16 years to search for TeV emission from GMCs in the inner molecular galacto-centric ring of our Galaxy. We implement a three dimensional FoV likelihood technique, and simultaneously model the hadronic background, the galactic diffuse emission and the emission expected from known VHE sources to probe for excess TeV gamma ray emission from GMCs.'

Collaborations
H.E.S.S.,

Keywords and Comments
'diffuse emission; high background; 3D FoV likelihood; Giant Molecular Clouds; IACT; cosmic rays', 'on behalf of the H.E.S.S. collaboration'

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Search for TeV emission from the base of the Fermi Bubbles with H.E.S.S.

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Emmanuel Moulin
Author and Co-Author
Emmanuel Moulin | Alessandro Montanari | Denys Malyshev | Dmitry Malyshev | for the H.E.S.S. collaboration,

Abstract
'While the Fermi Bubbles were discovered about a decade ago by Fermi-LAT as a double-emitting lobe extending up to ~50° in latitude above and below the Galactic Center GC), their origin is still unknown. The H.E.S.S. collaboration is currently performing the first ever survey in TeV gamma rays of the Milky Way inner region: the Inner Galaxy Survey (IGS). The IGS is intended to achieve the best sensitivity to faint and diffuse emissions in a region of several degrees around the Galactic Centre. It provides an unprecedented sensitivity to dark matter signals, new diffuse emissions, and TeV outflows from the Galactic Centre. Understanding the properties of the Fermi Bubbles at low Galactic latitudes will provide key insights into their origin. We search for TeV emission at the base of the Fermi Bubbles using low-latitude spectral and spatial templates. The first results obtained with the 2014-2020 H.E.S.S. observations will be reported.'

Collaborations
H.E.S.S.,

Keywords and Comments
'Fermi Bubbles; Galactic Centre', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

BL Lac object 1ES 0647+250, a decade of MWL observations

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 187

Presenter
Jorge Otero-Santos
Author and Co-Author
Jorge Otero-Santos, Daniela Dorner | Daniel Morcuende | David Paneque | Vandad Fallah Ramazani | Elisa Prandini | Giacomo Bonnoli | on behalf of the MAGIC and Fermi-LAT Collaborations and MWL partners

Abstract
'The High-peaked BL Lac object 1ES 0647+250 is one of the few distant blazars detected at very-high-energy (VHE, E > 100 GeV) gamma rays during non-flaring activity. Its redshift is still uncertain, but a lower limit of z>0.29 was recently calculated, based on the minimum equivalent width of absorption features expected from the host galaxy. This blazar was first detected by the MAGIC telescopes between 2009 and 2011 during its low state, displaying around 2% of the Crab Nebula flux above 100 GeV, but it has shown several periods of large activity, where the VHE gamma-ray flux increased by more than 1 order of magnitude. For the first time for this object, the detailed broadband spectral energy distribution will be presented for different activity levels. Based on the datasets collected from 2009 to 2020, the multi-band variability and correlations among various energy bands will be discussed in the context of the different emission models.'

Collaborations
MAGIC, Fermi-LAT

Keywords and Comments
'AGN; BL Lac object; VHE; gamma-rays; blazar', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Discovery of 100 TeV gamma-rays from HESS J1702-420: a new PeVatron candidate

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 55 Ultra-High-Energy Gamma-Ray Sources and PeVatrons | GAI
Presenter Forum Table

Presenter
Luca Giunti
Author and Co-Author
Luca Giunti | For the H.E.S.S. Collaboration,

Abstract
'The identification of active PeVatrons, hadronic particle accelerators reaching the knee of the cosmic-ray spectrum (at the energy of few PeV), is crucial to understand the origin of cosmic rays in the Galaxy. In this context, we report on new H.E.S.S. observations of the PeVatron candidate HESS J1702-420, which reveal the presence of gamma-rays up to 100 TeV. This is the first time in the history of H.E.S.S. that photons with such high energy are clearly detected. Remarkably, the new deep observations allowed the discovery of a new gamma-ray source component, called HESS J1702-420A, that was previously hidden under the bulk emission traditionally associated with HESSJ1702-420. This new object has a power-law spectral slope < 2 and a gamma-ray spectrum that, extending with no sign of curvature up to 100 TeV, makes it an excellent candidate site for the presence of PeV-energy cosmic rays. This discovery brings new information to the ongoing debate on the nature of the unidentified source HESSJ1702-420, one of the most compelling PeVatron candidates in the gamma-ray sky, and on the origin of Galactic cosmic rays.'

Collaborations
H.E.S.S.,

Keywords and Comments
'gamma-ray; PeVatron; H.E.S.S.; HESS; gammapy; multi-wavelength', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Recent Results from VERITAS AGN Observations

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Wystan Benbow
Author and Co-Author
Wystan Benbow | for the VERITAS Collaboration,

Abstract
'VERITAS is one of the world's most sensitive detectors of astrophysical very high energy (VHE; E > 100 GeV) gamma rays. This observatory has operated for ~14 years, and nearly 7,000 hours of its observations have been targeted on active galactic nuclei (AGN). Approximately 300 AGN were observed with VERITAS, and 40 are detected. These studies are generally accompanied by contemporaneous, broadband observations, which enable detailed probes of the underlying jet-powered processes. Recent scientific results from VERITAS AGN observations will be presented.'

Collaborations
VERITAS,

Keywords and Comments
'AGN; Blazar; VERITAS; TeV;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Observation of ultra-high-energy diffuse gamma rays from the galactic plane with the Tibet air shower array

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Kazumasa Kawata
Author and Co-Author
Kazumasa Kawata | For the Tibet ASgamma Collaboration,

Abstract
'The Tibet air shower (AS) array and underground water-Cherenkov-type muon detector (MD) array have been successfully operated since 2014, at an altitude of 4,300m in Tibet, China. The gamma-ray energy and arrival direction are determined by the Tibet AS array, while the MD array enable us to suppress more than 99.9% of background cosmic rays above 100 TeV, by means of counting number of muons in an air shower at 2.4m underground. We search for ultra-high-energy diffuse gamma rays from the galactic plane with the Tibet AS+MD array. In this presentation, we will report on observational results and the analysis method using the air shower and muon data collected by the Tibet AS+MD array.'

Collaborations
other (fill field below), Tibet ASgamma

Keywords and Comments
", "

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Resolving the origin of very-high-energy gamma-ray emission from the PeVatron candidate SNR G106.3+2.7 using MAGIC telescopes

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 55 Ultra-High-Energy Gamma-Ray Sources and PeVatrons | GAI
Presenter Forum Table

Presenter
Tomohiko Oka
Author and Co-Author
Tomohiko Oka, Hidetoshi Kubo | Takayuki Saito | Marcel Strzys

Abstract
'The supernova remnant (SNR) G106.3+2.7 is associated with a 100 TeV gamma-ray source reported by HAWC and is thus a promising PeVatron candidate. However, because of the poor angular resolution of HAWC, it is difficult to pinpoint the origin of the 100 TeV source. Because the SNR contains an energetic pulsar wind nebula (PWN) dubbed Boomerang and powered by the pulsar PSR J2229+6114, it is unclear whether the gamma-ray emission originates from the SNR or PWN complex and whether it is caused by hadronic or leptonic processes. We observed gamma rays above 200 GeV in the vicinity of the SNR G106.3+2.7 using the MAGIC telescopes for ~120 hours in total between May 2017 and August 2019, with an angular resolution of 0.07 – 0.1 degrees, which is unprecedented for this object at these energies. An extended gamma-ray emission spatially correlated with the radio continuum emission at the head and tail of SNR G106.3+2.7 was detected using the MAGIC telescopes. We find a hint of gamma-ray emission above 10 TeV only from the SNR tail region, while no significant emission above 5 TeV is found at the SNR head region containing the Boomerang PWN. Therefore, the gamma rays above 35 TeV detected with the air shower experiments are, likely, mainly emitted from the SNR tail region. In this presentation we discuss the morphology of the gamma-ray emission from this complex region and attempt self-consistent multiwavelength modeling of the energy spectrum from the different sources inside it.'

Collaborations
MAGIC,

Keywords and Comments
'Supernova remnants; Particle acceleration; Galactic cosmic ray; Gamma ray source; Gamma ray observation;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Observation of a relatively low luminosity long duration GRB 201015A by the MAGIC telescopes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 188

Presenter
Yusuke Suda
Author and Co-Author
Yusuke Suda | Manuel Artero | Katsuaki Asano | Alessio Berti | Lara Nava | Koji Noda | Kenta Terauchi | For the MAGIC Collaboration,

Abstract
'Starting from the first unequivocal detection of very high energy (VHE) emission from the luminous gamma-ray burst (GRB) GRB 190114C by the MAGIC telescopes, four detections of VHE emission from GRBs by ground-based telescopes were reported as of today. Such new energetic components were missing for a long time and these observations have become a new probe to explore GRB physics. In order to deepen our understanding, more GRB observations by VHE instruments are crucial. GRB 201015A was detected by the Swift/BAT and the duration of its prompt emission was measured as 9.78 +- 3.47 seconds. We started fast follow-up observations of this GRB with the MAGIC telescopes about 30 seconds after its onset under good observational conditions. Subsequent optical observations measured the redshift of the host galaxy as 0.42 and found the associated type Ic-BL supernova. The total isotropic equivalent energy of the prompt emission is then estimated to be the order of 10^50 erg, which means this is a long GRB with a relatively low luminosity. In this sense, GRB 201015A may have similar properties to GRB 190829A whose VHE emission was detected by the H.E.S.S. telescopes. The accurate analysis of the MAGIC data confirms the strong hint of detection, implying a significant energy release in the TeV range, comparable with that of the prompt emission in the keV-MeV band. We report these results and theoretical interpretation of GRB 201015A emission.'

Collaborations
MAGIC,

Keywords and Comments
'GRB; very high energy emission; MAGIC', ''

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Webpage icrc2021.desy.de

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Exploring the population of Galactic very-high-energy gamma-ray sources

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
Constantin Steppa
Author and Co-Author
Constantin Steppa | Kathrin Egberts,

Abstract
'At very high energies (VHE), the emission of gamma rays is dominated by discrete sources. Due to the limited resolution and sensitivity of current-generation instruments, only a small fraction of the total Galactic population of VHE gamma-ray sources has been significantly detected. The larger part of the population can be expected to contribute as a diffuse signal alongside emission originating from propagating cosmic rays. Without quantifying the source population, it is not possible to disentangle these two components. Based on the H.E.S.S. Galactic Plane Scan, a numerical approach has been taken to develop a model of the population of Galactic VHE gamma-ray sources, which is shown to accurately account for the observational bias. We present estimates of the absolute number of sources in the Galactic Plane and their contribution to the total VHE gamma-ray emission for five different spatial source distributions. Prospects for CTA and its ability to constrain the model are discussed. Finally, first results of an extension of our modelling approach using machine learning to extract more information from the available data set are presented.'

Collaborations

Keywords and Comments
'Galactic; very high energy; gamma ray; sources; population', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Gamma-ray Observation of the Cygnus Region with the Tibet Air Shower Array

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 189

Presenter
Yusaku KATAYOSE
Author and Co-Author
For the Tibet AS-gamma Collaboration | Yusaku KATAYOSE,

Abstract
'The Tibet air shower (AS) array and underground water-Cherenkov-type muon detector (MD) array have been successfully operated since 2014, at an altitude of 4,300m in Tibet, China. The gamma-ray energy and arrival direction are determined by the Tibet AS array, while the MD array enables us to suppress more than 99.9% of background cosmic rays above 100 TeV, by means of counting the number of muons in an air shower at 2.4m underground. We report on the observation of gamma-ray emission from the Cygnus region in our Galaxy.'

Collaborations
, Tibet AS-gamma

Keywords and Comments
'Cygnus region; ultra high energy gamma-ray;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Discovery of TXS 1515-273 at VHE gamma-rays and modelling of its Spectral Energy Distribution

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Serena Loporchio
Author and Co-Author
Serena Loporchio, Elina Lindfors | Vandad Fallah Ramazani | Filippo D'Ammando | Axel Arbet-Engels | Leonardo Di Venere | Francesco Giordano | Armin Nabizadeh | Elisabetta Bissaldi | Monica Orienti | Sara Cutini

Abstract
'In February 2019, a flaring state of the extreme blazar candidate TXS 1515-273 was registered by the Fermi-LAT, which triggered observations with the MAGIC telescopes and the X-ray satellites Swift, XMM-Newton and NuStar. The observations led to the discovery of the source at VHE gamma-rays and the detection of short time scales of variability (~1 h) in several X-ray bands.\r\nThe analysis of the observed variability helped us to constrain the emission region's physical parameters. Thanks to the high-quality X-ray data, the synchrotron peak location was determined. The source was classified as a high synchrotron peaked source during the flaring activity. We constructed the broadband spectral energy distribution from radio to TeV. We interpreted it assuming leptonic emission and taking into account the constraints from the X-ray variability. We tested two scenarios: a simple one-zone model and a two-component model. Both models were found to describe well the data from X-rays to VHE gamma rays, but the two-zone model allows for a more accurate modelling of the emission at radio and optical energies.'

Collaborations
MAGIC, Fermi-LAT

Keywords and Comments
'agn; multiwavelength', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Exploring the High-Energy Gamma-Ray Spectra of TeV Blazars

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Qi Feng
Author and Co-Author
Qi Feng | for the VERITAS Collaboration,

Abstract
'The highest-energy blazars exhibit non-thermal radiation extending beyond 1 TeV with high luminosities and strong variabilities, indicating extreme particle acceleration in their relativistic jets. The gamma-ray spectra of blazars contain information about the distribution and cooling processes of high-energy particles in jets, the extragalactic background light between the source and the observer, and potentially, the environment of the gamma-ray emitting region and exotic physics that modifies the opacity of the universe to gamma rays. We use data from Fermi-LAT and VERITAS to study the variability and spectra of a sample of TeV blazars across a wide range of gamma-ray energies, taking advantage of more than ten years of data from both instruments. The variability in both GeV and TeV gamma-ray bands is investigated using a Bayesian blocks method to identify periods with a steady flux, during which the average gamma-ray spectra, after correcting for the pair absorption effect from propagation, can be parameterized without the risk of mixing different flux states. We report on the search for intrinsic spectral curvature and spectral variability in these blazars, in an effort to understand the physical mechanisms behind the high-energy gamma-ray spectra of TeV blazars.'

Collaborations
VERITAS,

Keywords and Comments
'AGN: jets; AGN: variability; Particle acceleration; Gamma rays', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

The VERITAS-Stellar Intensity Interferometry (VSII) survey of Stellar Diameters

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 191

Presenter
David Kieda
Author and Co-Author
David Kieda | the VERITAS Collaboration,

Abstract
'The VERITAS Imaging Air Cherenkov Telescope (IACT) array was augmented in 2019 with high-speed focal plane electronics to allow the use of VERITAS for Stellar Intensity Interferometry (SII) observations. Since January 2019, VSII recorded more than 127 hours of moonlit observations on 22 different bright stars and binary systems (m_V < 3). The observations resulting in the measurement of the diameters of several stars at an effective optical wavelength of 417 nm with better than 5% resolution. This talk will describe the results of selected VSII observations, and discuss the sensitivity of these results to stellar phenomena such as limb darkening, rapid rotation, and other astrophysical effects.'

Collaborations
VERITAS,

Keywords and Comments
'Intensity Interferometry; stellar diameters; IACT arrays; stellar envelopes; limb darkening', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Explaining the TeV detection of blazar AP Librae: constraints from ALMA and HST

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Agniva Roychowdhury
Author and Co-Author
Agniva Roychowdhury, Eileen T. Meyer | Markos Georganopoulos | Peter Breiding

Abstract
'Powerful jets hosted by accreting super-massive black holes have long been candidates for the acceleration sites for high-energy extra-galactic cosmic rays, supported by the recent association of neutrinos from blazar TX0506+056. In the highly-aligned jets known as blazars, the X-ray to TeV radiation is usually attributed to inverse Compton scattering processes, but has not been clearly identified in most cases due to degeneracies in physical models. AP Librae, a blazar detected in TeV energies, has an extremely broad high-energy spectrum, covering $\sim$ 9 decades in energy. Using new ALMA and Hubble imaging of the kpc-scale jet and over 11 years of Fermi/LAT observations, we rule out previously proposed leptonic models attributing the high-energy emission to synchrotron self-Compton from the jet base and IC/CMB in the kpc-scale jet. In contrast, "lepto-hadronic" models remain viable, though underconstrained given the number of free parameters. We find that the origin of the TeV photons from this source remains debatable and show that leptonic and hadronic models can be further tested with deep and high dynamic range imaging in the sub-mm and far infrared and/or continued monitoring of the source at TeV energies to test for variability. Unmasking the origin of extragalactic TeV emission from blazar AP Librae would unlock vital clues to our understanding of particle acceleration and the origin of extra-galactic cosmic rays.'

Collaborations

Keywords and Comments
", "

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Deep observations of Kepler's SNR with H.E.S.S.

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Dmitry Prokhorov
Author and Co-Author
Dmitry Prokhorov | Rachel Simoni | Jacco Vink | Stefan Funk | Nukri Komin | Denys Malyshev | Lars Mohrmann | Stefan Ohm | Gerd Pühlhofer | for the H.E.S.S. collaboration,

Abstract
"Kepler's supernova remnant (SNR) which is produced by the most recent naked-eye supernova in our Galaxy is one of the best studied SNRs, but its gamma-ray detection has eluded us so far. Observations with modern imaging atmospheric Cherenkov telescopes (IACT) have enlarged the knowledge about nearby SNRs with ages younger than 500 years by establishing Cas A and Tycho's SNRs as very high energy (VHE) gamma-ray sources and setting a lower limit on the distance to Kepler's SNR. This SNR is significantly more distant than the other two and expected to be one of the faintest gamma-ray sources within reach of the IACT arrays of this generation. We report strong evidence for a VHE signal from Kepler's SNR based on deep observations of the High Energy Stereoscopic System (H.E.S.S.) with an exposure of 152 hours, including 120 hours accumulated in 2017-2020. We further discuss implications of this result for cosmic-ray acceleration in young SNRs."

Collaborations
H.E.S.S.,

Keywords and Comments
"gamma-ray; supernova remnant; Kepler's SNR; cosmic-ray acceleration", "

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Physics Performance of the Large Size Telescope prototype of the Cherenkov Telescope Array

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 192

Presenter
Ruben Lopez-Coto
Author and Co-Author
Ruben Lopez-Coto, Manuel Artero | Andres Baquero | Maria Isabelle Bernardos | Jose Luis Conteras | Federico Di Pierro | Enrique Garcia | Daniel Kerszberg | Marcos Lopez-Moya | Alvaro Mas Aguilar | Abelardo Moralejo | Daniel Morcuende | Maximilian Nöthe | Seiya Nozaki | Yos

Abstract
'The Large Size Telescope (LST) prototype of the future Cherenkov Telescope Array (CTA) is located at the Northern site of CTA, on the Canary Island of La Palma. It is designed to provide optimal performance in the lowest part of the energy range covered by CTA, observing gamma rays down to energies of tens of GeV. The LST prototype started performing astronomical observations in November 2019 during the commissioning of the telescope and it has been taking data since then. In this contribution, we will present the tuning of the characteristics of the telescope in the Monte Carlo (MC) simulations to describe the data obtained, the estimation of its angular and energy resolution, and an evaluation of its sensitivity, both with simulations and with observations of the Crab Nebula.'

Collaborations
CTA,

Keywords and Comments
", "

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

"The ASTRI Mini-Array: a breakthrough in the Cosmic Ray study"

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 193

Presenter
MARTINA CARDILLO
Author and Co-Author
MARTINA CARDILLO, For the ASTRI Mini-Array Collaboration

Abstract
'Despite the enormous efforts done in very recent years, both theoretically and experimentally, the basic three questions about the CR origin remain without clear answers: what are their sources, how are they accelerated, how do they propagate?\r\n\r\nGamma-ray astronomy plays a fundamental role in this field. Both relativistic protons and electrons can emit in the gamma-ray band with different processes but only the detection of hadronic gamma-ray emission is a direct proof of Cosmic-Ray acceleration. Distinguishing leptonic and hadronic components is one of the most tricky issues in high energy astrophysics, however, a gamma-ray detection at about 100 TeV would be a direct proof of the hadronic origin of the emission. Consequently, not only would it directly confirm the presence of CR acceleration in a source but also it gives us a large amount of information about their sources, their parent protons and their propagation. The ASTRI Mini-Array, with its unprecedented sensitivity at E > 10 TeV, will provide a fundamental contribution to close some of the most important CR open issues. It will provide fundamental additional data at the highest gamma-ray energies for some candidate Pevatron sources, confirming or disproving their hadronic nature. In the same way, its observations will bring a breakthrough in the understanding of the Crab 100 TeV emission and of the diffusion coefficient behavior near some Supernova Remnants. In this talk, some of the most important results expected by the ASTRI MA are illustrated.'

Collaborations
other (fill field below), ASTRI Mini-Array

Keywords and Comments
'Gamma-ray; Cherenkov Telescopes; origin of cosmic rays; pevatrons. radiation processes', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Relentless multi-wavelength variability of Markarian 421 and Markarian 501

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Sliusar Vitalii
Author and Co-Author
Sliusar Vitalii, Axel Arbet-Engels | Dominik Baack | Matteo Balbo | Noah Biederbeck | Adrian Biland | Thomas Bretz | Jens Buss | Daniela Dorner | Laura Eisenberger | Dominik Elsaesser | Dorothee Hildebrand | Roman Iotov | Karl Mannheim | Dominik Neise | Maximilian Noethe

Abstract
'The high-synchrotron-peaked blazars Markarian 421 and Markarian 501 are close bright and well-studied active galactic nuclei, which feature persistent GeV and TeV emission. FACT and Fermi-LAT have been monitoring these two sources providing the densest long-term dataset of unbiased gamma ray observations. Light curves in the TeV and GeV energy bands, spanning over a five-year period, were used to study the multi-wavelength emission. To characterize the variability and derive constraints on the emission mechanism model parameters, the dataset was augmented with contemporaneous multi-wavelength observations from radio to the X-rays. The blazars were found in various activity states, particularly a quiescent state of Markarian 501 after August, 2016. We correlate the light curves from radio to gamma rays, identify individual flares and look for inter-band connections, which are expected from the shock propagations within the jet. The fractional variability for both blazars shows a two-bump structure with the highest variability in the X-ray and TeV bands. The lag between X-ray and TeV light curves in Markarian 421 was found to be close to zero, supporting the SSC emission scenario. The timing between both TeV and X-ray flares in Markarian 421 is consistent with periods expected in the case of Lense–Thirring precession of the accretion disc. The variability of Markarian 501 on the long-term scale is also consistent with SSC, with a sub-day lag between X-ray and TeV variability.'

Collaborations
other (fill field below), FACT

Keywords and Comments
'AGN; Mrk 421; Mrk 501; blazars; FACT; IACT', ''

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Subcategory Experimental Results

H.E.S.S. ToO program on nearby core-collapse Supernovae : search for very-high energy gamma-ray emission towards the SN candidate AT2019krl in M74

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 194

Presenter
Nukri Komin
Author and Co-Author
Nukri Komin | Rachel Simoni | Matthieu Renaud | Stuart Ryder | for the H.E.S.S. Collaboration,

Abstract
'While the youngest known supernova remnants (SNRs), such as Cas A, have been proven to be able to accelerate CRs only up to $\\sim 10^{14}\\,\\mathrm{eV}$, recent studies have shown that particle energies larger than a few PeV ($10^{15}\\,\\mathrm{eV}$) could actually be reached during the early stages of a core-collapse Supernova (cc-SN), when the high-velocity forward shock expands into the dense circumstellar medium (CSM) shaped by the stellar progenitor wind. Such environments, in particular the type IIn SNe whose progenitors may exhibit mass loss rates as high as $10^{-2}\\,M_\\odot \\, \\mathrm{yr}^{-1}$, would thus lead to gamma-ray emission from $\\pi^0$ decay in hadronic interactions, potentially detectable with current Cherenkov telescopes at very-high energies (VHE). In that context, the High Energy Stereoscopic System (H.E.S.S.) has been carrying out a Target of Opportunity (ToO) program since 2016 to search for such an early VHE gamma-ray emission towards nearby (up to $\\sim 10\\,\\mathrm{Mpc}$) cc-SNe and SN candidates, within a few weeks of discovery. After giving an overview of this H.E.S.S. ToO program, we will present the results obtained from July 2019 observations towards the transient AT2019krl, originally classified as a type IIn SN, which occurred in the galaxy M74 at $\\sim 9\\,\\mathrm{Mpc}$. Although its nature still remains unclear, the derived H.E.S.S. constraints on this transient will be placed in the general context of the expected VHE gamma-ray emission from cc-SNe.'

Collaborations
H.E.S.S.,

Keywords and Comments
'supernovae; gamma rays; particle acceleration', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

The Ultra-High-Energy Source MGRO J1908+06

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 26 Galactic Sources & Winds | MM
Presenter Forum Table

Presenter
Kelly Malone
Author and Co-Author
Kelly Malone | for the HAWC Collaboration,

Abstract
'The TeV gamma-ray source MGRO J1908+06 is one of the highest-energy sources known, with observed emission by the High Altitude Water Cherenkov (HAWC) Observatory extending well past 100 TeV. The source exhibits both energy-dependent morphology and a spatially-dependent spectral index. The emission is likely to be dominantly leptonic, and associated with the radio-quiet PSR J1907+0602. However, one-population models do not describe the data well; a second particle population is needed to explain the shape of the spectral energy distribution at the highest energies. This component can be well-described by either leptonic or hadronic hypotheses. We discuss this feature and implications for detection by multi-wavelength and multi-messenger experiments.'

Collaborations
HAWC,

Keywords and Comments
'TeV gamma rays; PWN; multi-messenger; HAWC', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

A search for spectral hardening in HAWC sources above 56 TeV

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 195

Presenter
Kelly Malone
Author and Co-Author
Kelly Malone | for the HAWC Collaboration,

Abstract
'The High Altitude Water Cherenkov (HAWC) Observatory is a wide-field-of-view gamma-ray observatory that is optimized to detect gamma rays between ~300 GeV and several hundred TeV. The HAWC Collaboration recently released their third source catalog (3HWC), which contains 65 sources. One of these sources, the ultra-high-energy gamma-ray source 3HWC J1908+063, may exhibit a hardening of the spectral index at the highest energies (above 56 TeV). At least two populations of particles are needed to satisfactorily explain the highest energy emission. This second component could be leptonic or hadronic in origin. If it is hadronic in origin, it would imply the presence of protons with energies up to ~1 PeV near the source. We have searched other 3HWC sources for the presence of this spectral hardening feature. If observed, this would imply that the sources could make good PeVatron candidates.'

Collaborations
HAWC,

Keywords and Comments
'pevatrons; TeV; TeV gamma rays; HAWC; PWN; Galactic', ''

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Subcategory Experimental Results

VTSCat: The VERITAS Catalog of Gamma-Ray Observations

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 196

Presenter
Sameer Patel
Author and Co-Author
Sameer Patel | Gernot Maier | For the VERITAS collaboration,

Abstract
"We present a catalog of results published from 2008 to 2020 through gamma ray observations made by **VERITAS**. VERITAS is a ground based imaging atmospheric Cherenkov telescope observatory located at the Fred Lawrence Whipple Observatory (FLWO) in southern Arizona, sensitive to gamma-ray photons with energies in the range of $\\sim$ 100 GeV - 30 TeV. Its observation targets include galactic sources such as binary systems, pulsar wind nebulae, and supernova remnants, and extragalactic sources like active galactic nuclei, star forming galaxies, and gamma-ray bursts and some unidentified sources. The catalog includes all of the results published in 112 papers using VERITAS data and currently contains data on 57 sources. The catalog has been made accessible via GitHub and at NASA's HEASARC."

Collaborations
VERITAS,

Keywords and Comments
'observational catalog; gamma ray data; HEASARC', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Studying High-Mass Microquasars with HAWC

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 197

Presenter
Chang Dong Rho
Author and Co-Author
Chang Dong Rho | Ke Fang, for the HAWC Collaboration

Abstract
'High-mass microquasars (HMMQs) are powerful particle accelerators, but their mechanism of the high-energy emission is poorly understood. To date, only a handful of these particle engines have ever been observed to emit gamma-ray photons and are thus potential TeV gamma-ray emitters. In this work, we study four HMMQs, namely, LS 5039, Cyg X-1, Cyg X-3, and SS 433 using the data from the High Altitude Water Cherenkov (HAWC) observatory. We report the most stringent limit to date on the gamma-ray emission above 10 TeV for each HMMQ. Also, by stacking the fitted likelihoods of the HMMQs, we constrain the fraction of the jet luminosity in emitting very-high-energy (VHE) gamma rays and high-energy neutrinos. We show that the non-detection of VHE gamma rays implies a significant magnetic field, which challenges synchrotron radiation as the dominant mechanism of the microquasar emission between 10 keV and 10 MeV. Furthermore, we perform time dependent analysis on each HMMQ to look for any periodic variations in their flux.'

Collaborations
HAWC,

Keywords and Comments
'Gamma rays; High-mass x-ray binaries', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Is PKS 0625-354 another variable TeV active galactic nucleus?

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Dorit Glawion
Author and Co-Author
Dorit Glawion, Alicja Wierzcholska | for the H.E.S.S. Collaboration

Abstract
'The majority of the active galactic nuclei detected at very-high-energies above 100 GeV belong to the class of blazars with a small angle between the jet-axis and the line-of-sight. Only about 10 percent of the gamma-ray AGN are objects with a larger viewing angle resulting in a smaller Doppler boosting of the emission. Originally, it was believed that gamma-ray emission can only be observed from blazars and those are variable in its brightness. Instead, the last years have shown that non-blazar active galaxies also show a fascinating variability behaviour which provide important new insights into the physical processes responsible for the gamma-ray production and especially for flaring events.\r\n\r\nHere, we report on the observation of gamma-ray variability of the active galaxy PKS 0625-354 detected with the H.E.S.S. telescopes in November 2018. The classification of PKS 0625-354 is a still matter of debate. The H.E.S.S. measurements were performed as part of a flux monitoring program and showed in the first night of the observation a detection of the object within one observation run of 30 minutes. A denser observation campaign followed for the next nine nights resulting in a decrease of the gamma-ray flux. Those observations were accompanied with Swift and ATOM measurements in the X-ray and UV/optical band allowing for the reconstruction of the first simultaneous broad-band spectral energy distribution. We will discuss the implications of the gamma-ray variability of the object as well as the spectral energy distribution.'

Collaborations
H.E.S.S.,

Keywords and Comments
'AGN; Gamma rays; radio galaxy; multi-wavelength emission', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

MAGIC and H.E.S.S. detect VHE gamma rays from the blazar OT081 for the first time: a deep multiwavelength study

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Marina Manganaro
Author and Co-Author
Marina Manganaro, Monica Seglar Arroyo | Josefa Becerra González | David Sanchez | Matteo Cerruti | Vandad Fallah Ramazani | Fabrizio Tavecchio | Ivan Agudo | Stefano Ciprini | A Esteban-Guiterrez | A. V. Filippenko | Talvikki Hovatta | Helena Jermak | Svetlana Jorstad | A

Abstract
'OT081 is a luminous blazar well known for its variability in many energy bands.\r\nThe very-high-energy (VHE, E > 100 GeV) gamma-ray emission from the source was discovered by MAGIC and H.E.S.S. during flaring activity in July 2016, after a trigger from the LAT onboard the Fermi satellite.\r\nFrom the analysis of the multiwavelength (MWL) light curves and of the broadband spectral energy distribution (SED), we study the activity of the source, in particular during four identified states of activity in the window MJD 57575 to MJD 57600. The intrinsic gamma-ray spectrum can be described by a power law with spectral indices of 3.27+/- 0.44 (MAGIC) and 3.39 +/- 0.58 (H.E.S.S.) for energy ranges 60-300 GeV and 120-500 GeV, respectively.\r\nThe combined contemporaneous HE (E > 100 MeV) through VHE SED shows curvature and can be described by a log-parabola shape.\r\nVLBI analysis of the flare reveals the ejection of a superluminal knot and its subsequent passage through a stationary feature as a possible cause of the HE gamma-ray activity.\r\nA simple one-zone synchrotron self-Compton (SSC) model is not sufficient to describe the broadband SED, and external Compton is required to explain the high Compton dominance displayed by the source.\r\nThe presence of broad emission lines in the optical spectrum of the source challenges the categorization of OT081 as a BL Lac and, together with the emission scenarios tested, points to the possibility that the source is transitional in nature between a BL Lac and a flat spectrum radio quasar (FSRQ).'

Collaborations
MAGIC, H.E.S.S., Fermi-LAT

Keywords and Comments
'galaxies: active; BL Lacertae objects: individual: OT~081; gamma-rays; galaxies: non-thermal; galaxies: FSRQ; AGN; multiwavelength; multi-wavelength;', ''

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Subcategory Experimental Results

MAGIC detection of Geminga: an Inverse Compton tail?

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems, Microquasars | GAD-GAI
Presenter Forum Table

Presenter
Giovanni Ceribella
Author and Co-Author
Giovanni Ceribella | Marcos López-Moya | Razmik Mirzoyan | for the MAGIC Collaboration,

Abstract
'We report the detection of pulsed emission from the Geminga pulsar (PSR J0633+1746) with the MAGIC Telescopes. After the Crab and Vela pulsars, Geminga is the third one detected in the very high energy domain, and its estimated age of ~340 ky makes it the oldest one. The spectrum derived by MAGIC extends from ~15 GeV to 75 GeV and can be well modeled with a simple, soft power-law function. For energies below 40 GeV it overlaps with Fermi-LAT measurements. Joint fits to MAGIC and Fermi-LAT data disfavour the existence of a sub-exponential cut-off in this energy range. Our results are discussed in the framework of the outer gap accelerator model. Such power-law emission can be interpreted as the transition from curvature radiation to inverse Compton (IC) scattering of charges accelerated in the northern outer gap. The IC component is expected to continue towards higher energies. The model fails to fit the overall shape of the spectrum, indicating that a major review is required.\r\n\r\nThe MAGIC Telescopes are two IACTs on the Canary Island of La Palma. In recent years they have significantly improved their performance below 100 GeV with the introduction of a novel trigger system, the Sum-Trigger-II, which halves the energy threshold of the system.'

Collaborations
MAGIC,

Keywords and Comments
'Pulsars; Geminga; MAGIC; IACT;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

The variability patterns of PG 1553+113: a MAGIC perspective

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Elisa Prandini
Author and Co-Author
Elisa Prandini | Antonio Stamerra | Talvikki Hovatta | Tommaso Aniello | Paolo Da Vela | Luca Foffano | Ioannis Liodakis | Pablo Peñil | Sofia Ventura,

Abstract
'PG1553+113 is one of the few blazars with a convincing quasi-periodic emission in the gamma-ray band detected by the Fermi-LAT satellite. The source is also a very high-energy (>100 GeV) gamma-ray emitter. The MAGIC collaboration started a multi-year, multi-wavelength monitoring campaign of PG 1553+113 in 2015 involving several instruments in the radio, infra-red, optical photometry and polarimetry, UV, and soft X-ray bands. The purpose of the campaign is to characterise the properties of its broadband emission, in particular the variability at different timescales and energies, with the ultimate goal of pinpointing the physical processes at work in the jet driving the emission variability. In this contribution the main results of the campaign will be presented with a particular emphasis on the multi-year light curve from MAGIC and its connection to the periodicity seen in gamma rays by Fermi-LAT and, possibly, in the optical waveband, too.'

Collaborations
MAGIC,

Keywords and Comments
'Blazar; gamma rays; multi-wavelength; periodicity; MAGIC; IACT; extra-galactic', 'for the MAGIC collaboration and MWL partners'

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Subcategory Experimental Results

MAGIC observations of HESS J1809-193 using the Very Large Zenith Angle technique at energies above TeV

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 198

Presenter
Darko Zaric
Author and Co-Author
Darko Zaric, David Green | Marcel Strzys | Ievgen Vovk | on behalf of the MAGIC collaboration

Abstract
'The origin of Galactic Cosmic rays (GCRs), whose spectrum extends to PeV energies, is one of the longest-standing problems in astroparticle physics. One of the main sources of GCRs are regarded to be Supernova remnants (SNRs). While SNRs are known to accelerate protons, so far there is no evidence that SNRs can accelerate CRs to PeV energies. Providing that ~10% of the parent Cosmic ray energy is converted to gamma rays, the gamma-ray spectrum extending up to ~100 TeV would be a signature of a so-called Galactic PeVatron, an object responsible for the production of protons up to the knee of the Cosmic ray spectrum. The current multi-wavelength data indicate that HESS J1809-193 is one of the most promising Galactic PeVatron candidates. So far, no firm identification on the source nature has been established as there are several possible counterparts at lower energies; one of them being SNR G11.0−0.0. We report here the results of an observational campaign performed by the MAGIC telescopes on HESS J1809-193 since 2019 in the very-high-energy gamma-ray domain (E>100 GeV). The data were obtained with the Very Large Zenith Angle (VLZA) technique, which increased the collection area significantly to about one square kilometer. We used ~60 hours of collected VLZA data to explore the spectrum and the morphology of the source at energies above several TeV.'

Collaborations
MAGIC,

Keywords and Comments
'gamma rays; very large zenith angles; HESS J1809-193; PeVatron', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Multiwavelength monitoring of gravitationally lensed blazar QSO B0218+357 between 2016 and 2020

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Julian Sitarek
Author and Co-Author
Julian Sitarek, Vandad Fallah Ramazani | Alessandra Lamastra | Elina Lindfors | Marina Manganaro | Kari Nilsson | for the MAGIC Collaboration | Francesco Longo | Francesco de Palma | Filippo D'Ammando | for the Fermi-LAT Collaboration | Anna Barnacka | Kazuhiro Hada |

Abstract
'QSO B0218+357 is currently the only gravitationally lensed source from which very-high-energy (VHE,>~100GeV) gamma-ray emission has been detected. We report the multiwavelength monitoring observations of this source performed between 2016 and 2020 in radio interferometry, optical, X-ray and gamma-ray bands. During the monitoring individual flares in optical, X-ray and GeV bands have been observed. Simultaneous data taken by the MAGIC telescopes allow us to search for the associated VHE emission, constraining the VHE gamma-ray duty cycle of the source.\r\nWe use the exceptional multiwavelenght dataset collected to characterize the lensing galaxy, model the source-lens-observer geometry, and determine the magnifications and time delays for different components of the image.\r\nWe model the quiescent emission in which the high energy bump is explained as a combination of Synchrotron-Self-Compton and External Compton processes. The bulk of the low energy emission is explained as originating from a tens of parsecs scale jet.'

Collaborations
MAGIC, Fermi

Keywords and Comments
'AGN; lensing; non-thermal processes', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Upper limits on VHE emission from GRBs

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 54 Gamma-Ray Bursts in the VHE regime | GAI
Presenter Forum Table

Presenter
Longo Francesco
Author and Co-Author
Alessio Berti | Zeljka Bosnjak | Alice Donini | Satoshi Fukami | Jarred Green | Longo Francesco | Davide Miceli | Elena Moretti | Lara Nava | Koji Noda,

Abstract
"The MAGIC telescopes has developed a dedicated observational strategy to repoint rapidly towards gamma-ray bursts (GRB). In this contribution we present the information extracted from the large sample of the GRBs observed but not detected by MAGIC from 2013 to 2019 aiming to shed light on the reasons behind those non-detections.The same strategy led to the successful detection of two GRBs at very high energies (VHE, E>~100 GeV).\r\nWe describe the details of the MAGIC GRB observational procedure and the general properties for each observed GRB. The lack of detection can be attributed either to unfavourable conditions or GRB intrinsic properties, such as the magnetic field's energy density, the bulk Lorentz factor, or the emitting region's size.\r\nFor the presented sample of GRBs, we show the methods used to obtain flux upper limits in the VHE range, and propose physical implications of the non-detection of VHE emission.\r\nThese results constitute an essential reference point to study the broadband emission of GRBs, and for the Cherenkov telescope community to organize future follow-ups of GRBs at VHE energies."

Collaborations
MAGIC,

Keywords and Comments
'Gamma Ray Bursts', 'on behalf of the MAGIC collaboration'

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Study of the gamma-ray emission from 3HWC J1928+178

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 53 PWN and Halos | GAD-GAI
Presenter Forum Table

Presenter
Armelle Jardin-Blicq
Author and Co-Author
Armelle Jardin-Blicq | for the HAWC Collaboration,

Abstract
'The gamma-ray source 3HWC J1928+178, discovered by HAWC, is coincident with the 82 kyr pulsar PSR J1928+1746, located 4 kpc away. It has not been reported by any Imaging atmospheric Cherenkov Telescope (IACT), until the recent detection of emission from this region by HESS, using an analysis adapted to extended sources. No counterpart in GeV gamma-rays from Fermi-LAT data or in X-ray has been reported so far. In this contribution, I give the multiwavelength context of the region surrounding 3HWC J1928+178 and present a multi-component model derived using the Multi-Mission Maximum Likelihood framework (3ML). I explore the possibility to model the gamma-ray emission of 3HWC J1928+178 by an extended source with continuous diffuse emission. Together with the age of the pulsar and its extended nature, it may indicate a transition from a pulsar wind nebulae to a halo, where the electrons have started to cool and diffuse away from the source'

Collaborations
HAWC,

Keywords and Comments
'Very-High-Energy gamma rays -- Multi-component fit -- Pulsar wind nebulae -- TeV halo', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Deep Learning Transient Detection with VERITAS

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Konstantin Johannes Pfrang
Author and Co-Author
Konstantin Johannes Pfrang | for the VERITAS Collaboration,

Abstract
'Ground-based gamma-ray observatories such as the VERITAS array of imaging atmospheric Cherenkov telescopes provide insight into very-high-energy (VHE, E>100 GeV) astrophysical transient events. Examples include the evaporation of primordial black holes and gamma-ray bursts. Identifying such an event with a serendipitous location and time of occurrence is difficult. Thus, employing a robust search method becomes crucial. An implementation of a transient detection method based on deep learning techniques for VERITAS will be presented. This data-driven approach significantly reduces the dependency on the characterization of the instrument response and the modelling of the expected transient signal. The response of the instrument is affected by various factors, such as the elevation of the source and the night sky background. The study of these effects allows enhancing the deep learning method with additional parameters to infer their influences on the data. This improves the performance and stability for a wide range of observational conditions. We use our method to investigate archival VERITAS data from 2012 to 2020 for second- to minute-scale VHE transients'

Collaborations
VERITAS,

Keywords and Comments
'deep learning; transient; gamma-ray; IACT; VERITAS; PBH; GRB;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Detection of new Extreme BL Lac objects with H.E.S.S. and SWIFT

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Angel Priyana Noel
Author and Co-Author
Angel Priyana Noel | Manuel Meyer | David Sanchez | Tomas Bylund | Mathieu de Bony de Lavergne,

Abstract
'Extreme high synchrotron peaked blazars (EHBLs) are amongst the most powerful accelerators found in nature. Usually the synchrotron peak frequencyof an EHBL is above 10^17 Hz, i.e., lies in the range of medium to hard X-rays making them ideal sources to study particle acceleration and radiative processes. EHBL objects are commonly observed at energies beyond several TeV, making them powerful probes of gamma-ray absorption in the intergalactic medium. During the last decade, several attempts have been made to increase the number of EHBL detected at TeV energies and probe their spectral characteristics.\r\nHere we report new detections of EHBLs in the TeV energy regime, each at a redshift of less than 0.25, by the High Energy Stereoscopic System (H.E.S.S.). Also, we report on X-ray observations of these EHBLs candidates with *Swift* XRT. In conjunction with the very high energy observations, this allows us to probe the radiation mechanisms and the underlying particle acceleration processes.'

Collaborations
H.E.S.S.,

Keywords and Comments
'', 'for H.E.S.S. collaboration'

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

TeV emission from FSRQs: The first systematic and unbiased survey

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Sonal Ramesh Patel
Author and Co-Author
Sonal Ramesh Patel | For the VERITAS collaboration,

Abstract
'Flat spectrum radio quasars (FSRQs) have been detected at TeV energies by ground-based atmospheric Cherenkov telescope mainly during flaring states. VERITAS is carrying out the first systematic and unbiased search for TeV emissions from a set of FSRQs. Fermi-LAT-detected FSRQs with positive declinations and extrapolated fluxes from the 3FHL catalog exceeding 1% Crab at >200 GeV after correcting for EBL absorption were selected for this survey, resulting in eight targets. Additionally, four FSRQs that were already detected at TeV energies are also included in this survey. In an unbiased fashion, the observations of twelve FSRQs, even without detection, provide the first constraints on the duty cycle of TeV emission from these FSRQs. Constraints on the TeV fluxes from these sources are used to probe the origin of the GeV to TeV spectral breaks. From this ongoing survey, the results of the sources observed during 2020-21 season are discussed in this work.'

Collaborations
VERITAS,

Keywords and Comments
'Blazars', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

A GeV to TeV view of shell-type SNRs

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Henrike Fleischhack
Author and Co-Author
Henrike Fleischhack | for the Fermi-LAT and HAWC collaborations,

Abstract
'Shock acceleration by the shells of supernova remnants (SNRs) has been hypothesized to be the mechanism that produces the bulk of Galactic Cosmic Rays, possibly up to PeV energies. Some SNRs have been shown to accelerate cosmic rays to TeV energies and above. But which SNRs are indeed efficient accelerators of protons and nuclei? And what is the maximum energy up to which they can efficiently accelerate particles? Measurements of non-thermal emission, especially in the gamma-ray regime, are essential to answer these questions.\r\n\r\nThe High-Altitude Water Cherenkov (HAWC) observatory, surveying the northern TeV gamma-ray sky, is currently the most sensitive wide field-of-view survey instrument in the VHE (very-high-energy, >100 GeV) range and has recorded more than five years of data. The Large Area Telescope (LAT) onboard the Fermi satellite has been surveying the GeV gamma-ray sky for more than ten years. Combining measurements from both instruments allows the study of gamma-ray emission from SNRs over many orders of magnitude in energy. In this presentation, I will show measurements of VHE gamma-ray emission from Fermi-LAT-detected SNRs with the HAWC Observatory.'

Collaborations
HAWC, Fermi-LAT

Keywords and Comments
'Supernova remnants; SNRs; gamma rays', 'Technically, this could go into gamma-ray direct as well (since both LAT and HAWC data will be used).'

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Study of the morphology of the region surrounding eHWC J1850+001

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 199

Presenter
Chad Brisbois
Author and Co-Author
Chad Brisbois | For the HAWC Collaboration,

Abstract
'Although at extreme energies (>50 TeV) γ-ray sources generally have large angular separations from one another as observed on Earth, at lower energies in the galactic plane this is often not the case. HAWC observes extended emission from the source eHWC J1850+001 exceeding 50 TeV, and at lower energies this region appears to consist of multiple sources of γ-ray emission. These include the 3HWC J1849+001 source but also two nearby H.E.S.S. sources observed in their Galactic Plane Survey. Therefore, a full description of the region requires a morphological study including the full energy range of HAWC data. Understanding the spatial features of the emission in this region is important to associate the sources observations at other wavelengths, which may point to hadronic or leptonic origins for the γ-ray emission. There are multiple pulsar wind nebulae and super nova remnant systems in the vicinity that may be responsible for the emission in this region, including the pulsar PSR J1849+001 and its pulsar wind nebula, which is a likely candidate for the >50 TeV energy emission seen by HAWC.'

Collaborations
HAWC,

Keywords and Comments
'VHE; PWN; SNR; HAWC; multisource; likelihood;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Characterizing gamma-ray sources with HAL (HAWC Accelerated likelihood) and 3ML

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 200

Presenter
Chad Brisbois
Author and Co-Author
Chad Brisbois | For the HAWC Collaboration,

Abstract
'The open-source Multi-Mission Maximum likelihood (3ML) Framework allows for the common analysis of diverse datasets. The ability to consistently fit and characterize astronomical data across many decades in energy is key to understanding the origin of the emission we measure with many different instruments. 3ML uses plugins to encapsulate the interfaces to data and instrument response functions. The user can then define a model with one or multiple sources to describe a given region of interest. The model is fit to the data to determine the locations, spatial shapes, and energy spectra of the sources in the model. The High Altitude Water Cherenkov (HAWC) Observatory, a wide FoV instrument sensitive to energies from 300 GeV to above 100 TeV, has used 3ML for data analysis for several years using a plugin optimized for single source analysis. As multisource fitting became more common, a faster plugin was required. Spectral fits to the Crab Nebula and the nearby source HAWC J0543+233 obtained using HAL, the HAWC plugin for 3ML, will be presented.'

Collaborations
HAWC,

Keywords and Comments
'software; 3ML; crab; likelihood', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Limits on the Diffuse Gamma-Ray Background with HAWC

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 201

Presenter
Mora Durocher
Author and Co-Author
Mora Durocher | For the HAWC Collaboration, Pat Harding

Abstract
'The high-energy Diffuse Gamma-Ray Background (DGRB) is expected to be produced by unresolved extra-galactic objects such as active galactic nuclei and isotropic Galactic gamma rays. At TeV energies, observations or stringent limits on the DGRB could have significant multi-messenger implications, such as constraining the origin of TeV-PeV astrophysical neutrinos detected by IceCube. With its continuous sensitivity to gamma rays from 300 GeV to 100 TeV and its wide field-of-view, the High Altitude Water Cherenkov (HAWC) observatory is well-suited to significantly improve searches for the DGRB. In this work, strict cuts have been applied to the HAWC dataset to better isolate gamma-ray air showers from background hadronic showers. The sensitivity to the DGRB was then verified using 535 days of Crab data and Monte Carlo simulations, leading to a new limit on the DGRB above 24 TeV.'

Collaborations
HAWC,

Keywords and Comments
", "

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Detection of the Crab Nebula by the prototype Schwarzschild-Couder Telescope

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 202

Presenter
Brent Mode
Author and Co-Author
Brent Mode | for the CTA SCT Project,

Abstract
'The Schwarzschild-Couder Telescope (SCT) is a medium-sized telescope technology proposed for the Cherenkov Telescope Array. It uses a novel dual-mirror optical design that removes comatic aberrations across its entire field of view. The SCT camera employs high-resolution silicon photomultiplier (SiPM) sensors with a pixel size of 4 arc minutes. A prototype SCT (pSCT) has been constructed at the Fred Lawrence Whipple Observatory in Arizona, USA. An observing campaign in 2020, with a partial camera of 1600 pixels (2.7 degrees by 2.7 degrees field of view) resulted in detection of the Crab Nebula at 8.6 sigma statistical significance. Work on the pSCT camera and optical system is ongoing to improve performance and prepare for an upcoming camera upgrade. The pSCT camera upgrade will replace the current camera modules with improved SiPMs and readout electronics and will expand the camera to its full design field of view of 8 degrees in diameter (11,328 pixels). The fully upgraded pSCT will enable next-generation very-high-energy gamma-ray astrophysics through excellent background rejection and angular resolution. In this presentation we will describe first results from the successful operation of the pSCT and future plans.'

Collaborations
CTA,

Keywords and Comments
'gamma rays; Crab Nebula; CTA; IACT', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Particle Acceleration in the Cygnus Superbubble

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Binita Hona
Author and Co-Author
Binita Hona | for the HAWC Collaboration,

Abstract
'The Cygnus Cocoon is the first gamma-ray superbubble powered by a massive stellar association, the OB2 association. It was postulated that the combined effects of the stellar wind of the massive type O stars of the OB2 association can accelerate the cosmic rays to PeV energy in the Cocoon. The conclusive proof of acceleration to PeV energy in the Cocoon will identify the stellar association as a PeV cosmic-ray accelerator. However, the Cocoon has been previously studied only up to 10 TeV. In this contribution, using 1343 days of High Altitude Water Cherenkov (HAWC) observatory data, we present the morphological and spectral study of the Cocoon above 1 TeV to beyond 100 TeV. The analysis at higher TeV energies reveals a softer spectrum compared to the GeV gamma-ray observation. This result suggests that either the accelerator's efficiency decreases significantly around hundreds of TeV, or after being accelerated, the highest-energy protons escape the region. The study above 10 TeV presented here demonstrates how CR accelerators operate in these extreme energies and how particle transport impacts high-energy emission.'

Collaborations
HAWC,

Keywords and Comments
'Very-high-energy gamma-ray', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Very High Energy Gamma-ray Emission from the Binary System LS I +61 303

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems, Microquasars | GAD-GAI
Presenter Forum Table

Presenter
David Kieda
Author and Co-Author
David Kieda | for the VERITAS Collaboration,

Abstract
'LS I +61 303 is one of around ten gamma-ray binaries detected so far, each characterized by a spectral energy distribution dominated by MeV-GeV photons. It is located at a distance of 2 kpc and consists of a compact object (black hole or neutron star) in an eccentric orbit around a 10-15 $M\odot$ Be star, with an orbital period of 26.5 days. The binary orbit modulates the emission ranging from radio to TeV energies. A second, longer, modulation period of 1667 days (the super-orbital period) has also been detected from radio to TeV observations. The VERITAS imaging atmospheric Cherenkov telescope array has been observing LS I +61 303 since 2006, and has accumulated a dataset that fully covers the entire orbit. Increased coverage of the source in the very-high-energy band is currently underway to provide more results on the modulation pattern, super-orbital period, and orbit-to-orbit variability at the highest energies. The spectral measurements at the highest energies will reveal more information about gamma-ray production/absorption mechanisms, the nature of the compact object, and the particle acceleration mechanism. Using >150 hrs of VERITAS data, we present a detailed study of the spectral energy distribution and periodic behavior of this rare gamma-ray source type at very-high energy.'

Collaborations
VERITAS,

Keywords and Comments
'VHE gamma rays; HMXB; microquasar; Be star; TeV binary; superorbital modulation; orbital modulation', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

VERITAS Observations of the Galactic Center Region at Multi-TeV Gamma-Ray Energies

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 203

Presenter
James Ryan
Author and Co-Author
James Ryan, for the VERITAS Collaboration

Abstract
'The Galactic Center region hosts a variety of powerful astronomical sourcesand rare astrophysical processes that emit a large flux of non-thermal radiation. We present the analysis of the very-high-energy gamma-ray emission above 2 TeV of the region around the Galactic Center known as the Central Molecular Zone using 125 hours of data taken with the VERITAS imaging-atmospheric Cherenkov telescope between 2010 and 2018. This analysis employs new shower reconstruction algorithms and instrument response functions optimized for data taken at large zenith angles such as the Galactic Center sources. We report positions and spectra for point sources VER J1745-290, G0.9+0.1, and HESS J1746-285, along with a light curve for VER J1745-290, the brightest source in the region consistent with the position of the supermassive black hole Sagittarius A*. We also measure the spectrum of the diffuse emission from the Galactic Center ridge region, which has been claimed as evidence of a Galactic PeVatron.'

Collaborations
VERITAS,

Keywords and Comments
'Galactic Center; Central Molecular Zone', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Unveiling the complex correlation patterns in Mrk 421

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 204

Presenter
Axel Arbet-Engels
Author and Co-Author
Axel Arbet-Engels, David Paneque | Lea Heckmann | for the MAGIC, FACT and Fermi-LAT Collaborations and multi-wavelength collaborators

Abstract
'The blazar Mrk421 (redshift $z=0.031$) is one of the brightest and closest BL Lac type objects, making it an ideal target to probe blazar physics. We report on an extensive multi-wavelength observing campaign in 2017, during which the intra-band correlation patterns show some disparity and complex behaviours. Observations from several instruments are used to achieve an optimal temporal coverage from radio to TeV energies. In particular, four multi-hour NuSTAR observations organised simultaneously with MAGIC allow to obtain a precise measurement of the falling segments of the two spectral components. A detailed investigation of the very-high-energy (VHE; >100 GeV) versus X-ray flux correlation is performed, by binning the data into several sub-energy bands. A positively correlated variability is observed, but the correlation characteristics change substantially across the various bands probed. Furthermore, during the simultaneous MAGIC and NuSTAR observations a clear change of the Compton dominance is detected without a simultaneous change in the synchrotron regime, indicating "orphan gamma-ray activity". We also investigate an intriguing bright flare at VHE without a substantial flux increase in the X-rays. Within a leptonic scenario, this behaviour is best explained by the appearance of a second population of highly-energetic electrons spanning a narrow range of energies. Finally, our multi-wavelength correlation study also reveals an anti-correlation between the UV/optical and X-ray bands at a significance level above 3 sigma.'

Collaborations
MAGIC, FACT, Fermi-LAT

Keywords and Comments
'BL Lacertae objects; AGN ; gamma rays; radiation mechanisms; modelling', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Galactic Diffuse Emission Analysis With HAWC Data

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Amid Nayerhoda
Author and Co-Author
Amid Nayerhoda | Sabrina Casanova | Francisco Salesa Greus,

Abstract
'The Galactic gamma-ray diffuse emission is produced by the interaction of cosmic rays with ambient gas and electromagnetic radiation fields in the interstellar medium (ISM). Studying this radiation helps reconstruct the particle transport mechanisms and the particle distribution in the Galaxy. In this work, we analyze TeV emissions in a chosen region of the Galactic plane using data collected with the High Altitude Water Cherenkov (HAWC) detector. The energy and spatial distributions of the diffuse Galactic gamma-ray emission have been studied after subtracting extended and point sources detected with greater than 5 sigma significance from the region map. The spectral and morphological features of the aforementioned emission are compatible with the gamma-ray emissivity obtained from the locally measured proton and heavier nuclei spectrum, convolved with the gas distribution in the Galaxy.'

Collaborations
HAWC,

Keywords and Comments
'Diffuse emission; Galactic; TeV gamma-ray', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

TeV Analysis of the Probable PWN Component of 3HWC J2031+415

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 205

Presenter
Ian Herzog
Author and Co-Author
Ian Herzog | For the HAWC Collaboration,

Abstract
'The Cygnus Cocoon region is a complex region containing an OB star cluster that is prominent in the TeV energy range. Located in this region is 3HWC J2031+415, a significant TeV gamma ray source whose emission is possibly associated with 2 components, the Cygnus OB2 star cluster and a pulsar wind nebula (PWN). In this work, several modelling methods are presented to best describe the emission. These models disentangle emission believed to be from the Cocoon and isolate the component emitted by the probable PWN. I will present several spectral models to describe the emission of the probable PWN using the latest data set from the High-Altitude Water Cherenkov (HAWC) observatory. Furthermore, I will present an energy morphology study of the PWN component of 3HWC J2031+415 in distinct energy bins.'

Collaborations
HAWC,

Keywords and Comments
'Gamma ray; Morphology study', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Effective pointing of the ASTRI-Horn telescope using the Cherenkov camera with the Variance method

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 206

Presenter
Simone Iovenitti
Author and Co-Author
Simone Iovenitti, Giorgia Sironi | Osvaldo Catalano | Alberto Segreto | Teresa Mineo | for the ASTRI project

Abstract
'Cherenkov telescope cameras are not suitable to perform astrometrical pointing calibration since they are not designed to produce images of the sky, but rather to detect nanosecond atmospheric flashes due to very high-energy cosmic radiation. Indeed, these instruments show only a moderate angular resolution (fractions of degrees) and are almost blind to the steady or slow-varying optical signal of starlight. For this reason, auxiliary optical instruments are typically adopted to calibrate the telescope pointing. However, secondary instruments are possible sources of systematic errors. Furthermore, the Cherenkov camera is the only one framing exactly the portion of the sky under study, and hence its exploitation for pointing calibration purposes would be desirable.\r\nIn this work, we present a procedure to assess the pointing accuracy of the ASTRI-Horn telescope by means of its innovative Cherenkov camera. This instrument is endowed with a statistical method, the so-called Variance method, implemented in the logic board and able to provide images of the night sky background light as ancillary output.\r\nTaking into account the convolution between the optical point spread function and the pixel distribution, Variance images can be used to evaluate the position of stars with sub-pixel precision. In addition, the rotation of the field of view during observations can be exploited to verify the alignment of the Cherenkov camera with the optical axis of the telescope, with a precision of ~1 arcsec. This information is essential to evaluate the effective pointing of the telescope, enhancing the scientific accuracy of the system.'

Collaborations
other (fill field below), ASTRI

Keywords and Comments
'pointing; assessment; FOV rotation; variance; ASTRI; runtime; alignment; tracking;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

First follow-up of transient events with the CTA Large Size Telescope prototype

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 54 Gamma-Ray Bursts in the VHE regime | GAI
Presenter Forum Table

Presenter
Alessandro Carosi
Author and Co-Author
Koji Noda | Mykhailo Dalchenko | Armand Fiasson | Satoshi Fukami | David Sanchez | Pol Bordas | Yukiho Kobayashi | Alice Donini | Luca Foffano | Francesco Longo | Mathieu de Bony de Lavergne | Alessio Berti | Monica Seglar Arroyo | Fabian Schussler | Hali,

Abstract
"The recent detection of a very high energy (VHE) emission from Gamma-Ray Bursts (GRBs) above 100 GeV performed by the MAGIC and H.E.S.S. collaborations, has represented a significant, long-awaited result for the VHE astrophysics community. Although these results' scientific impact has not yet been fully exploited, the possibility to detect VHE gamma-ray signals from GRBs has always been considered crucial for clarifying the poorly known physics of these objects. Furthermore, the discovery of high-energy neutrinos and gravitational waves associated with astrophysical sources have definitively opened the era of multi-messenger astrophysics, providing unique insights into the physics of extreme cosmic accelerators. In the near future, the Cherenkov Telescope Array (CTA) will play a major role in this observation type. Within this framework, the Large Size Telescopes (LSTs) will be the instruments best suited to significantly impact on short time-scale transients follow-up thanks to their fast slewing and large effective area. The observations of the early emission phase of a wide range of transient events with good sensitivity below 100 GeV will allow us to open new opportunities for time-domain astrophysics in an energy range not affected by selective absorption processes typical for other wavelengths. In this contribution, I will report about the observational program and first transients follow-up observations performed by the LST-1 telescope currently in its commissioning phase on La Palma, Canary Islands, the CTA northern hemisphere site"

Collaborations
CTA,

Keywords and Comments
'', 'for the CTA LST project'

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Monitoring the radio galaxy M87 with HAWC

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 207

Presenter
Tomás Capistrán
Author and Co-Author
Tomás Capistrán | Daniel Avila Rojas | Maria Magdalena Gonzalez | Nissim Fraija | Ruben Alfaro | For the HAWC Collaboration,

Abstract
"Studies of radio galaxies at TeV energies are of particular interest because their jets are misaligned with respect to our sightline. This provides us with a unique opportunity for studying the structure of their jets, the radiative processes, and the acceleration mechanisms involved in them. Some radio galaxies have presented variability in their emission, like the giant radio galaxy M87, which has reported several activity periods. Due to its duty cycle > 95% and instantaneous field of view of 2 sr, HAWC is providing daily monitoring of variable sources visible from the Northern Hemisphere. In this work, we show the results of monitoring M87 between January 2015 and December 2019. HAWC's observation are consistent with the low acivity state reported by other instruments (like H.E.S.S and MAGIC). However, after September 2017 (~MJD 58000), the HAWC measurements of M87 show hints of higher activity."

Collaborations
HAWC,

Keywords and Comments
'Radio Galaxies; High Energy; HAWC', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Study of the eHWC J1825-134 at the Highest Energy with HWAC

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 208

Presenter
Dezhi Huang
Author and Co-Author
Dezhi Huang | Francisco Salesa Greus | Sabrina Casanova | Petra Huentemeyer,

Abstract
'eHWC J1825-134 is one of the brightest Galactic gamma-ray sources above 50 TeV observed by High Altitude Water Cherenkov Gamma-Ray Observatory (HAWC). Detailed morphological studies have revealed a new point-like source inside this region with a spectral energy distribution extending beyond 200 TeV without any cutoff. These very-high-energy gamma rays emission can originate from leptonic or hadronic processes. The new point-like source is located in a region containing PWNe and a high density giant molecular cloud [MML2017]99. If the source emission is associated with the hadronic scenario the TeV gamma rays may have been produced by cosmic rays colliding with ambient gas. If this were the case, eHWC J1825-134 is an indicator of the existence of a galactic PeVatron in the region that accelerates particles up to PeV energies.'

Collaborations
HAWC,

Keywords and Comments
", "

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Modeling the non-flaring VHE emission from M87 as detected by the HAWC gamma ray observatory

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Fernando Ureña Mena
Author and Co-Author
Fernando Ureña Mena | Alberto Carramiñana | Anna Lia Longinotti | Daniel Rosa González | for the HAWC Collaboration,

Abstract
'M87 is a giant radio galaxy located in the Virgo Cluster, known to be a very high energy (VHE) gamma-ray source. As radio galaxies are considered the misaligned low-redshift counterparts of blazars, they are excellent laboratories for testing AGN emission models. M87 has been detected and monitored by Fermi-LAT and several atmospheric Cherenkov telescopes. Recently, the HAWC Collaboration has reported weak evidence of long-term TeV gamma-ray emission from this source. However, HAWC data has the potential to constrain the average VHE emission of sources of complex behavior, like M87, for which the physical origin of the VHE gamma-ray emission is still uncertain. We fitted a lepto-hadronic scenario to the broadband spectral energy distribution of M87 to model its non-flaring VHE emission using HAWC data'

Collaborations
HAWC,

Keywords and Comments
'Active galactic nuclei; Gamma rays; M87; Radiation mechanisms', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Follow-up Analysis to Geminga's contribution to the Local Positron Excess with HAWC Gamma-Ray Observatory

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 209

Presenter
Ramiro Torres Escobedo
Author and Co-Author
Ramiro Torres Escobedo | Hao Zhou | For the HAWC collaboration | Mattia Di Mauro,

Abstract
'The experiments PAMELA and AMS-02 measured an anomalous local positron excess above energies of 10 GeV. The reason for this excess is not well understood but has been considered as indirect evidence of dark matter, but could also be produced from nearby pulsars. The HAWC collaboration previously studied the extended gamma-ray emission of two nearby pulsars, Geminga and PSR 0656+14, but found these two pulsars did not contribute a significant amount to this excess. The previous study of HAWC led to the reinterpretation of our result and initiated the concept of inverse Compton (IC) halos. Fitting a new halo model together with 1343 days of data from the HAWC gamma-ray observatory may better constrain the contribution of these pulsars to the positron excess. This halo model utilizes 3D templates of gamma-ray emission from electron IC interactions to fit the diffusion coefficient and electron injection spectral index. This model can further help study the energy dependent diffusion and incorporate anisotropic diffusion with the proper motion of the pulsar.'

Collaborations
HAWC,

Keywords and Comments
'Gamma-ray; halo; PWNe', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Detection of emission from Cygnus Cocoon above 100TeV with LHAASO

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Li Cong
Author and Co-Author
Li Cong | SongZhan Chen | Sha Wu | Ruoyu Liu | Ruizhi Yang,

Abstract
'The energy spectrum of cosmic rays implies that our Galaxy contains PeV proton accelerators (PeVatrons). However, the origin of PeV cosmic rays is still an open question. Star forming regions (SFR) have long been advised as ideal candidates of PeV cosmic ray accelerators. The gamma-ray radiation of Cygnus Cocoon measured by Fermi-LAT may be produced by newly accelerated cosmic rays from Cygnus OB2, which is an example of gamma-ray emission associated with SFR. Benefiting from the best sensitivity above tens of TeV, LHAASO has successfully detected an extended gamma-ray source spatially coincident with Cygnus Cocoon with a significance exceeding 10sigma above 100TeV. The energy spectrum from 10TeV to PeV is studied. Detailed morphological studies can give us a deeper understanding of the acceleration and transport of particles around the OB2 cluster.'

Collaborations
Lhaaso,

Keywords and Comments
'Cygnus Cocoon; 100TeV;LHAASO', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Multi-messenger characterization of Mrk501 during historically low X-ray and gamma-ray activity

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Lea Heckmann
Author and Co-Author
Lea Heckmann, David Paneque | Sargis Gasparyan | Matteo Cerruti | Narek Sahakyan | Axel Arbet-Engels | for the MAGIC and Fermi-LAT Collaborations and multi-wavelength collaborators

Abstract
'Blazars, together with other active galactic nuclei, are the most luminous persistent sources in our universe; and therefore a prime candidate for very-high-energy (>0.2 TeV, VHE) gamma-ray observations. For the two MAGIC telescopes, the Mrk501 galaxy is among the brightest observed blazars due to its proximity.\r\nWe report a multi-wavelength and multi-messenger study of Mrk501 with data from 2017 to 2020, when Mrk501 showed a VHE flux typically below 10% that of the Crab Nebula. During this time, we performed three long observations with NuSTAR, which characterised the hard X-ray emission during three different low-activity flux levels. This Mrk501 dataset provided the unprecedented opportunity to study multi-wavelength variability and correlations with sensitive instruments during historically low X-ray and VHE gamma-ray emission (below 5% of the Crab Nebula flux in the VHE range), which could be considered as the baseline emission of Mrk501. We complemented the broadband spectral energy distributions (SED) of the identified historically low X-ray and VHE gamma-ray flux with data published by IceCube, in order to evaluate the potential existence of a hadronic component that is stable (or slowly variable), and less visible than the leptonic component that may dominate the emission during typical and flaring activity. In this contribution we will also describe the evolution of the broadband SED data comparing different theoretical scenarios.'

Collaborations
MAGIC, Fermi-LAT

Keywords and Comments
'gamma-ray; AGN; blazar; multi-messenger; multi-wavelength', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Fast X-ray variability of radio galaxy M87

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 210

Presenter
Ryo Imazawa
Author and Co-Author
Ryo Imazawa, Yasushi Fukazawa | Hiromitsu Takahashi | Mahito Sasada

Abstract
'M87 is one of the nearest radio galaxy. We can study the core, jet, and some components by radio to X-ray observations. \r\nRegarding TeV gamma ray observations, it is known to show an intra-day variability.\r\nSuch fast variability may occur at the particle acceleration region. But due to rough angular resolution, we cannot know which component causes this variability.\r\nWe searched for fast X-ray variability of the M87 from long-exposure X-ray archive data. As a result, we found an intra-day variability during Suzaku/XIS data in 2006.\r\nSuzaku/XIS cannot resolve each component, but HST-1 was the brightest component in the X-ray band in this period; core had 1/4 of HST-1 flux.\r\nTherefore, this variability possibly comes from HST-1, but we cannot rule out the possibility of large core variability.\r\nA soft photon index > 2.0 in the X-ray band indicates that variability component is synchrotron emission from accelerated electrons in HST-1 or core.\r\nIn addition, we also find a possible variability of core on the Chandra/HRC observation in 2017.\r\nIn this period, NuSTAR X-ray spectra have a power law with a photon index of 1.8, and thus not likely a synchrotron spectrum from the jet. Here the X-ray emission from the core was dominant in this period.\r\nAlso, we find that one NuSTAR observation showed a higher flux than other NuSTAR observations by a factor of 2.5.\r\nFrom these results, both core and HST-1 can be the origin of the X-ray variability.\r\nWe will discuss the variability site and emission mechanism.'

Collaborations

Keywords and Comments
'AGN; X-ray', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

The Crab Nebula: observations and a search for gamma-ray flares at UHE with LHAASO

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 211

Presenter
Lingyu Wang
Author and Co-Author
Lingyu Wang, songzhan chen | Zhen Cao | Huihai He | Sha Wu | Cong Li | Zhe Li | on behalf of the LHAASO collaboration

Abstract
'The Crab Nebula is a steady radiation source, which has been used as a reference source in very high energy gamma-ray astronomy for calibration and verification of detectors, however the gamma-ray flares around GeV from the Crab Nebula have been observed many times by AGILE and Fermi-LAT since 2007. These observations challenge the standard models for particle acceleration in pulsar wind nebula. One square kilometer detector array (KM2A) of the Large High Altitude Air Shower Observatory (LHAASO) is designed to detect gamma ray sources with high sensitivity at 100 TeV. Half of the LHAASO-KM2A array has been running stably since the end of 2019. In this work, the observations of the Crab Nebula in energy range above 10 TeV and the results of searching for gamma-ray flares will be reported by using about 1-year data of the half-array LHAASO-KM2A'

Collaborations
Lhaaso,

Keywords and Comments
'PWN; Crab; Flare', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Observations of the brightest UHE Gamma-Ray Sources With the LHAASO-KM2A

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 212

Presenter
sha wu
Author and Co-Author
sha wu, chao hou | songzhan chen | Ruoyu Liu | jun fang

Abstract
'Cosmic rays are high energy particles that come from outside of the solar system. It plays an important role in the evolution of our Galaxy. Gamma rays, produced by cosmic rays , are unique probe of cosmic rays and their accelerator. As a key sub-array of the Large High Altitude Air Shower Observatory (LHAASO), KM2A is the most sensitive gamma-ray detector at ultra-high energy (UHE, >100TeV). Here, we report two of the brightest UHE sources, LHAASO J1908+0621 and LHAASO J2018+3651. The morphology and spectral energy distribution of this two region are studied respectively using the KM2A data collected from December 2019 to December 2020. The origin of the UHE gamma-ray emission is also discussed taking into account multi-wavelength observations.'

Collaborations
Lhaaso,

Keywords and Comments
'LHAASO-KM2A; UHE gamma-ray', 'for the LHAASO Collaboration'

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Carpet-2 observation of E>300 TeV photons accompanying a 150-TeV neutrino from the Cygnus Cocoon

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 55 Ultra-High-Energy Gamma-Ray Sources and PeVatrons | GAI
Presenter Forum Table

Presenter
Viktor Romanenko
Author and Co-Author
Viktor Romanenko | For the Carpet-3 Collaboration,

Abstract
'We report on the observation of an excess of E>300 TeV gamma-ray candidate events in temporal and spatial coincidence with the IceCube high-energy neutrino alert consistent with the origin in the Cygnus Cocoon. The Cygnus Cocoon is a prospective Galactic source of high-energy neutrinos and photons. The observations have been performed with Carpet-2, a surface air-shower detector equipped with a large-area muon detector at the Baksan Neutrino Observatory in the Northern Caucasus.'

Collaborations
, Carpet-3 Collaboration

Keywords and Comments
'Gamma-ray; high-energy neutrino; experiment; IceCube; Carpet-2; air-shower detector', 'Viktor Romanenko for the Carpet-3 collaboration.'

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

A Novel Approach towards the Search for Gamma-ray Emission from the Northern Fermi Bubble with HAWC

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Pooja Surajbali
Author and Co-Author
Pooja Surajbali | for the HAWC collaboration,

Abstract
'The *Fermi* bubbles are structures observed in gamma rays at GeV energies, emanating from the central region of our galaxy and extending up to 8.5 kpc above and below the galactic plane. While initial studies showed a flat brightness across the entire structure, more recent work found a brightening at the base. We perform a template-based search for TeV signals from the northern *Fermi* bubble and just from the base of it in data from the High Altitude Water Cherenkov (HAWC) gamma-ray observatory. We employ a profile likelihood approach to calculate the significance and flux from the search regions. With no significant signal from the northern *Fermi* bubble and its base, we report new upper limits on the integral flux at 95% confidence level. Our integral flux upper limits for the northern *Fermi* bubble are more constraining than the previous limits reported by HAWC. Moreover, we present, for the first time, TeV limits pertaining to the base of the bubble which constitutes a more fair comparison to Fermi-LAT data points close to this particular region.'

Collaborations
HAWC,

Keywords and Comments
'Fermi bubbles; background reduction; particle acceleration', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

FACT - Highlights from more than Eight Years of Unbiased TeV Monitoring

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Daniela Dorner
Author and Co-Author
Daniela Dorner | Axel Arbet-Engels | Dominik Baack | Matteo Balbo | Noah Biederbeck | Adrian Biland | Thomas Bretz | Jens Buss | Laura Eisenberger | Dominik Elsaesser | Dorothee Hildebrand | Roman Iotov | Karl Mannheim | Dominik Neise | Maximilian Noethe,

Abstract
"The First G-APD Cherenkov Telescope (FACT) has been monitoring blazars at TeV energies for more than eight years. Using solid state photo sensors and performing robotic operations results in a maximized duty cycle of the instrument and minimized observational gaps, providing an unprecedented data sample of more than 14700 hours of physics data. With an unbiased observing strategy, a small sample of sources is monitored. Results of an automatic quick-look analysis are published \r\nwith low latency on an open-access website. Since 2014, close to 150 alerts including 11 astronomer's telegrams have been issued triggering target-of-opportunity observations and a variety of multi-wavelength studies.\r\n\r\nIn 2016, FACT alerted MAGIC to a high state of 1ES 2344+51.4. The combined observations revealed a renewed extreme behaviour of the source. Thanks to target-of-opportunity observations and preplanned campaigns, several rich datasets with combined observations with INTEGRAL, XMM-Newton and AstroSAT are available for Mrk 421. Furthermore, dedicated campaigns each observing season provide multi-wavelength light curves and spectral energy distributions for the brightest blazars. \r\n\r\nThe unprecedented, unbiased TeV data sample also provides the unique chance to study the duty cycle and the long-term spectral and temporal behaviour of the sources, including the search for periodic signals. Studying the long-term variability of Mrk 421 and Mrk 501 in the multi-wavelength context, correlations of different wavelengths are investigated searching for delays. \r\n\r\nIn this presentation, selected highlights from more than eights years of monitoring will be summarized, including results from deep multi-instrument campaigns and long-term studies."

Collaborations
other (fill field below), FACT

Keywords and Comments
'AGN; Blazars; TeV; Monitoring; MWL;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Observations of extended very-high-energy halos around Geminga and Monogem with the LHAAS0-KM2A

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 53 PWN and Halos | GAD-GAI
Presenter Forum Table

Presenter
yingying Guo
Author and Co-Author
yingying Guo, yi zhang | qiang yuan | hongbo hu

Abstract
'Gamma-ray halos around pulsars at very-high energies are an effective probe of particle propagation in the interstellar medium. Using the data collected by the half-array of the Large High Altitude Air Shower Observatory (LHAASO), we study the morphologies and spectra of the >25 TeV gamma-ray emission around Geminga and Monogem. The significance of Geminga (Monogem) above 25 TeV is ~10sigma (~7sigma) assuming a point source template with one-year's exposure of the half array. Energy-dependent morphologies are investigated, which are very useful in constraining the energy-dependence of the diffusion coefficient. The energy spectra of Geminga and Monogem are also analyzed.'

Collaborations
Lhaaso,

Keywords and Comments
'Diffusion process; pulsar halo ; Geminga; lhaaso', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Search for very high energy γ-ray emission from $\rm GRB~190829A$ with LHASSO-WCDA1 triggerless data

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 54 Gamma-Ray Bursts in the VHE regime | GAI
Presenter Forum Table

Presenter
yuhua yao
Author and Co-Author
yuhua yao,

Abstract
"The observation of very high energy ($\\rm VHE: >100GeV$) photon from $\\gamma$-ray bursts (GRBs) can advance our understanding of their radiation mechanism, the evolution of host-galaxies, violations of Lorentz invariance, extragalactic background light, and intergalactic magnetic field. Recently the measurements on VHE emission from afterglow phase have blossomed and borne fruit while results of the prompt emission is null. It's important to observe prompt emissions by ground-based instruments which take advantage of wide field of view and high duty cycle. Up to now, of the total 6 GRBs reported with VHE $\\gamma$-ray emissions, $\\rm GRB~190829A$ is the nearest one. The detection of its VHE emission was announced by HESS at about 4h 20m after the burst. While during its prompt phase, $\\rm GRB~190829A$ was at the edge of the field of view of LHAASO. Benefiting by the high altitude of 4430 m and the triggerless observation mode, the energy threshold of LHAASO is largely reduced to tens of GeV. This work presents the search for VHE $\\gamma$-ray emission from $\\rm GRB~190829A$ with the triggerless data taken by the first pond of LHAASO-WCDA. The analysis shows no indication of VHE emission neither in the prompt nor in $\\rm2$ hours afterglow phase, thus $95\\%$ upper limits are yielded."

Collaborations
Lhaaso,

Keywords and Comments
'GRB; VHE Gamma ray emission; LHAASO', 'For the LHAASO Collaboration'

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

The luminosity function of TeV-emitting BL Lacs: observations of an HBL sample with VERITAS

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Manel Errando
Author and Co-Author
Manel Errando | for the VERITAS Collaboration,

Abstract
'High-frequency-peaked BL Lacs (HBLs) dominate the extragalactic TeV sky, with more than 50 objects detected by the current generation of TeV observatories. Still, the properties of TeV-emitting HBLs as a population are poorly understood due to biases introduced by the observing strategies of Cherenkov Telescopes, limiting our ability to estimate the potential contribution of TeV blazars to the diffuse neutrino, gamma-ray, and cosmic-ray backgrounds as well as their role in the late-stage evolution of active galactic nuclei. The VERITAS Collaboration has designed a program to quantify and minimize observational biases by selecting a sample of 36 HBLs and measuring their TeV fluxes at times that are not motivated by high-flux states. First results from this survey, which is the basis for a measurement of the luminosity function of TeV-emitting HBLs, will be presented at the conference.'

Collaborations
VERITAS,

Keywords and Comments
'AGN; blazars; surveys; neutrinos; gamma-rays; TeV', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

HAWC observations of Active Galactic Nuclei

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Alberto Carramiñana
Author and Co-Author
Alberto Carramiñana | Daniel Rosa González | Anna Lia Longinotti | Fernando Ureña Mena | Sara Coutiño de León,

Abstract
'Since starting full operations, the HAWC gamma-ray observatory has detected and monitored the high-energy TeV emission of the nearby BL Lac objects Markarian 421 and Markarian 501. HAWC performed a follow-up survey of Active Galactic Nuclei selected from the 3FHL Fermi Catalog covering 60% of the sky and up to redshift z<0.3. Using over 4.5 years of HAWC data we found low-significance evidence for persistent TeV emission from the radiogalaxy M87 and the BL Lac objects VER J0521+211 and 1ES 1215+303. We present here an update on the HAWC follow-up survey adding over a year of new HAWC data.'

Collaborations
HAWC,

Keywords and Comments
'AGN; TeV gamma rays', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

TeV and Optical Observations of the Be/pulsar binary 1A0535+262 during the 2020 giant outburst

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems, Microquasars | GAD-GAI
Presenter Forum Table

Presenter
Matthew Lundy
Author and Co-Author
Matthew Lundy | For the VERITAS Collaboration,

Abstract
"1A 0535+262 is a Be X-ray binary pulsar and one of the only galactic pulsar systems to show radio jet emission. Characterizing the very high energy emission (VHE, >100 GeV) in these extreme microquasars is critical to understanding their contribution to the origin of galactic cosmic rays. The 2020 giant outburst of this system, where X-ray fluxes exceeded 12 Crab, marked a rare opportunity to investigate the gamma-ray and rapid optical variability of these transient systems while in such an extreme state. This month of activity marked one of the brightest flares ever measured in this system. VERITAS's developing optical capabilities in tandem with the ability to measure TeV gamma rays allowed for a unique campaign to be undertaken. VERITAS's observations of this system during the outburst will be presented in the context of observations at lower energies and previous observations of this system by imaging atmospheric Cherenkov telescopes."

Collaborations
VERITAS,

Keywords and Comments
'binaries; acceleration of particles; gamma rays', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Gamma-ray and Optical Observations of Repeating Fast Radio Bursts with VERITAS

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Matthew Lundy
Author and Co-Author
Matthew Lundy | For the VERITAS Collaboration,

Abstract
"Fast radio burst (FRBs) are an exciting class of bright, extragalactic, millisecond radio transients. The recent development of large FOV radio telescopes has caused a rapid rise in the number of identified single burst and repeating FRBs. This has allowed for extensive multi-wavelength follow-ups to search for the potential counterparts predicted by theoretical models. New observations of similar radio transients in galactic magnetars like SGR 1935+2154 have continued to motivate the search for rapid optical and very high energy (VHE, >100 GeV) counterparts. Since 2016 VERITAS has engaged in an FRB observing campaign to search for the prompt optical and VHE emission from multiple repeating FRBs. We present these new results from VERITAS's observations of five repeating sources including data taken simultaneously with bursts observed by the CHIME radio telescope."

Collaborations
VERITAS,

Keywords and Comments
'radio transients; gamma rays;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Studying the long-term spectral and temporal evolution of 1ES 1959+650

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 213

Presenter
Shunsuke Sakurai
Author and Co-Author
Shunsuke Sakurai | Wrijupan Bhattacharyya | Daniela Dorner | Pietro Grespan | Daniel Morcuende | Yasuyuki Nabatame | Elisa Prandini | Bernd Schleicher | Mari Takahashi | Mitsunari Takahashi | on behalf of the MAGIC Collaboration,

Abstract
'The high-frequency peaked BL Lac type object (HBL) 1ES 1959+650 is one of the brightest blazars in the very-high-energy (VHE, E > 100 GeV) gamma-ray sky. HBLs have been proposed as possible neutrino emitters implying the presence of hadrons in the emission mechanisms. In 2002, AMANDA reported neutrino candidates from this source simultaneously observed with a gamma-ray flaring activity without an X-ray emission enhancement, interpreted as an orphan flare. Standard one-zone synchrotron self-Compton emission models cannot explain this behavior.\r\nThe MAGIC telescopes have been observing 1ES 1959+650 since 2004. An extreme outburst triggered by multi-wavelength observations reaching 300% of the Crab nebula flux level above 300 GeV was detected in 2016. Leptonic and hadronic models are equally successful in describing the observed emission. To study the long-term behavior and the characteristics in different emission states of 1ES 1959+650, we have monitored it densely since 2017 for more than 300 hours. Together with the FACT monitoring (more than 2000 hours since 2012), this is the most intense monitoring for any blazar after Mrk 421 and Mrk 501 in the VHE range. The monitoring showed a decline of the VHE flux with occasional flaring episodes reaching in 2019 a low-state emission corresponding to 10% of the Crab nebula.\r\nWe will present the long-term monitoring study results using multi-wavelength data from MAGIC, FACT, Fermi-LAT, and Swift. Furthermore, we will discuss the differences in the spectral energy distributions between the flaring states from 2016 and the low state in 2019.'

Collaborations
MAGIC,

Keywords and Comments
'', 'on behalf of the MAGIC Collaboration.'

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Measurement of the diffuse gamma-ray emission from Galactic plane with LHAASO-KM2A

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
shiping zhao
Author and Co-Author
shiping zhao, rui Zhang | yi Zhang | qiang yuan

Abstract
'Galactic diffuse gamma ray emission (GDE) is introduced by the galactic cosmic rays interacting with the interstellar medium and/or radiation fields. We report the measurements of the GDE in several regions of the Galactic plane with energies ranging from 10 to 100TeV by the half-array of LHAASO-KM2A. A modified equal-zenith angle method is employed for background estimation, in which the known gamma-ray sources have been carefully extracted. The energy spectrum of GDE is obtained by using the forward-folding method. The LHAASO results will help to understand the propagation of cosmic rays in the Galaxy.'

Collaborations
Lhaaso,

Keywords and Comments
'diffuse gamma ray ; lhaaso', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Data analysis and key science results of LHAASO-WCDA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 214

Presenter
Min Zha
Author and Co-Author
Min Zha | Guangman Xiang | Shicong Hu | Jinyan Liu | Yanjin Wang | Chuandong Gao | Ran Wang | Zhiguo Yao,

Abstract
'Large High Altitude Air Shower Array (LHAASO) is a large\r\nhybrid EAS experiment located in Haizi Moutain, Daocheng, Sichuan\r\nprovince of P.R.C . Water Cherenkov Detector Array (WCDA) is one\r\nof subarrays aiming at VHE gamma ray astronomy. LHAASO-WCDA\r\nhas finished 2 pools installation and data-taking in the year of 2020.\r\nBased on these data a lot of works and implementation have been\r\nproceed, such as the gamma emssions from the full northern sky.\r\nThe preliminary analysis results, including observed significant\r\nsource candidates, the spectrum measurement and other related\r\nworks are presented in this talk.'

Collaborations
Lhaaso,

Keywords and Comments
'gamma astronomy; sky survey; SED', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

The detection of high energy gamma-rays (>40 TeV) from Crab Nebular by a hybrid method of TAIGA installation

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 215

Presenter
Lyubov Sveshnikova
Author and Co-Author
Lyubov Sveshnikova | TAIGA collaboration,

Abstract
'The deployment of the first part of TAIGA (Tunka Advanced Instrument for cosmic ray physics and Gamma Astronomy) installation is being completed in Tunka Valley. The installation will include a grid of wide-angle (0.6 sr) timing Cherenkov light stations, named TAIGA-HiSCORE (High Sensitivity Cosmic Origin Explorer) on the area of 1 km2 and 3 IACTs. The results of detection high energy gamma-ray (>40 TeV) from Crab Nebular obtained by a hybrid method implemented TAIGA is presented. The data from one quarter of TAIGA-HiSCORE array and one IACT are used. The energy of two from these events exceeds 100 TeV. The hybrid method for selection high energy gamma-rays, experimental data analysis and comparison of experimental results with Monte-Carlo simulations will be discussed.'

Collaborations
TAIGA,

Keywords and Comments
'Extensive Air Showers; Cherenkov light; gamma astronomy; Crab signal', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Observing the gammas rays emission from the Markarian 421 with the LHAASO-WCDA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 216

Presenter
Ran Wang
Author and Co-Author
Ran Wang | Min Zha | Cunfeng Feng,

Abstract
'Abstract: Mrk421 is one of the brightest blazars in the northern sky. The radiation of Mrk421 is a broadband continuum ranging from radio through X-rays to gamma-rays. In the Large High Altitude Air Shower Observatory (LHAASO), the water Cherenkov detector array(WCDA) has the advantage of low energy threshold in observation of VHE flares, and is dedicated in surveying the northern sky for sources of gamma rays (100GeV to 30TeV). In this work, we report the monitoring results of Mrk421 over period from 2019 July to 2020 February. Based on the Fermi-LAT observation on the flux levels, we split the observation time into periods, classified as steady and flaring phases. The spectrum of the two phases\r\nare calculated, and to be presented in this talk.'

Collaborations

Keywords and Comments
'', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

A new Probabilistic Neural Network based method for sensitivity improvement of MACE gamma-ray telescope.

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
V K Dhar
Author and Co-Author
V K Dhar, P Chandra | S Verma | C Borwankar | N Bhatt | K K Yadav

Abstract
'Major Atmospheric Cherenkov Experiment (MACE) is a ground based imaging telescope installed at Hanle, Ladakh (~4.3 kms above sea level) in the northern region of India. With a large parabolic reflector of 21meter diameter and focal length of 25meter, MACE is expected to have an energy threshold of ~20 GeV for the gamma rays. The telescope is expected to generate about 500GB of data for a typical observation night when subjected to observations of gamma-ray sources. While the segregation potential of the conventional neural network classifiers has been investigated in the past, the main purpose of this study is to explore the gamma - hadron segregation potential of a probabilistic neural network (PNN) method. The technique which offer a scalable alternative to neural networks has the advantage of both the reduced training time as well as training data. Results obtained from the application of PNN method for gamma -hadron segregation of the simulated data generated for MACE telescope will be discussed in the paper. The study will also be extended to the MACE real data when it becomes available.'

Collaborations
other (fill field below), HIGRO

Keywords and Comments
'Neural Networks; probabilistic Neural Network; MACE gamma ray', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Telescope Array search for EeV photons

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 217

Presenter
Oleg Kalashev
Author and Co-Author
Oleg Kalashev | Grigory Rubtsov,

Abstract
'We present updated results of the search for the ultra-high energy photons with primary energies greater than 1 EeV. The data of the Telescope Array Surface Detector collected over 12 years are used in this work. The method is based on the machine learning classifier, which trains on both the reconstructed composition-sensitive parameters of the event and the calibrated waveform signals at each triggered station of the Surface Detector.'

Collaborations
Telescope Array,

Keywords and Comments
'ultra high energy cosmic rays; GZK photons;Telescope Array; Surface Detector', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Extreme blazars under the eyes of MAGIC

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Axel Arbet-Engels
Author and Co-Author
Axel Arbet-Engels, Cornelia Arcaro | Katsuaki Asano | Josefa Becerra González | Giacomo Bonnoli | Matteo Cerruti | Filippo D'Ammando | Paolo Da Vela | Daniela Dorner | Vandad Fallah Ramazani | Luca Foffano | Jenni Jormanainen | Marina Manganaro | Elisa Prandini | Fabrizio T

Abstract
'Extreme high-frequency-peaked BL Lac objects (EHBLs) are the most energetic persistent sources in the universe. This contribution reports on long-term observing campaigns of tens of EHBLs that have been organized by the MAGIC collaboration to enlarge their population at VHE and understand the origin of their extreme properies. EHBLs are characterized by a spectral energy distribution (SED) featuring a synchrotron peak energy above 1 keV. Several EHBLs display a hard spectral index at very high energies (VHE; E>100 GeV), suggesting a gamma-ray SED component peaking significantly above 1 TeV. Such extreme properties are challenging current standard emission and acceleration mechanisms. Recent studies have also unveiled intriguing disparities in the temporal characteristics of EHBLs. Some sources seem to display a persistent EHBL behaviour, while others belong to the EHBL family only temporarily.\r\nWe will focus on the recent results of the first hard-TeV EHBL catalog. The MAGIC observations are accompanied by an extensive multi-wavelength coverage to obtain an optimal determination of the SED. This allow us to investigate leptonic and hadronic scenarios for the emission. We will also present the recent detection of the EHBL 1RXS0812.0+0237 in the VHE band by MAGIC. Finally, we will discuss a broad multi-wavelength campaign on the BL Lac type object 1ES2344+514, which showed intermittent EHBL characteristics in August 2016.'

Collaborations
MAGIC, FACT

Keywords and Comments
'AGN; gamma-ray; non-thermal radiation ; modelling; BL Lacertae objects; Extreme blazars', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Multiwavelength variability and correlation studies of Mrk421 during historically low X-ray and γ-ray activity in 2015–2016

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 218

Presenter
Biswajit Banerjee
Author and Co-Author
Biswajit Banerjee | Pratik Majumdar | David Paneque | Tomislav Terzić | For the MAGIC, FACT, Fermi-LAT Collaboration and MWL partners.,

Abstract
'In this work, we report multi-band flux variability and correlations of the nearby (z=0.031) blazar Markarian 421 (Mrk421) using multi-wavelength (MWL) data from November 2014 until June 2016. In this period, Mrk421 exhibited historically low activity in X-rays and very-high-energy gamma rays (VHE; E>0.1 TeV). During this period, an additional spectral component was observed by Swift-BAT. The highest flux variability occurs in X-rays and VHE which, despite the low activity, show a significant positive correlation with no time lag. The hardness ratios in the X-rays and VHE gamma rays show the "harder-when-brighter" trend observed in many blazars. Interestingly, the trend flattens at the highest fluxes, which suggests different processes dominating the brightest states. Enlarging our data set with data from the years 2007 to 2014, we measured a positive correlation between the optical and GeV emission centered at zero time lag, and a positive correlation between the optical/GeV and the radio emission over a range of about 60 days centered at a time lag of 43+9/-6 days. This observation is consistent with the radio-bright zone being located about 0.2 parsec downstream from the optical/GeV emission regions. In most of the energy bands, the flux distribution follows the Lognormal, rather than the Normal function, indicating that the variability may be dominated by a multiplicative process.'

Collaborations
MAGIC, FACT, Fermi-LAT Collaboration and MWL partners

Keywords and Comments
'galaxies: active – BL Lacertae objects: individual: Mrk 421 – methods: data analysis – methods: observational – radiation mechanisms: non-thermal', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Confronting observations of VHE gamma-ray blazar flares with reconnection models

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Jenni Jormanainen
Author and Co-Author
Jenni Jormanainen | Talvikki Hovatta | Elina Lindfors | Maria Petropoulou Petropoulou | Ian Christie | Ioannis Liodakis,

Abstract
'Several models have been suggested to explain the fast gamma-ray variability observed in blazars, but its origin is still debated. One scenario is magnetic reconnection, a process that can efficiently convert magnetic energy to energy of relativistic particles accelerated in the reconnection layer. In our study, we compare results from state-of-the-art particle-in-cell simulations with observations of blazars at Very High Energy (VHE, E > 100 GeV). Our goal is to test our model predictions on fast gamma-ray variability with data and to constrain the parameter space of the model, such as the magnetic field strength of the unreconnected plasma and the reconnection layer orientation in the blazar jet. For this first comparison, we used the remarkably well-sampled VHE gamma-ray light curve of Mrk 421 observed with the MAGIC and VERITAS telescopes in 2013. The simulated VHE light curves were generated using the observable parameters of Mrk 421, such as the jet power, bulk Lorentz factor, and the jet viewing angle, and sampled as real data. Our results pave the way for future model-to-data comparison with next-generation Cherenkov telescopes, which will help further constrain the different variability models.'

Collaborations

Keywords and Comments
'AGN; blazars; VHE gamma-rays; fast variability; magnetic reconnection; jets', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Statistical properties of flux variations in blazar light curves at GeV and TeV energies

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 219

Presenter
Sarah Wagner
Author and Co-Author
Sarah Wagner | Daniela Dorner | Karl Mannheim,

Abstract
'Despite numerous detections of individual flares, the cause of the rapid variability observed from blazars remains uncertain. Using Bayesian blocks and the HOP algorithm, we characterize all significant flux variations in a set of light curves and determine the statistical properties of the rise and decay behavior in order to constrain the physical mechanisms driving blazar variability. Long-term gamma-ray light curves of TeV-bright blazars observed with the First G-APD Cherenkov Telescope (FACT) are compared to those of GeV-bright blazars observed with the Fermi Gamma-ray Space Telescope (Fermi-LAT). Furthermore, we test for time-reversal invariance which is expected if the light curves can be described by a stochastic model such as the Ornstein-Uhlenbeck process.'

Collaborations
other (fill field below), FACT

Keywords and Comments
'AGN; blazars; variability', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Multi-wavelength study of Mrk 421 during a TeV outburst

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Andrea Gokus
Author and Co-Author
Andrea Gokus | Matthias Kadler | Michael Kreter | Felicia Krauss | Daniela Dorner | Tobias Beuchert | Thomas Bretz | Thomas Dauser | Dominik Elsaesser | Dorit Glawion | Alex Kraus | Annika Kreikenbohm | Ingo Kreykenbohm | Marcus Langejahn | Katharina Leit,

Abstract
'The blazar Mrk 421 shows frequent, short outbursts in the TeV energy regime.\r\nDue to the fast nature of such episodes, we often fail to obtain sufficient simultaneous information about flux variations in several energy bands. To overcome this lack of multi-wavelength (MWL) coverage, especially for the pre- and post-flare periods, we began a program to monitor the object with the *FACT* (TeV energies) and the *Neil Gehrels Swift Observatory* (X-rays). In case of flaring activity being detected, additional observations in the X-ray band can be triggered from our approved programs (*XMM-Newton*, *INTEGRAL*).\r\nOn June 9 2019, Mrk 421 showed a TeV outburst reaching a flux level (> 0.8 TeV) of more than two times the flux of the Crab Nebula at TeV energies.\r\nWe triggered all instruments involved in our campaign and acquired simultaneous MWL data. For the first time, we can study a TeV blazar in outburst taking advantage of highly sensitive X-ray data from *XMM-Newton* and *INTEGRAL* combined. Our dataset is complemented by continous monitoring by the *Fermi* satellite in the MeV-GeV range and pointed radio observations by Effelsberg at GHz frequencies. The dense X-ray coverage during the TeV flare revealed significant spectral hardening, short-time variability and a shift of the lower-hump peak in the spectral energy distribution of Mrk 421.\r\nWe present the results of the timing analysis, as well as the multi-wavelength analysis, and their implications on modeling the spectral energy distribution of blazars.'

Collaborations
Ferrmi-LAT, FACT

Keywords and Comments
'AGN; Blazar; multi-wavelength; FACT; Mrk 421; TeV outburst; X-rays; gamma-rays; timing analysis; SED modelling', ''

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Subcategory Experimental Results

Search for gamma rays above 30 TeV from the Crab Nebula with the GRAPES-3 experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 220

Presenter
Diptiranjan Pattanaik
Author and Co-Author
Diptiranjan Pattanaik, For the GRAPES-3 Collaboration

Abstract
'The GRAPES-3 is a high-altitude, near-equator extensive air shower array at Ooty, India which is designed to observe cosmic and gamma rays in TeV-PeV energy range. It consists of a dense array of 400 scintillator detectors operating in conjunction with a 560 m^2 area muon telescope. Due to recent improvements in the measurements of shower arrival time and size and age dependent corrections for shower front curvature, the angular resolution of the array has been significantly improved (0.4$^\\circ$ at 30 TeV). Also employing an efficient rejection of the cosmic ray background using the muon content of the shower, a search for gamma rays above 30 TeV from the Crab Nebula has been performed. The results will be presented during the conference.'

Collaborations
other (fill field below), GRAPES-3

Keywords and Comments
'GRAPES-3; Crab Nebula; Gamma ray; cosmic ray sources;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Characterizing the isotropic diffuse gamma-ray flux (10-300 TeV) by the GRAPES-3 experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 221

Presenter
Bhanu Pant
Author and Co-Author
Bhanu Pant, For the GRAPES-3 Collaboration

Abstract
'A diffuse gamma-ray emission at $\\sim$100 TeV can be expected as a result of the interactions of ultra-high-energy cosmic rays (UHECRs) with the cosmic microwave background (CMB) during their propagation. This radiation carries the information on the distribution of energetic sources and hence the cosmological evolution of the Universe. The GRAPES-3 is an extensive air shower (EAS) array, located at Ooty in southern India. It consists of 400 plastic scintillators (each 1 m^2) and a large area (560 m^2) muon telescope. The muon telescope has the ability to differentiate the gamma-rays from charged cosmic rays through their muon content. We report on the study of isotropic diffuse gamma-ray flux from GRAPES-3 over 10$-$300 TeV.'

Collaborations
other (fill field below), GRAPES-3

Keywords and Comments
'diffuse radiation; gamma-rays; grapes-3; extensive air shower', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Status and results of the prototype Large Size Telescope of CTA

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table

Presenter
Daniel Mazin
Author and Co-Author
Daniel Mazin,

Abstract
'The Large Size Telescopes (LSTs) of Cherenkov Telescope Array (CTA)\r\nare designed for gamma-ray studies focusing on low energy threshold,\r\nhigh flux sensitivity, rapid telescope repositioning speed and a large field of view. Once the CTA array is complete the LSTs will be dominating the CTA performance between 20 GeV and 150 GeV. During the CTA North construction phase, however, the LSTs will be dominating the array performance until several TeVs.\r\nIn this presentation we will report on the status of the LST-1 telescope inaugurated in La Palma, Canary islands, Spain in 2018.\r\nWe will show the progress of the telescope commissioning, compare the expectations with the achieved performance and give a glance of the first physics results.'

Collaborations
CTA,

Keywords and Comments
'Imaging Atmospheric Cherenkov Telescopes; Gamma rays; AGNs; pulsars; PWN', 'for the CTA LST project'

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Searching for >100 TeV emission in the vicinity of Mrk 501 with HAWC

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 222

Presenter
Andrea Albert
Author and Co-Author
Andrea Albert,

Abstract
'The High Altitude Water Cherenkov (HAWC) Observatory surveys 2/3 of the gamma-ray sky each day for gamma rays from 300 GeV to over 100 TeV. Using recently improved energy reconstruction, HAWC has detected several Galactic sources with emission above 100 TeV. We extend this analysis to search for >100 TeV emission in the vicinity of Mrk 501. High-energy emission from Mrk 501 could, for example, be evidence of Axion Like Particles, a theoretical dark matter candidate. We found a hint of two >100 TeV lobes about 0.5 degrees above and below Mrk 501. Specifically, a preliminary analysis shows that the flux of each of the potential lobes has a pretrials significance of ~3 sigma above the background assuming a power law flux with and index of -2. We will summarize our analysis and discuss potential origins of this emission.'

Collaborations
HAWC,

Keywords and Comments
", "

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Fast simulation of gamma/proton event images for the TAIGA-IACT experiment using generative adversarial networks

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Julia Dubenskaya
Author and Co-Author
Julia Dubenskaya, Alexander Kryukov

Abstract
'High energy cosmic rays and gamma rays interacting the atmosphere produce extensive air showers (EAS) of secondary particles emitting Cherenkov light. Being detected with a telescope this light forms "images" of the air shower. In the TAIGA project, in addition to images obtained experimentally, model data are widely used. The difficulty is that the computational models of the underlying physical processes are very resource intensive, since they track the type, energy, position and direction of all secondary particles born in EAS. This can lead to a lack of model data for future experiments. To address this challenge, we applied a machine learning technique called Generative Adversarial Networks (GAN) to quickly generate images of two types: from gamma and protons events. As a training set, we used a sample of 2D images obtained using TAIGA Monte Carlo simulation software, containing about 50,000 events. It has been experimentally established that the generation results best fit the training set in the case when for two different types of events we create two different networks and train them separately. For gamma events a discriminator with a minimum number of convolutional layers was required, while for proton events, more stable and high-quality results are obtained if two additional fully connected layers are added to the discriminator. Testing the generators of both networks using third-party software showed that more than 90% of the generated images were found to be correct. Thus, the use of GAN provides reasonably fast and accurate simulations for the TAIGA project.'

Collaborations
TAIGA,

Keywords and Comments
'gamma event images; proton event images; fast simulation; generative adversarial networks; neural networks; machine learning', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Multi-epoch monitoring of TXS 0506+056 with MAGIC and MWL partners

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 49 Studying the variable emission from AGN in a multi-wavelength context | GAD-GAI-MM
Presenter Forum Table

Presenter
Konstancja Satalecka
Author and Co-Author
Konstancja Satalecka | Tommaso Aniello | Elisa Bernardini | Wrijupan Bhattacharyya | Matteo Cerruti | Filippo D'Ammando | Elisa Prandini | Chiara Righi | Narek Sahakyan | Ilaria Viale | Matthias Kadler | Florian Eppel | Andrea Gokus | Jonas Heßdörfer | Ge,

Abstract
'The measurement of an astrophysical flux of high-energy neutrinos by IceCube is an important step towards finding the long-sought sources of cosmic rays. Nevertheless, the long exposure neutrino sky map shows no significant indication of point sources so far. The real-time follow-up of neutrino events turned out to be the most successful approach in neutrino point-source searches. It brought, among others, the most compelling evidence for a neutrino point source: the flaring gamma-ray blazar TXS 0506+056 in coincidence with a single high-energy neutrino from IceCube (IceCube-170922A). The fast MWL follow-up of this alert was key for establishing this coincidence and constrain the subsequent theoretical modeling for this event. In the long term, accurate and contemporaneous MWL spectral measurements are essential ingredients in investigating the physical processes leading to particle acceleration and emission of radiation. A deeper understanding of those processes allows us to put constraints on the potential neutrino emission. Here we present the light curves and simultaneous spectral energy distributions from several years of MAGIC and MWL monitoring of TXS 0506+056 (November 2017 till February 2021). We also present the theoretical interpretation of these observations. We discuss their implications on cosmic-ray accelerations in AGN and the physics of relativistic jets from supermassive black holes.'

Collaborations
MAGIC, OVRO ,TELAMON team

Keywords and Comments
'', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Satellite-based Calibration of the TAIGA-HiSCORE Cerenkov Array by the LIDAR on-board CALIPSO

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 223

Presenter
Andrea Porelli
Author and Co-Author
Andrea Porelli | Ralf Wischnewski | For the TAIGA Collaboration,

Abstract
'The wide-angle Air-Cerenkov array HiSCORE is a major component of the TAIGA facility in the Tunka valley, built for Gamma Astronomy and Cosmic Ray research. HiSCORE will contain 120 stations distributed over a 1km2 area.\r\n\r\nHere, we report a multi-year detection of light flashes in HiSCORE from the LIDAR on-board the Sun-synchronous CALIPSO satellite, obtained from 2015-2021. The 100mJ laser (532nm) is observed up to distances beyond 10km away from the ground light spot. This study complements first observations of a space-based LIDAR, performed in 2015/2017 with the 28-station HiSCORE prototype and the CATS LIDAR on-board the International Space Station. We present HiSCORE calibration methods developed for the LIDAR events to optimize the pointing resolution of the array; and additionally perform a detailed array performance analysis over 6 years.\r\n\r\nThe angular resolution for this special class of HiSCORE events - bright flashes, with a plane wave light front - is found to be <0.05°, which is much below the high-energy limit of ~0.1° for air-showers. The satellite event sample allows to optimize rare event search strategies, like for optical flashes of astrophysical origin. We will also report on scheduled joint LIDAR observation by HiSCORE and TAIGA-IACTs, as well as optical ground instruments - to independently calibrate the absolute array-pointing precision.'

Collaborations
TAIGA,

Keywords and Comments
'timing array; LIDAR; time calibration; ground Cherenkov detection; gamma astronomy; satellite', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

TAIGA-Observatory: First 5 years of operation of the HiSCORE Air-Cerenkov Array

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 224

Presenter
Andrea Porelli
Author and Co-Author
Andrea Porelli | Ralf Wischnewski | For the TAIGA Collaboration,

Abstract
'TAIGA-HiSCORE is a wide-aperture Air-Cherenkov array, and is a major component of the TAIGA-Observatory (Tunka Instrument for high-energy gamma-ray astronomy and cosmic ray physics), located in the Tunka valley, 50km from Lake Baikal, Russia. A main science target of TAIGA is gamma ray astronomy above ten's of TeV, in particular the search for sources of few 100 TeV gamma rays (candidate “PeVatrons”), the possible sites of Galactic cosmic ray acceleration. The HiSCORE array will consist of 120 optical Cerenkov stations, deployed on an area of 1km2. Its construction will be finished in 2021.\r\n\r\nThis report presents the performance of HiSCORE during the\xa0 first 5 years of operation, in\xa0 various configurations, from 28 to 88 stations. A key for high sensitivity to gamma point sources is precision timing of the whole array down to sub-nsec level, required to be stable for the observation period. We apply different methods to reach this goal. The pointing resolution of the array for extended air-showers is obtained as 0.1° for highest energies, and is experimentally verified, based on independent approaches. We present results of a 5-year-search for gamma-like point sources with HiSCORE, and compare to MC-predictions.'

Collaborations
TAIGA,

Keywords and Comments
'EAS; gamma astronomy; cosmic rays; timing array; angular resolution; time calibration; ground Cherenkov detection', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

News from the African Gamma-ray sky: Highlights from the H.E.S.S. experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 225

Presenter
Stefan Wagner
Author and Co-Author
Stefan Wagner, for the H.E.S.S. collaboration

Abstract
'The H.E.S.S. experiment has entered a new phase with an advanced camera, improved hardware, optimized operational procedures and enhanced open source analysis tools. This results in a significant gain in performance, observing time and sensitivity with corresponding benefits for quantity and quality of observational results in time-domain and time-integrated studies.\r\n\r\nBeyond individual results, recent studies provide major steps towards population studies, scan multidimensional parameter spaces for different types of objects and extend the base for the science program of more sensitive, future facilities. \r\n\r\nThe combination of improved angular resolution and extended spectral coverage sharpens conclusions on prototypical sources and focuses goals in formulating the next scientific questions.\r\n\r\nMoreover, an extended time-domain program is combined with a thorough multi-frequency program to relate temporal variability throughout the electromagnetic spectrum and explore relations to other messengers.\r\n\r\nIn this presentation we will describe the highlights of the recent observations and the advancements of the H.E.S.S. experiment that enable these results. The implications for specific physical interpretation will be discussed in the broader context of different source classes.'

Collaborations
H.E.S.S.,

Keywords and Comments
'', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Periodicity Analysis of Mrk 501 and Mrk 421 in Gamma Rays

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 226

Presenter
Roman Iotov
Author and Co-Author
Roman Iotov | Thomas Bretz | Thompson Dave | Daniela Dorner | Vincent Eberle | Torsten Ensslin | P. Frank | A. Kostic | Michael Kreter | Boettcher Manuel | Volodymyr Marchenko | Arras Phillip | Bernd Schleicher | Mariusz Tarnopolski | Fabian Theissen |,

Abstract
'Results from different methods searching for Quasi periodic oscillations\r\n(QPOs) in blazars will be shown, indicating no significant evidence for periodic signals beyond the noise level. Blazars are a subclass of active galactic nuclei (AGN), and are highly variable objects. QPOs, which might originate from a binary black hole located at the AGN core, have been found in some blazar light curves. For the blazars Mrk 421 and Mrk 501, we test the possible QPO behaviour using a variety of methods (generalized Lomb-Scargle Periodogram, CARMA, Wavepal and A-T plane), studying in detail systematic effects. We use gamma-ray light curves from FACT, a ground-based imaging air Cherenkov telescope and Fermi-LAT, a gamma-ray satellite. Furthermore, we explore the possibility to search for periodicities with the information field theory.'

Collaborations
other (fill field below), FACT

Keywords and Comments
'periodicity; gamma-rays; blazars', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

A northern sky survey for ultra-high-energy gamma-ray source using the Tibet air-shower array and muon-detector array.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 227

Presenter
Xu Chen
Author and Co-Author
Xu Chen, The Tibet ASγ Collaboration

Abstract
'The Tibet ASγ experiment located at 4300 m above sea level, Tibet, China, has a wide field of view and large effective area. It consists of the Tibet air-shower array (Tibet-AS), the air-shower core-detector array (YAC) and the underground water-Cherenkov muon-detector array (Tibet-MD). The Tibet-MD array significantly improves gamma-ray sensitivity in the 10-1000 TeV energy region by an order of magnitude better than any other previously existing experiments in the world. In this talk we will present the catalog of TeV gamma-ray sources using 720 days of data from the Tibet ASγ experiment. The catalog represents the most sensitive survey of the northern gamma-ray sky at energies above several tens of TeV. These ultra-high-energy gamma-ray sources are believed to be related to pulsars and supernova remnants.'

Collaborations
other (fill field below), The Tibet ASγ Collaboration

Keywords and Comments
'northern sky survey;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Southern African Large Telescope Spectroscopy of BL Lacs for the CTA project

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 228

Presenter
Eli Kasai
Author and Co-Author
Eli Kasai | For the CTA Collaboration,

Abstract
'In the last decade, very-high-energy gamma-ray astronomy has reached maturity: over 200 sources have been detected, both Galactic and extragalactic by ground-based experiments. At present, Active Galactic Nuclei (AGN) make up about 40% of the 200+ sources detected at very high energies with ground-based telescopes, the majority of which are blazars, i.e. their jets are closely aligned with the line of sight to Earth and three quarters of which are classified as high-frequency peaked BL Lac objects. One challenge to studies of the cosmological evolution of BL Lacs is the difficulty of obtaining redshifts from their nearly featureless, continuum-dominated spectra. It is expected that a significant fraction of the AGN to be detected with the future world-wide Cherenkov Telescope Array (CTA) observatory will have no spectroscopic redshifts, compromising the reliability of BL Lac population studies, particularly of their cosmic evolution. We started an effort in 2019 to measure the redshifts of a large fraction of the AGN that are likely to be detected with CTA, using the Southern African Large Telescope. In this talk, we present some preliminary results of this on-going collaborative multi-facility effort among African, European, North and South American institutions.'

Collaborations
CTA, None

Keywords and Comments
'AGN; BL Lacs; Redshifts; Spectroscopy', 'This will be a talk on redshift measurements of BL Lacs with the Southern African Large Telescope for the future CTA project.'

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

Gamma-ray Observation of SNR G106.3+2.7 with the Tibet Air Shower Array

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 55 Ultra-High-Energy Gamma-Ray Sources and PeVatrons | GAI
Presenter Forum Table

Presenter
Munehiro OHNISHI
Author and Co-Author
Munehiro OHNISHI | for the Tibet ASgamma Collaboration,

Abstract
'We have been observing cosmic rays and gamma rays above TeV energies with an air shower (AS) array located in Tibet, China at an altitude of 4,300 m and in operation since 1990. In 2014 we added to the air shower array an underground muon detector (MD) array that enables us to observe gamma-ray-induced air showers with far better sensitivity than before, suppressing background cosmic-ray events by counting the number of muons contained in air showers. The background rejection power is typically estimated at 99.9% above 100 TeV. In this presentation, we report the observation of very-high-energy gamma-ray emissions from supernova remnant G106.3+2.7 using the data taken by the Tibet AS array and the MD array.'

Collaborations
, The Tibet ASgamma Collaboration

Keywords and Comments
'Gamma rays; G106.3+2.7', ''

Branch GAI | Gamma Ray Indirect

Subcategory Experimental Results

P1 and P2 Emission of the Crab Pulsar for Medium to Large-Size IACT Calibration

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 229

Presenter
Razmik Mirzoyan
Author and Co-Author
Razmik Mirzoyan, Giovanni Ceribella | Yuki Iwamura | Takayuki Saito | Masahiro Teshima | Giacomo D'Amico

Abstract
'Mid to large size imaging atmospheric Cherenkov telescopes for gamma-ray astrophysics in the very high energy domain have a typical threshold of (20 – 200) GeV. In this energy range sensitive observations of the Crab Nebula reveal the emission from the Crab pulsar at phases P1 and P2. Observations of MAGIC show that the P2/P1 is monotonically increasing function of energy. In tens of GeV energy range sensitivity of MAGIC overlaps with that of the Fermi-LAT mission. Comparison of the P2/P1 ratio from the MAGIC and Fermi-LAT Crab pulsar data provides an alternative method to cross-calibrate the two instruments and minimize the impact of Monte Carlo simulations. Here we explore this possibility for absolute calibration of the operational energy range of IACTs.'

Collaborations

Keywords and Comments
'IACT; calibration; Crab pulsar; pulsar emission phase; IACT-Fermi intercalibration; P1 and P2', ''

Branch GAI | Gamma Ray Indirect

Subcategory Future projects

Performance of the ASTRI Mini-Array at the Observatorio del Teide

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 230

Presenter
Saverio Lombardi
Author and Co-Author
Saverio Lombardi, Lucio Angelo Antonelli | Ciro Bigongiari | Cardillo Martina | Stefano Gallozzi | Jarred Green | Fabrizio Lucarelli | Francesco Gabriele Saturni | for the ASTRI Project

Abstract
'The ASTRI Mini-Array is a project led by INAF to build and operate an observatory of next-generation Imaging Atmospheric Cherenkov Telescopes for ground-based gamma-ray astronomy in the energy range between 1 TeV and 200 TeV and beyond. It will be composed by 9 small-sized (4 meter in diameter) and large field-of-view (~10 degrees) double-mirror telescopes equipped with silicon photomultiplier cameras. The ASTRI Mini-Array will be deployed within the next few years at the Observatorio del Teide (Tenerife, Spain) and will perform deep observations of the galactic and extragalactic sky with a significantly improved performance at multi-TeV energies with respect to current arrays of Cherenkov telescopes. In order to assess the performance of the system at the Teide site and to generate suitable Instrument Response Functions for high-level scientific studies, dedicated Monte Carlo simulations have been generated and subsequently reduced with A-SciSoft (ASTRI Scientific Software), the official scientific software package of the ASTRI Project. In this contribution, we present the performance of the ASTRI Mini-Array achieved with the aforementioned Monte Carlo simulations and describe the main features of both the simulation and data processing chains.'

Collaborations
, ASTRI

Keywords and Comments
'gamma rays; cosmic rays; Cherenkov telescopes; IACT technique; Monte Carlo simulations; data analysis', ''

Branch GAI | Gamma Ray Indirect

Subcategory Future projects

The Cherenkov Telescope Array: layout, design and performance

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 231

Presenter
Orel Gueta
Author and Co-Author
Orel Gueta,

Abstract
'The Cherenkov Telescope Array (CTA) will be the next generation very-high-energy gamma-ray observatory. CTA is expected to provide substantial improvement in accuracy and sensitivity with respect to existing instruments thanks to a tenfold increase in the number of telescopes and their state-of-the-art design. Detailed Monte Carlo simulations are used to further optimise the number of telescopes and the array layout, and to estimate the observatory performance using updated models of the selected telescope designs. These studies are presented in this contribution for the two CTA sites located on the island of La Palma (Spain) and near Paranal (Chile) and for different operation and observation conditions.'

Collaborations
CTA, CTA Observatory

Keywords and Comments
'', 'for the CTA Consortium and the CTA Observatory'

Branch GAI | Gamma Ray Indirect

Subcategory Future projects

Survey of the Galactic Plane with the Cherenkov Telescope Array

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
Quentin Remy
Author and Co-Author
Quentin Remy | Luigi Tibaldo | For the CTA Galactic Science Working Group,

Abstract
'Observations with the current generation of very-high-energy gamma-ray telescopes have revealed an astonishing variety of particle accelerators in the Milky Way, such as supernova remnants, pulsar wind nebulae, and binary systems. The upcoming Cherenkov Telescope Array (CTA) will be the first instrument to enable a survey of the entire Galactic plane in the energy range from a few tens of GeV to 300 TeV with unprecedented sensitivity and improved angular resolution. In this contribution we will revisit the scientific motivations for the survey, proposed as a Key Science Project for CTA. We will highlight recent progress, including improved physically-motivated models for Galactic source populations and interstellar emission, advance on the optimization of the survey strategy, and the development of pipelines to derive source catalogues tested on simulated data. Based on this, we will provide a new forecast on the properties of the sources that CTA will detect and discuss the expected scientific return from the study of gamma-ray source populations.'

Collaborations
CTA,

Keywords and Comments
'TeV Gamma-ray Astronomy; CTA; Simulation; Galactic sources catalogue;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Future projects

Active Galactic Nuclei population studies with the Cherenkov Telescope Array

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 232

Presenter
Anthony Brown
Author and Co-Author
Anthony Brown, Atreya Acharyya | Alberto Dominguez | Tarek Hassan | Jean-Philippe Lenain | Santiago Pita

Abstract
'The Cherenkov Telescope Array (CTA) is the next generation ground-based imaging atmospheric Cherenkov telescope (IACT) observatory. Building on the strengths of current IACTs, CTA is designed to achieve an order of magnitude increase in sensitivity, with unprecedented angular and energy resolution. CTA will also increase the energy reach of ground-based gamma-ray astronomy, observing photons in the energy range of 20 GeV to beyond 100 TeV. These improvements in telescope performance will see CTA heralding in a new era for ground-based gamma-ray astronomy, with the emphasis shifting from source discovery to population studies and precision measurements. In this talk we discuss CTA's ability to conduct population studies of gamma-ray bright Active Galactic Nuclei, and how this ability will enhance our understanding of the redshift evolution of this important gamma-ray source type.'

Collaborations
CTA,

Keywords and Comments
'CTA; AGN; population studies', 'for the CTA Consortium.'

Branch GAI | Gamma Ray Indirect

Subcategory Future projects

Extragalactic Observatory Science with the ASTRI Mini-Array at the Observatorio del Teide

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 233

Presenter
Francesco Gabriele Saturni
Author and Co-Author
Francesco Gabriele Saturni, Lucio Angelo Antonelli | Cornelia Arcaro | Barbara Balmaverde | Josefa Becerra González | Alessandro Caccianiga | Milvia Capalbi | Elisabete Elisabete M. de Gouveia Dal Pino | Roberto Della Ceca | Jarred Green | Alessandra Lamastra | Saverio Lombardi | F

Abstract
'The ASTRI Mini-Array is a system of nine imaging atmospheric Cherenkov telescopes to be deployed at the Observatorio del Teide (Tenerife, Spain). In a first phase, the instrument will be operated as an experiment, with an observation schedule focused on primary science cases at multi-TeV energies (origin of cosmic rays, cosmology and fundamental physics, GRBs and multi-messenger astrophysics). Afterwards, a guest-observer observatory phase will follow, in which other significant targets will be pointed at. In this contribution, we focus on this second phase, presenting the observational feasibility of the most relevant extragalactic gamma-ray emitters (high-synchrotron peaked blazars, Seyfert 2 galaxies, self-interacting dark matter dominated dwarf spheroidal galaxies) and astrophysical processes detectable over long-term time scales that best complement and expand the ASTRI Mini-Array core science. In order to derive our results, detailed simulations have been performed by means of the most up-to-date ASTRI Mini-Array instrument response functions. The prospects of observing extragalactic targets with the ASTRI Mini-Array include the characterization of spectral shape and features of the multi-TeV emission from the analyzed classes of AGN with mid-to-long duration (5 to 500 h) observations, the improvement of the constraints on cross section and lifetime of dark matter particles with 100-h observations of optimal dwarf galaxies, and the possibility to serendipitously detect ancillary sources falling in the same field of view (a few degrees) of the ASTRI Mini-Array main pointings.'

Collaborations
other (fill field below), ASTRI Project

Keywords and Comments
'Telescopes; Gamma Rays; Galaxies; Blazars; Dark Matter', ''

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Subcategory Future projects

Development of an advanced SiPM camera for theLarge Size Telescope of the Cherenkov TelescopeArray Observatory

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table

Presenter
Matthieu Heller
Author and Co-Author
Matthieu Heller, Thomas Armstrong | Maria Isabelle Bernardos | Mykhailo Dalchenko | Domenico della Volpe | Davide Depaoli | Federico Di Pierro | Gabriel Emery | Ruben Lopez-Coto | Mose Mariotti | David Medina Miranda | Teresa Montaruli | Andrii Nagai | Riccardo Rando | Hi

Abstract
'Silicon photo-multipliers (SiPMs) have become the baseline choice for cameras of the small-sized telescopes (SSTs) of the Cherenkov Telescope Array (CTA), as the pioneering work of the FACT telescope and the prototypes of SSTs have demonstrated. On the other hand, covering larger surfaces and operating at higher data rates still represent a challenge for SiPMs to surpass photo-multiplier tubes (PMTs) explaining why the medium and large-size telescopes (MSTs and LSTs) of CTA employ PMTs. The larger light collection surfaces added to the higher sensitivity in the near infra-red of SiPMs compared to PMTs represent challenges as the night sky background rate increases greatly. In order not to affect the energy threshold of the instruments, a dedicated R&D activity needs to be carried out. On the other hand, the robustness of the SiPMs represents a unique opportunity to ensure long-term operation with low maintenance and better duty cycle being sensitive even at high levels of background light. The proposed camera for LSTs will feature 0.05 deg pixels, low power and fast front-end electronics and a fully digital readout enabling the use of machine learning algorithms as close as possible to the sensor for on-the-fly data volume reduction and background rejection. In this work, we present the status of the research on the sensor and the front-end stage. Additionally, we present the performance evaluation of the camera coupled to the LST optical system. This was done by means of dedicated Monte Carlo simulations and using advanced image reconstruction methods, taking advantage of the higher granularity offered by the smaller pixels.'

Collaborations
CTA, LST

Keywords and Comments
'photodetection;gamma ray; camera;cherenkov;SiPM', ''

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Subcategory Future projects

TeV Transients with the ASTRI Mini-Array: a case study with GRB 190114C

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 54 Gamma-Ray Bursts in the VHE regime | GAI
Presenter Forum Table

Presenter
Antonio Stamerra
Author and Co-Author
Antonio Stamerra | Francesco Gabriele Saturni | Jarred Green | Lara Nava | Fabrizio Lucarelli | Lucio Angelo Antonelli | for the ASTRI project,

Abstract
'The recent discovery of a teraelectronvolt (TeV) component in a few long GRBs and possibly in the short GRB 160821B, deepened the insight on GRB physics and opened the new TeV window in their observation, and in the study of the multi-messenger counterparts, e.g. gravitational waves. The exact nature of the TeV component and the details on the implications on the emission region need to be confirmed with successive detections. The planned ASTRI Mini-Array, composed of nine imaging atmospheric Cherenkov telescopes at the Teide Observatory site, will play a crucial role in the study of the new TeV component, by further extending the explored range to energies greater than few TeV. \r\nWe have studied the capabilities of the ASTRI Mini-Array to detect transients using the observed and modelled TeV light curve and spectrum of GRB190114C as a template to simulate the emission from GRBs, rescaled for shorter cosmological distances. The proper amount of absorption due to the extragalactic background light (EBL) has been included. The simulations show the feasibility of the detection of TeV emission by the ASTRI Mini-Array from GRB 190114C, and the ability to confirm the afterglow emission from nearby GRBs, at redshift between about 0.1 and 0.4. The spectrum can be measured at energies between 1 and 10 TeV, up to few minutes from the onset of the burst. In case of detection, for the closest and bright bursts, the ASTRI Mini-Array can reveal the presence of a >1 TeV spectral cutoff, either originated by the EBL absorption or intrinsic.'

Collaborations
other (fill field below), ASTRI project

Keywords and Comments
'GRB; gamma-ray; TeV-GRB; transients; cherenkov telescopes', ''

Branch GAI | Gamma Ray Indirect

Subcategory Future projects

The Southern Wide-field Gamma-ray Observatory reach for Primordial Black Hole evaporation

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 234

Presenter
Ruben Lopez-Coto
Author and Co-Author
Ruben Lopez-Coto, Michele Doro | Alessandro De Angelis | Mose Mariotti | Pat Harding | for the SWGO Collaboration

Abstract
'The search for Primordial Black Hole (PBH) signatures is very broad in techniques and the origin of these signatures. Searches for imprints of evaporation involve several observables such as the Extragalactic Gamma-Ray background or direct measurement of different species of cosmic rays. Using these observables, one can put very tight constraints on the PBH number density in a mass range ~10^14 g. To perform direct observations of the evaporation of these PBHs, one needs to perform observations in the Very High Energy gamma-ray range, either using Imaging Atmospheric Cherenkov telescopes or wide field of view gamma-ray arrays. The Southern Wide-field Gamma-ray Observatory is a projected ground-based gamma-ray detector that will be located in the Southern Hemisphere and it is now in its design phase. In this contribution, we will show the anticipated sensitivity for PBH evaporation achievable by SWGO.'

Collaborations
SWGO,

Keywords and Comments
", "

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Branch GAI | Gamma Ray Indirect

Subcategory Future projects

Galactic Science with the Southern Wide-field Gamma-ray Observatory

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
Ruben Lopez-Coto
Author and Co-Author
Ruben Lopez-Coto, Alison Mitchell | for the SWGO Collaboration

Abstract
'The Southern Wide-field Gamma-ray Observatory is a proposed ground-based gamma-ray detector that will be located in the Southern Hemisphere and is currently in its design phase. In this contribution, we will outline the prospects for Galactic science with this Observatory. Particular focus will be given to the detectability of extended sources, such as gamma-ray halos around pulsars; optimisation of the angular resolution to mitigate source confusion between known TeV sources; and studies of the energy resolution and sensitivity required to study the spectral features of PeVatrons at the highest energies. Such a facility will ideally complement contemporaneous observatories in studies of high energy astrophysical processes in our Galaxy.'

Collaborations
SWGO,

Keywords and Comments
'', ''

Branch GAI | Gamma Ray Indirect

Subcategory Future projects

Benchmarking the Science for the Southern Wide-Field Gamma-ray Observatory (SWGO)

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 235

Presenter
Ulisses Barres de Almeida
Author and Co-Author
Ulisses Barres de Almeida | Gwenael Giacinti | for the SWGO Collaboration,

Abstract
"The Southern Wide-field Gamma-ray Observatory (SWGO) is the project to build a new extensive air shower particle detector for the observation of very-high-energy gamma-rays in South America. SWGO is currently planned for installation in the Southern Hemisphere, which grants it a unique science potential among ground-based gamma-ray detectors. It will complement the capabilities of CTA, working as a wide-field instrument for the monitoring of transient and variable phenomena, and expand the sky coverage of Northern Hemisphere facilities like HAWC and LHAASO, thus granting access to the entire Galactic Plane and the Galactic Center. SWGO aims to achieve excellent sensitivity over a very large target energy range from ~100 GeV to beyond a PeV, and improve on the performance of current sampling array instruments in all observational parameters, including energy and angular resolution, background rejection, and single-muon detection capabilities. The directives for the final observatory design will be given by a number of key science goals which are being defined over the course of the Project's R&D phase. In this contribution we will present the selected core science topics and target performance goals that serve as benchmarks for SWGO's design configuration."

Collaborations
SWGO,

Keywords and Comments
'Gamma-ray Astronomy; EAS detector; SWGO', ''

Branch GAI | Gamma Ray Indirect

Subcategory Future projects

CTA prospects for probing cosmology and fundamental physics with gamma rays

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 236

Presenter
Ievgen Vovk
Author and Co-Author
Ievgen Vovk | Jonathan Biteau | Manuel Meyer | Humberto Martínez-Huerta | Santiago Pita | For the CTA Consortium,

Abstract
'The Cherenkov Telescopic Array (CTA), the next-generation ground-based gamma-ray observatory, will have unprecedented sensitivity in the very-high-energy gamma-ray regime, elucidating open questions in gamma-ray cosmology and fundamental physics. Using simulations of active galactic nuclei observations foreseen in the CTA Key Science Program, we find that CTA will measure gamma-ray absorption by the extragalactic background light with a statistical error below 15% up to the redshift of 2 and detect or establish limits on gamma halos induced by an intergalactic magnetic field of at least 0.3 pG. Extragalactic observations using CTA also demonstrate the potential for testing physics beyond the Standard Model. The best state-of-the-art constraints on the Lorentz invariance violation from astronomical gamma-ray observations will be improved at least two- to threefold. CTA will also probe the parameter space where axion-like particles can represent a significant proportion - if not all - of dark matter. Joint multiwavelength and multimessenger observations, carried out together with other future observatories, will further foster the growth of gamma-ray cosmology.'

Collaborations
CTA,

Keywords and Comments
'CTA; extragalactic background light; Lorentz invariance violation; intergalactic magnetic field; dark matter', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Future projects

Study of the water Cherenkov detector design for the SWGO experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 237

Presenter
Francesca Bisconti
Author and Co-Author
Francesca Bisconti, Andrea Chiavassa | for the SWGO Collaboration

Abstract
'The Southern Wide-field Gamma-ray Observatory (SWGO) is a next-generation ground-based gamma-ray detector under development to reach a full sky coverage together with the current HAWC and LHAASO experiments in the northern hemisphere. It will complement the observation of transient and variable multi-wavelength and multi-messenger phenomena, offering moreover the possibility to access the Galactic Centre. SWGO will consist of an array of water Cherenkov tanks, with a high fill-factor inner array and a low-density outer array, covering an overall area of one order of magnitude larger than HAWC. To reach a high detection efficiency and discrimination capability between gamma-ray and hadronic air showers, various tank designs were studied. Double-layer tanks with several sizes, shapes and number of photomultiplier tubes have been considered. Single-particle simulations have been performed to study the tank response, using muons, electrons, and gamma-rays with energies typical of extensive air showers particles, entering the tanks with zenith angles from 0 to 60 degrees. The tank response was evaluated considering the particle detection efficiency, the number of photoelectrons detected by the photomultiplier tubes, and the time resolution of the first photoelectron. The study allowed to compare the performance of tanks with circular, square and hexagonal base, to understand which design optimizes the performance of the array. The method used in the study and the results will be discussed in this paper.'

Collaborations
SWGO,

Keywords and Comments
'Gamma-rays; water Cherenkov detector; simulations', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Future projects

The ASTRI Mini-Array Core Science Program

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 238

Presenter
Stefano Vercellone
Author and Co-Author
Stefano Vercellone, for the ASTRI Project

Abstract
'The portion of the electromagnetic spectrum above a few Teraelectronvolt (TeV) is currently being investigated by means of both ground-based imaging atmospheric Cherenkov telescopes and water Cherenkov detector arrays. In a few years, an array composed of at least nine ASTRI dual-mirror, Schwarzschild-Couder telescopes will be deployed and start scientific observations at the Observatorio del Teide (Tenerife, Spain). The ASTRI Mini-Array will devote the first three to four observing years to specific science topics, with the aim of providing robust answers to a few selected open questions in the very high-energy (VHE, E > 0.1 TeV) domain. We identified the following Core Science topics, a.k.a. the "Science Pillars", to be investigated: the origin of cosmic rays, the extra-galactic background light and the study of fundamental physics, the novel field in the VHE domain of gamma-ray bursts and other multi-messenger transients, and finally the usage of the ASTRI Mini-Array to investigate ultra high-energy cosmic rays and to address stellar intensity interferometry studies. We review the results obtained by means of dedicated scientific simulations, proving the potential of the ASTRI Mini-Array in pursuing breakthrough discoveries and discuss the synergies with current and future VHE facilities.'

Collaborations
other (fill field below), ASTRI

Keywords and Comments
'IACTs; Cosmic ray acceleration; Blazars; PWN; SNR;; GRBs', ''

Branch GAI | Gamma Ray Indirect

Subcategory Future projects

The ASTRI mini-array at Teide Observatory

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table

Presenter
Lucio Angelo Antonelli
Author and Co-Author
Lucio Angelo Antonelli,

Abstract
'The ASTRI MINI-ARRAY is an international project led by the Italian National Institute of Astrophysics (INAF) with the participation of the Instituto de Astrofisica de Canarias, Brazil and South Africa to be installed at the Teide Observatory, in Tenerife, to observe the Very High Energy sky in the range of a few TeV up to 100 TeV and beyond. The ASTRI MINI-ARRAY technology is based on the ASTRI-Horn prototype, a small-sized Cherenkov telescope (SST) developed by INAF within the Cherenkov Telescope Array (CTA) Project and located in Italy at the INAF "M.C. Fracastoro" observing station (Mt. Etna, Sicily). The telescope is characterized by a dual-mirror optical system and curved focal surface covered by a SiPM sensors camera managed by a fast front-end electronics. The ASTRI MINI-ARRAY is composed of nine ASTRI-Horn-like telescopes. It is going to be developed by the ASTRI Collaboration in all aspects from the design, construction and implementation of the entire hardware and software system, including a dedicated off-site Data Center, to the final scientific products. The ASTRI MINI-ARRAY will be operated as an observation facility led by INAF and thanks to its sensitivity, especially at energies greater than 1 TeV, represents the key instrument to perform very soon a ground breaking achievement in the field of extreme gamma rays, up to 100 TeV and beyond. In this contribution, after a short description of the major results obtained by the prototype in Serra La Nave, I will review about the MINI-ARRAY status and expected performance.'

Collaborations
other (fill field below), ASTRI

Keywords and Comments
'Gamma ray Astronomy; Imaging Atmospheric Cherenkov Telescopes;', 'on behalf of ASTRI Collaboration.'

Branch GAI | Gamma Ray Indirect

Subcategory Future projects

Half ALPACA and its sensitivity to sub-PeV gamma rays from the Galactic Center

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 240

Presenter
Yoshichika Yokoe
Author and Co-Author
Yoshichika Yokoe,

Abstract
'ALPACA is a project aimed at the wide field-of-view observation of cosmic rays and gamma rays with an 83,000 m^2 air shower array composed of approximately 400 surface scintillation counters and a large underground muon detector array, at an altitude of 4,740m near the Chacaltaya mountain in Bolivia. After a prototype air-shower array currently under construction, we plan to expand the array to 'half\r\nALPACA', which covers an area of 83,000 m^2 with roughly 200 surface scintillation counters. Also, we will\u3000construct an underground muon detector array with an area of 4,000 m^2 that allows us to dramatically improve the sensitivity to gamma rays by discriminating gamma rays from cosmic rays based on the number of muons\u3000in air showers.\r\n One of our main interests is the detection of gamma rays beyond 100 TeV from\u3000the Galactic center.\u3000In 2016, H.E.S.S observed the diffuse gamma-rays around the Galactic\u3000center. This data suggests that a cosmic-ray accelerator exists around it.\r\n In this presentation, we report on the performance of half ALPACA, especially its sensitivity to sub-PeV gamma rays from the Galactic center, based on our detailed MC simulations.'

Collaborations

Keywords and Comments
", "

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Branch GAI | Gamma Ray Indirect

Subcategory Future projects

Galactic Science with the ASTRI-Mini Array during the Observatory phase of the project

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 241

Presenter
Antonino DAi
Author and Co-Author
Antonino DAi,

Abstract
'The ASTRI-Mini Array will be composed of nine imaging atmospheric Cherenkov telescopes\r\nat the Teide Observatory site. The array will observe in the 1-200 TeV range with an\r\nangular resolution of few arc-minutes and an energy resolution of about 10%.\r\nA core-science programme will be devoted in the first three years to\r\na limited number of key science targets. Additionally, thanks to a field-of-view\r\nof about 6 degree radius, ASTRI-MA will collect data from many other field sources\r\nthat will constitute the base of a long-term Galactic observatory programme.\r\nIn this contribution, I will overview the main themes for this extended observatory science programme for the different astrophysical Galactic environments, e.g. pulsar wind nebulae, supernova remnants, gamma-ray binaries, globular clusters, and dark matter search.'

Collaborations
other (fill field below), ASTRI

Keywords and Comments
'ASTRI-Mini Array; IACT; Galactic VHE sources;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Future projects

Untangling the Complexity in the Galactic Centre: a way to understand the origin of the gamma-ray emission from the inner Galaxy

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 242

Presenter
Sofia Ventura
Author and Co-Author
Sofia Ventura,

Abstract
'The origin of the high-energy gamma-ray emission from the Milky Way centre is still unclear and debated because of the impact of systematics afflicting the measurements from current experiments. Several theories and phenomenological models attempt to explain the intricate panorama. The presence of a *PeVatron* in the Central Molecular Zone or in its vicinity, the contribution of the hard component of the diffuse gamma-ray emission, and dark matter annihilation scenario are among the most promising mechanisms to describe the observed excess. The development of increasingly precise models able to reproduce the measured gamma-ray emission is the challenge for the scientific community in view of the next generation telescopes.\r\nA detailed treatment of phenomenological models for the dubbed *Cosmic Rays Sea* (CR-*sea*) characterised by different configurations is scrutinised in comparison with the observed spectra in several regions of the inner Galaxy using recently distributed DRAGON2 and HERMES codes. Updated maps of atomic and molecular components of the gas distribution in Our Own Galaxy are considered, as well as the systematics arising from the analysis of *Fermi*-LAT data performed with different approaches.'

Collaborations

Keywords and Comments
'', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Future projects

Double-layered Water Cherenkov Detector for SWGO

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 243

Presenter
Samridha Kunwar
Author and Co-Author
Samridha Kunwar | for the SWGO Collaboration,

Abstract
'The Southern Wide-field-of-view Gamma-ray Observatory (SWGO) will use the well-established and cost-effective technique of detecting Cherenkov light produced in water-filled detection units for TeV gamma-ray astronomy. Leveraging detector material reflectivity together with optimised aspect-ratio is an option to improve the performance of an array of such detector units. The double-layered Water Cherenkov Detector units comprise chambers with single photosensors in each. A reflective upper compartment enhances sensitivity to impinging secondary particles. A shallow lower compartment enables muon tagging and consequently improves the gamma hadron separation power of the observatory. Here we present detailed studies on the double-layered unit design.'

Collaborations
SWGO,

Keywords and Comments
'Gamma-ray; SWGO; Water Cherenkov Detector; Double-layered WCD', ''

Branch GAI | Gamma Ray Indirect

Subcategory Future projects

Simulating the performance of the Southern Wide-view Gamma-ray Observatory

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 56 New Instruments, Performance & Future Projects for Ground-Based Gamma-Ray Astronomy | GAI
Presenter Forum Table 244

Presenter
Harm Schoorlemmer
Author and Co-Author
Harm Schoorlemmer | Ruben Conceição | Andrew James Smith | for the SWGO Collaboration,

Abstract
'Abstract: The Southern Wide-view Gamma-ray Observatory (SWGO) will be a next-generation gamma-ray observatory using a large array of particle detectors at a high elevation site in South America. This project is currently in a three years R&D phase in which the design will be optimised for cost and performance. Therefore it is crucial to efficiently evaluate the impact of different design options on the scientific objectives of the observatory. In this contribution, we will introduce the strategy and the simulation framework in which this evaluation takes place. This development builds upon the established simulation framework by the HAWC collaboration and simultaneously adapts to ideas and concepts of the broader gamma-ray and astroparticle communities.'

Collaborations
SWGO,

Keywords and Comments
'water-Cherenkov detector; Wide-field of view; gamma-ray instrumentation.', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Future projects

HAWC J2227+610: a potential PeVatron candidate for the CTA in the northern hemisphere

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 55 Ultra-High-Energy Gamma-Ray Sources and PeVatrons | GAI
Presenter Forum Table

Presenter
Gaia Verna
Author and Co-Author
Gaia Verna, Franca Cassol | Heide Costantini

Abstract
'Recent observations of VER J2227+608 and the associated supernova\r\nremnant G106.3+2.7 by the High Altitude Water Cherenkov (HAWC)\r\nobservatory confirm the special interest of this source as a Galactic Pe-\r\nVatron candidate in the northern hemisphere. HAWC J2227+610 emits\r\nVHE gamma-ray emission, above 100 TeV, from a region coincident with\r\nmolecular clouds and shows a hard energy spectrum without clear cutoff.\r\nThis has induced several authors to suggest or claim a potential hadronic\r\norigin for its gamma-ray emission. CTA could play a crucial role to under-\r\nstand the particle acceleration mechanisms behind this source thanks to\r\nits improved sensitivity with respect to the present IACT generation. The\r\npurpose of this work is to investigate the potentiality of CTA to observe\r\nHAWC J2227+610 and to disentangle the different suggested scenarios\r\nof hadronic and leptonic emission. In particular we study the capability\r\nin resolving the morphology of this source and its eventual energy de-\r\npendence taking advantage of the unprecedent angular resolution. The\r\nstudy is based on simulations; the CTA prototype science tool *gammapy*\r\nis employed.'

Collaborations
CTA,

Keywords and Comments
'PeVatrons; CTA', ''

Branch GAI | Gamma Ray Indirect

Subcategory Future projects

The COMET multiperspective event tracker for wide field-of-view gamma-ray astronomy

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 245

Presenter
Gašper Kukec Mezek
Author and Co-Author
for the ALTO/COMET Collaboration | Gašper Kukec Mezek, Yvonne Becherini | Martin Tluczykont | Patrizia Romano | Ahmed Saleh | Satyendra Thoudam | Stefano Vercellone | Jean-Pierre Ernenwein | Michael Punch | Tomas Bylund | Mohanraj Senniappan

Abstract
'The ALTO/COMET R&D project focuses on the development of a new technique for the observation of very high-energy (VHE) gamma-rays from the ground at energies above ~200 GeV, thus covering emission from soft-spectrum sources. The ALTO/COMET proposed array under study combines 1241 particle detector units, distributed over a circular area of ~160 m in diameter and placed at a very high altitude (5.1 km), with atmospheric Cherenkov light detectors.\r\n\r\nThe atmospheric Cherenkov light detectors, inspired by the "HiSCORE" design and improved for the energy range of interest, can be operated together with the particle detectors during clear nights. As such, the instrument becomes a Cosmic Multiperspective Event Tracker (COMET). ALTO/COMET is expected to improve the reconstruction of arrival direction, energy and shower maximum determination for gamma-ray-induced showers during darkness, which is crucial for the reduction of background contamination from cosmic rays. Prototypes of both particle and atmospheric Cherenkov light detectors are already installed at the Linnaeus University in Sweden, while we simulate the detector response and estimate the reconstruction improvement for gamma-ray events.\r\n\r\nIn this contribution, we present Monte-Carlo simulations of the detector array, consisting of CORSIKA shower simulations and custom detector response simulations, together with the coupling of particle and atmospheric Cherenkov light information, the reconstruction strategy of the complete array and the detection performance on point-like VHE gamma-ray sources. In addition, we briefly present the prototype experience.'

Collaborations
other (fill field below), ALTO/COMET

Keywords and Comments
'gamma-rays; wide field-of-view; Cherenkov radiation; very high-energies; atmospheric showers', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Methods

On the Use of Convolutional Neural Networks for Turbulent Magnetic Field Helicity Classification

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 246

Presenter
Nicolò Oreste Pinciroli Vago
Author and Co-Author
Nicolò Oreste Pinciroli Vago | Ibrahim A. Hameed | Michael Kachelriess,

Abstract
'The presence of non-zero helicity in intergalactic magnetic fields (IGMF) is a smoking gun for their primordial origin. Helical magnetic fields break CP invariance, what can be sued as an experimental signature. An estimator Q based on the triple scalar product of the wave vectors of photons generated in electromagnetic cascade from, e.g., TeV blazars has been suggested previously. Here, we propose the application of deep learning to helicity classification, by means of a Convolutional Neural Network (CNN), and show that this method outperforms the Q estimator.'

Collaborations

Keywords and Comments
'intergalactic magnetic fields; helical magnetic fields; TeV photons; electromagnetic cascades; machine learning', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Methods

Modeling intrinsic time-lags in flaring blazars in the context of Lorentz Invariance Violation searches

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 57 New Physics | CRD-CRI-DM-GAD-GAI-NU-MM-SH
Presenter Forum Table

Presenter
Christelle Levy
Author and Co-Author
Christelle Levy, Julien Bolmont | Hélène Sol

Abstract
"Some Quantum Gravity (QG) theories, aiming at unifying general relativity and quantum mechanics, predict an energy-dependent modified dispersion relation for photons in vacuum leading to a Violation of Lorentz Invariance (LIV). One way to test these theories is to monitor TeV photons time-of-flight emitted by distant, highly energetic and highly variable astrophysical sources such as flaring active galactic nuclei. Only one time-lag detection was reported so far. We have recently shown however that significant intrinsic time-lags should arise from *in situ* blazar emission processes at TeV energies and should consequently interfere with LIV searches.\r\nIn this contribution we will review how intrinsic time delays and LIV-induced propagation effects simultaneously contribute to modify blazars' observed spectral energy distributions and lightcurves. Using a time-dependent model, we provide predictions on both contributions for different emission scenarii. We will also introduce hints and methods on how to disentangle intrinsic time delays from extrinsic ones in order to highlight LIV effects."

Collaborations
H.E.S.S., CTA

Keywords and Comments
'AGN; Blazar; Modelisation; Jet; LIV; Time-delays; Intrinsic effects; IACT; Gamma-rays;', ''

Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Methods

Deep-learning applications to the multi-objective optimisation of IACT array layouts.

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 52 Analysis, Methods, Catalogues, Community Tools, Machine Learning... | GAD-GAI
Presenter Forum Table

Presenter
Bernardo Fraga
Author and Co-Author
Bernardo Fraga | Ulisses Barres de Almeida | Clecio De Bom,

Abstract
'The relative disposition of individual telescopes in the ground is one of the important factors in optimising the performance of a stereoscopic array of imaging atmospheric Cherenkov telescopes (IACTs). Following previous attempts at an automated survey of the broad parameter space involved using evolutionary algorithms, in this paper we will present a novel approach to optimising the array geometry based on deep learning techniques. The focus of this initial work will be to test the algorithmic approach and will be based on a simplified toy model of the array. Despite being simplified, the model heuristics aims to capture the principal array performance features relevant for the layout optimisation. Our final goal is to create an algorithm capable of scanning the large parameter space involved in the design of a large stereoscopic array of IACTs to assist optimisation of the array geometry (in face of external constraints and multiple performance objectives). The use of simple heuristics precludes direct comparison to existing real-world experiments, but the analysis is internally consistent and gives insight as to the potential of the technique. Deep learning techniques are being increasingly applied to tackle a number of problems in the field of Gamma-ray Astronomy, and this work represents a novel, original application of this modern computational technique to the field.'

Collaborations

Keywords and Comments
'IACT array; optimisation; Deep Learning;Cherenkov', ''

Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Methods

Gamma-gamma absorption in the Galactic Center

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Francesco Conte
Author and Co-Author
Francesco Conte, Richard Tuffs

Abstract
'Francesco Conte: $\\gamma-\\gamma$ absorption in the Galactic Center\r\n===\r\n\r\nThe Galactic Center (GC) is an intriguing lab for non-thermal astrophysics due to its proximity and its transparency in radio, X-ray and $\\gamma$ bands. In addition to hosting a supermassive black hole, a compact luminous young star cluster, and the circumnuclear ring, the central few parsecs of the Milky Way are also notable for hosting a source of cosmic rays extending up to PeV in energy - the first known galactic "Pevatron". However, the spectrum of the brightest $\\gamma$ source, possibly associated with SgrA*, showed a clear cut-off at 1-10 TeV in the H.E.S.S. data. Since the H.E.S.S. PSF FWHM is several arcminutes wide, a possible explanation would be the $\\gamma$-photon interaction with the IR radiation field in the central 2-3 arcminutes. To investigate the absorption by pair creation, I computed the mid-IR 3d emissivity and thus the mid-IR radiation field with an arcsecond resolution in the central few parsecs, deriving the total opacity given a modeled $\\gamma$ source. I will present the latest results, showing how this method could potentially determine the accelerator position with unprecedented precision in $\\gamma$ astronomy. Lastly, I will quickly go through a few possible applications of my 3d-model for future investigations of the Galactic Center at very-high energies.'

Collaborations

Keywords and Comments
'Galactic Center; absorption; secondaries; pair production', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Modification of the gamma-ray spectra from active galaxies by soft radiation of transiting luminous stars

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 247

Presenter
Wlodek Bednarek
Author and Co-Author
Wlodek Bednarek | Julian Sitarek,

Abstract
"Gamma-ray emission in active galaxies is expected to originate in a close priximity of the supermassive black hole surrounded by a reach cluster of luminous stars. We consider the effects of luminous stars (early type of red supergiant, separate or in binary systems) crossing accidentally the gamma-ray beam close to the observer's line of sight. We show that soft radiation of massive stars can create enough target for transient absorption of the gamma rays in multi-GeV to TeV energy range. We predict characteristic, time-dependent effects on the gamma-ray spectra due to the encounter with stars. As an example, we consider such effects on the spectra observed from a typical blazar, 1ES 1959+650 (in an active state) and also in the case of a radio galaxy M87 (in a low state). Observation of such transient characteristic features in the gamma-ray spectra of blazars and radio galaxies lays within the sensitivity of the future Cherenkov Telescope Array."

Collaborations

Keywords and Comments
'AGN;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Gamma-ray signatures from pair cascades in recombination-line radiation fields

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 48 Modelling AGN's spectral energy distribution | GAD-GAI-MM
Presenter Forum Table

Presenter
Christoph Wendel
Author and Co-Author
Christoph Wendel | Josefa Becerra González | Amit Shukla | David Paneque | Karl Mannheim,

Abstract
'Beams of ultra-relativistic electrons in blazar jets develop pair cascades interacting with ambient soft photons. Employing coupled kinetic equations with escape terms, we model the unsaturated pair cascade spectrum. We assume that the gamma rays predominantly scatter off recombination-line photons from clouds photoionised by the irradiation from the accretion disk and the jet. The cascade spectrum is rather insensitive to the injection of hard electron spectra associated with the short-time variability of blazars. Adopting physical parameters representative of Markarian 501 and 3C 279, respectively, we numerically obtain spectral energy distributions showing distinct features imprinted by the recombination-line photons. The hints for a peculiar feature at 3 TeV in the spectrum of Markarian 501, detected with the MAGIC telescopes during a strong X-ray flux activity in 2014 July, can be explained in this scenario as a result of up-scattering of line photons by beam electrons and the low pair-creation optical depth. Inspecting a high-fidelity Fermi-LAT spectrum of 3C 279 reveals troughs in the spectrum that coincide with the threshold energies for gamma rays producing pairs in collisions with recombination-line photons and the absence of exponential attenuation. Our finding implies that the gamma rays in 3C 279 escape from the edge of the broad emission line region.'

Collaborations

Keywords and Comments
'AGN; blazars; non-thermal; radiation processes; electromagnetic cascade; pair production; inverse Compton; magnetosperic vacuum gap; 3C 279; Markarian 501', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Origin of the very high energy gamma-ray emission from pulsar wind nebulae

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 53 PWN and Halos | GAD-GAI
Presenter Forum Table

Presenter
Gwenael Giacinti
Author and Co-Author
Gwenael Giacinti | Brian Reville | John Kirk,

Abstract
'We study electron and positron acceleration at the termination shock of a striped pulsar wind by integrating particle trajectories in a prescribed model of the magnetic field and flow pattern. We find that drift motion on the shock surface maintains either electrons or positrons on Speiser orbits in a ring-shaped region close to the equatorial plane of the pulsar, where they are accelerated to very high energy by the first-order Fermi mechanism. We calculate the resulting inverse Compton emission from these electrons, and demonstrate that the observed > TeV gamma-ray emission from the Crab Nebula can be well reproduced for reasonable parameters of the Crab pulsar wind and turbulence levels in the nebula. We show that future observations of the Crab Nebula at ~ PeV energies, e.g. by LHAASO, will allow for putting relevant constraints on parameters of the Crab pulsar wind that are still poorly known.'

Collaborations

Keywords and Comments
'Particle acceleration; Pulsar wind nebulae; Gamma-rays', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Magnetic field amplification by turbulent dynamo in relativistic collisionless shocks

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 248

Presenter
Sara Tomita
Author and Co-Author
Sara Tomita | Yutaka Ohira,

Abstract
'Cosmic rays are thought to be efficiently produced in collisionless shocks in high-energy astrophysical sources, where cosmic rays are diffusively scattered by magnetic fluctuations. The magnetic field near the shock decides the maximum energy of cosmic rays\u3000accelerated in the shock and the emission by the accelerated particles. However, the magnetic field strength and structure around the shock are not understood yet. Recent magnetohydrodynamics (MHD) simulations of shocks propagating into inhomogeneous media show that the ambient magnetic field is amplified by turbulent dynamo in the downstream region. According to these simulations, the turbulent dynamo always works as long as the magnetic energy is smaller than the kinetic energy of the downstream turbulence. However, the shocks formed in astrophysical phenomena are often driven by collisionless plasma, where non-thermal particles are generated, so that it is unknown whether or not the MHD approximation is applied to the downstream flow. In particular, for shocks in gamma-ray bursts, the size of density fluctuations has to be about ten times the gyroradius of the thermal protons to amplify the magnetic field by the downstream turbulence. We perform particle-in-cell simulations of relativistic collisionless shocks propagating into a pair plasma with a density clump whose size is ten times the gyroradius of downstream thermal plasmas. We found that the magnetic field amplification does not work if the amplitude of the upstream density fluctuation is below a critical value.'

Collaborations

Keywords and Comments
'Magnetic field amplification; Collisionless shock; Particle acceleration; Gamma-ray burst;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Analytical Model of Magnetically Dominated Jets: Jet Launching, Acceleration, and Collimation

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 249

Presenter
Liang Chen
Author and Co-Author
Liang Chen | Bing Zhang,

Abstract
'Jets are ubiquitously in association with different celestial objects. However, most of previous theoretical studies of them rely on numerical calculations, not being able to provide a more convenient way for understanding rather abundant observational results. Now we have obtained a general analytical solution for describing a magnetically dominated jet, through separating the jet “core equation” (which maintains the radial dynamic equilibrium) into rotating and non-rotating terms, finding that each of the two-term equations can be solved analytically, and the two solutions match each other very well. The analytical model based on this solution can explain the main results of jet observations and numerical simulations, such as jet shape configuration, acceleration profile (from non-relativistic to relativistic), and polarization pattern etc. Furthermore, the solution is applicable to, e.g., limb-brightening (a hollow jet), periodical variability (a helical jet), and "complex" proper motion pattern (a stratified jet) etc. I this talk, I will present the details of the theory, examples of comparing with observations, and a variety of predictions (Ref. Chen & Zhang, 2021, ApJ, 906, 105).'

Collaborations

Keywords and Comments
'Relativistic jets; Magnetic fields; Gamma-ray bursts; Active galactic nuclei; Charged black holes; Gamma-rays; Cosmic rays; Pulsars; Neutron stars', ''

Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

The TeV gamma-ray source population of the Milky-Way.

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 51 The Census of Gamma-Ray Sources | GAD-GAI
Presenter Forum Table

Presenter
Vittoria Vecchiotti
Author and Co-Author
Maddalena Cataldo | Giulia Pagliaroli | Vittoria Vecchiotti | Francesco Lorenzo Villante,

Abstract
'In this work we perform a population study of the H.E.S.S. Galactic Plane Survey (HGPS) catalogue. Namely, we analyze the flux, latitude and longitude distributions of gamma-ray sources detected by H.E.S.S. with the goal of inferring the main properties of galactic TeV source population.\r\nWe show that the total Milky Way luminosity in the 1-100 TeV energy range is relatively well constrained by H.E.S.S. data, obtaining $L_{\\rm MW} = 1.7^{+0.5}_{-0.4}\\times 10^{37} {\\rm erg}\\,{\\rm s}^{-1}$, and that the total Galactic flux in the H.E.S.S. observational window is $\\Phi_{\\rm tot} = 3.8^{+1.0}_{-1.0}\\times 10^{-10} {\\rm cm}^{-2}\\, {\\rm s}^{-1}$. \r\nThe above results allows us to estimate the flux produced by sources not resolved by H.E.S.S.. These sources, which are too faint (or too extended) to be detected by H.E.S.S., contribute to the large-scale diffuse signal observed at the TeV range. We show that unresolved source contribution is not negligible (about $60\\%$ of the resolved signal measured by H.E.S.S.) and potentially responsible for a large fraction of the diffuse-large scale gamma-ray signal observed by H.E.S.S. and other experiments in the TeV domain.\r\nFinally, in the hypothesis that the majority of bright sources detected by H.E.S.S. are powered by pulsar activity, like e.g. Pulsar Wind Nebulae or TeV halos, we estimate the main properties of the pulsar population: we obtain a constrain on the fading time $\\tau$, the initial period P_{0} and the magnetic field B.'

Collaborations

Keywords and Comments
'High energy astrophysics; Gamma-ray sources; PWN.', ''

Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Gamma-ray morphology of SNRs and their halos

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Robert Brose
Author and Co-Author
Martin Pohl | Robert Brose | Iurii Sushch,

Abstract
'We use our time-dependent acceleration code RATPaC to study the formation of extended gamma-ray halos around supernova remnants and the morphological implications that arise when the high-energetic particles start to escape from the remnant.\r\n\r\nWe performed spherically symmetric 1-D simulations in which we simultaneously solve the transport equations for cosmic rays, magnetic turbulence, and the hydrodynamical flow of the thermal plasma in a volume large enough to keep all cosmic rays in the simulation.\r\n\r\nFor older supernova remnants we find strong morphological differences between the\r\nhadronic and the leptonic gamma-ray intensity. At early times both - the inverse-Compton and the Pion-decay morphology - are shell-like. However, as soon as the maximum-energy of the freshly accelerated particles starts to fall, the inverse-Compton morphology starts to become center-filled whereas the Pion-decay morphology retains its shell-like structure. Escaping high-energy electrons start to produce an emission halo around the remnant at this time. There are good prospects for detecting the spectrally hard halo component with the future Cherenkov Telescope Array, likewise for detecting variations of the gamma-ray spectral index across the interior of the remnant, whereas current-generation gamma-ray observatories have insufficient sensitivity.'

Collaborations

Keywords and Comments
'SNR; particle acceleration; gamma-ray halo', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Modeling non-thermal emission from SN 1987A

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 250

Presenter
Robert Brose
Author and Co-Author
Robert Brose | Jonathan Mackey,

Abstract
"The remnant of SN 1987A is the best-studied object of its kind. The rich data-set of its thermal and non-thermal emission across the electromagnetic spectrum poses a unique testbed for the elaboration of particle-acceleration theory.\r\n\r\nWe use 2D simulations of the progenitor's wind to obtain hydro-profiles for the medium around the supernova explosion. Various cones along prominent features of the ambient medium are then used in our time-dependent acceleration code RATPaC to model the evolution of the emission of SN 1987A and compare it to observational data.\r\n\r\nWe solve for the transport of cosmic rays, magnetic turbulence, and the hydrodynamical flow, in the test-particle limit. The simulation code relies on 1D profiles but the large expansion speed of the young remnant renders lateral transport unimportant.\r\n\r\nWe find that the increase in thermal X-ray emission predates the increase in the low-energy gamma-ray brightness by several years. The increase of the gamma-ray brightness at lower energies is followed by a smooth increase at the highest energies. The gamma-ray spectrum at the highest energies appears soft during the brightening but hardens as more material in the equatorial ring gets shocked. The X-ray and gamma-ray brightness remain almost constant once the SNR blast-wave passed the region of peak-density in the equatorial plane."

Collaborations

Keywords and Comments
'SNR; SN 1987A; modeling; X-ray; gamma-ray; CSM', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Sensitivity reach of gamma-ray measurements for cosmological magnetic fields

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 251

Presenter
Alexander Korochkin
Author and Co-Author
Alexander Korochkin | Oleg Kalashev | Andrii Neronov | Dmitri Semikoz,

Abstract
'A primordial magnetic field with the strength in the 1-10 pG range can resolve the tension between different measurements of the Hubble constant and provide an explanation for the excess opacity in the 21 cm line at redshift 15<z<20, if it is present during the recombination and reionization epochs. This field can also survive in the voids of the large-scale Structure in the present day universe. We study the sensitivity reach of the gamma-ray technique for measurement of cosmological magnetic field using deep exposure(s) of the nearest hard spectrum blazar(s) with CTA telescopes. We show that the gamma-ray measurement method can sense the primordial magnetic field with a strength of up to 10−11~G. Combination of the cosmic microwave background and gamma-ray constraints can thus sense the full range of possible cosmological magnetic fields to confirm or rule out their relevance to the problem of the origin of cosmic magnetic fields, as well as their influence on recombination and reionization epochs.'

Collaborations

Keywords and Comments
'Intergalactic Magnetic Field; AGN; Gamma-ray astronomy', ''

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Webpage icrc2021.desy.de

Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Probing cosmic-ray distribution around Cygnus OB2

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 44 The Origins of Galactic Cosmic Rays | GAD-GAI-CRD
Presenter Forum Table

Presenter
Stefano Menchiari
Author and Co-Author
Stefano Menchiari, Elena Amato | Giovanni Morlino | Niccolò Bucciantini

Abstract
'Recently, massive star clusters have received renewed attention as possible cosmic-ray (CR) factories. In the neighborhood of a massive star cluster, assuming a steady-state injection lasting a few million years, the density of escaping, freshly accelerated CRs is expected to decrease following a 1/r profile. As CRs diffuse away from the cluster, the hadronic component interacts with molecular clouds (MCs) in its vicinity, causing a distinct observed morphology in the gamma-ray band, which results from the convolution of the spatial distribution of CRs and MCs. Cygnus OB2 is one of the most massive star clusters in the Milky Way, located near the Cygnus X star-forming complex. Fermi observations of the region revealed an extended gamma-ray emission (Cygnus Cocoon) possibly coming from CRs accelerated by Cygnus OB2. Recent studies claim that this extended emission is compatible with a CR distribution of freshly accelerated escaping particles. In this work, we aim to infer the shape of the distribution of CRs around Cygnus OB2 by studying the 3D Cocoon morphology. For this purpose, we implemented a 3D model of MCs distribution around Cygnus OB2, where their distance is obtained using maser parallaxes and dust reddening information.'

Collaborations

Keywords and Comments
'Massive star clusters;', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

CONSTRAINTS ON THE VERY HIGH ENERGY GAMMA-RAY EMISSION FROM GRB170206A WITH HAWC.

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 54 Gamma-Ray Bursts in the VHE regime | GAI
Presenter Forum Table

Presenter
Yunior Pérez
Author and Co-Author
Yunior Pérez | Maria Magdalena Gonzalez | Nissim Fraija | Simone Dichiara | for the HAWC Collaboration,

Abstract
'Gamma-ray bursts (GRBs) are among the most luminous sources in the universe. The nature of their emission at TeV energies is one of the most relevant open issues related to these events. Due to its large field of view and duty cycle, HAWC is ideal for studying transient phenomena with gamma-ray emission and probing different model assumptions. In this work, we search for gamma-ray emission in the energy range of 80 to 800 GeV coming from GRB 170206A, the third brightest short GRB detected by Fermi-GBM. We show that the upper limits obtained from HAWC (with a 90% confidence level) would be capable of restricting the synchrotron-self Compton model in the fast cooling regime when a typical redshift value for short GRBs is assumed.'

Collaborations
HAWC,

Keywords and Comments
'Gamma-ray bursts; Transient phenomena; the synchrotron-self Compton model.', ''

Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Predictions for gamma-rays from clouds associated with supernova remnant PeVatrons

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 55 Ultra-High-Energy Gamma-Ray Sources and PeVatrons | GAI
Presenter Forum Table

Presenter
Alison Mitchell
Author and Co-Author
Alison Mitchell | Gavin Rowell | Silvia Celli | Sabrina Einecke,

Abstract
'Interstellar clouds can act as target material for hadronic cosmic rays; gamma-rays produced through inelastic proton-proton collisions and spatially associated with the clouds can provide a key indicator of efficient particle acceleration. \r\nHowever, even for PeVatron sources reaching PeV energies, the system of cloud and accelerator must fulfil a several conditions in order to produce a detectable gamma-ray flux. \r\nIn this contribution, we characterise the necessary properties of both cloud and accelerator. \r\nUsing available Supernova Remnant (SNR) and interstellar cloud catalogues, and assuming particle acceleration to PeV energies in a nearby SNR, we produce a ranked shortlist of the most promising target systems, for which a detectable gamma-ray flux is predicted. \r\nWe discuss detection prospects for future facilities including CTA, LHAASO and SWGO; and compare our predictions with known gamma-ray sources.\r\nA range of model scenarios are tested, including variation in the diffusion coefficient and particle spectrum, under which the best candidate clouds in our shortlist are consistently bright. \r\nOn average, a detectable gamma-ray flux is more likely for more massive clouds; systems with lower separation distance between the SNR and cloud; and for slightly older SNRs.'

Collaborations

Keywords and Comments
'Gamma-rays; Cosmic rays; supernova remnants; clouds; PeVatrons', ''

Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Galactic diffuse emission of gamma rays and neutrinos of energy above 100 TeV

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 45 Probing the Distribution of Cosmic Rays in Galaxies | GAD-GAI-CRD
Presenter Forum Table

Presenter
Silvia Vernetto
Author and Co-Author
Silvia Vernetto | Paolo Lipari,

Abstract
"Galactic cosmic rays propagating in interstellar space interact with gas and radiation fields producing gamma ray and neutrino emissions of comparable intensity. These emissions result in diffuse fluxes of secondary particles reaching the Earth that encode information on the space distribution, energy spectra and mass composition of the parent CR's in the entire volume of the Galaxy, where direct detection is not possible.\r\n Extending the measurements of the diffuse gamma ray flux to very high energy (>100 TeV) and detecting a neutrino flux above the atmospheric foreground is of great importance for our understanding of cosmic ray acceleration in Galactic sources and of the magnetic structure of the Milky Way. The study of this energy range is of particular importance because the CR particles that generate gamma rays and neutrinos are around the prominent spectral feature known as the ``knee''.\r\n The absorption probability for gamma rays of energy > 100 TeV is large and distorts the energy and angular distributions of the diffuse flux, but taking into account these effects it is possible to obtain very valuable information also from observations in this energy range.\r\n In this work we compare our predictions on the diffuse gamma ray and neutrino fluxes at high energy, developed under different hypothesis, with the existing data of neutrino telescopes and gamma ray detectors, including the new results by the Tibet AS array above 100 TeV, and discuss the potential of future observations."

Collaborations

Keywords and Comments
'Galactic Gamma rays; Neutrinos; Diffuse emission', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Particle escape from supernova remnants and related gamma-ray signatures

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Silvia Celli
Author and Co-Author
Silvia Celli | Giovanni Morlino,

Abstract
'The escape process of particles accelerated at supernova remnant (SNR) shocks is here studied with a phenomenological approach which allows to quantify its impact on the CR spectrum observed on Earth as well as on the gamma-ray spectral signatures emerging from these sources. Under the assumption that in the spatial region immediately outside of the remnant the diffusion coefficient is suppressed with respect to the average Galactic one, we show that a significant fraction of particles are still located inside the SNR long time after their nominal release from the acceleration region. This fact results into a gamma-ray spectrum arising from hadronic collisions that resembles a broken power law, similar to those observed in several middle-aged SNRs. Above the break, the spectral steepening is determined by the diffusion coefficient outside of the SNR and by the time dependence of maximum energy. Consequently, the comparison between the model prediction and data will possibly allow to determine these two quantities. We also calculate the spectrum of run-away particles injected into the Galaxy by SNRs and compare it with the CR electron and proton spectra measured at Earth, which suggest that electrons are injected with a spectrum steeper than protons for energies above ~ 10 GeV.'

Collaborations

Keywords and Comments
'Supernova remnants; gamma rays; cosmic rays', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Cosmic ray transport in the proximity of pulsars and the formation of gamma-ray halos

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 53 PWN and Halos | GAD-GAI
Presenter Forum Table

Presenter
Sarah Recchia
Author and Co-Author
Sarah Recchia | MATTIA DI MAURO | Silvia Manconi | Fiorenza Donato | Felix Aharonian | Stefano Gabici,

Abstract
'The detection of an extended multi-TeV gamma ray emission around the\r\nGeminga pulsar by the HAWC collaboration provides a unique tool to investigate the transport properties of cosmic rays in the turbulent magnetized interstellar medium.\r\nIn this work, different regimes of propagation of ultrarelativistic\r\nelectrons in the proximity of pulsars are analyzed and their implications\r\nfor the angular and energy distributions of the resulting secondary\r\nradiation are discussed. The results are discussed in the context of the interpretation of the\r\ngamma-ray halo around Geminga reported by HAWC.'

Collaborations

Keywords and Comments
'cosmic rays; gamma rays; pulsars', ''

Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

The gamma—ray signal from core—collapse supernovae.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 252

Presenter
Pierre Cristofari
Author and Co-Author
Pierre Cristofari | Matthieu Renaud | Alexandre Marcowith | Vincent Tatischeff | Vikram Dwarkadas,

Abstract
'The shock wave resulting from the core-collapse of a massive star can accelerate particles up to PeV energies in the first few days to weeks after explosion. This can lead to the production of a potentially detectable gamma—ray signal. The gamma-ray flux however is strongly affected by the two photon—annihilation process, where gamma—ray photons interact with photons from the SN photosphere. It is therefore not surprising that there has been no confirmed detection of gamma-rays from core-collapse supernovae at very high energies.\r\n\r\nIn order to probe the detectability of the gamma-rays with current and upcoming gamma-ray observatories, we estimate the gamma—ray flux from typical type IIp core collapse supernovae (CCSNe). These are the most common type of supernovae, and are presumed to arise from red supergiant progenitors. We include a detailed time-dependent calculation of two—photon absorption. Our results will be very useful in creating a strategic observing program to detect CCSNe with the next generation gamma—ray observatory, such as the Cherenkov Telescope Array (CTA).'

Collaborations

Keywords and Comments
'supernova; cosmic ray; gamma--ray astronomy; gamma rays; particle acceleration', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Modelling uncertainties in GeV - TeV flux predictions of Galactic globular clusters

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems, Microquasars | GAD-GAI
Presenter Forum Table

Presenter
Christo Venter
Author and Co-Author
Christo Venter, Hambeleleni Ndiyavala-Davids | Andreas Kopp | Michael Backes

Abstract
'Globular clusters are multi-band emitters, with their gamma-ray emission having been variously attributed as due to dark matter annihilation, a resident gamma-ray burst, white-dwarf population, or a millisecond-pulsar population hosted by the cluster. Terzan 5 has plausibly been detected in the gamma-ray band by H.E.S.S., which produced constraining stacking upper limits on the integral gamma-ray flux of a population of other globular clusters. Using a leptonic model that invokes host millisecond pulsars in globular clusters as sources of relativistic particles, we demonstrate that uncertainty in model parameters leads to a large spread in the predicted high-energy flux, yet there are regions in parameter space for which the stringent H.E.S.S. stacking upper limits are satisfied. Two additional case studies on M15 and Omega Cen (from which five pulsars have recently been detected at radio frequencies) indicate that it is important to increase measurement accuracy on key model parameters in order to improve precision in predictions of cluster fluxes. This has important implications for the observational strategy of the Cherenkov Telescope Array.'

Collaborations

Keywords and Comments
'Globular clusters; pulsars; gamma rays', ''

Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Modelling Spatial and Temporal Emission Properties of the Young Pulsar Wind Nebula Kes 75

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 253

Presenter
Christo Venter
Author and Co-Author
Christo Venter, Carlo Van Rensburg

Abstract
'The H.E.S.S. Collaboration has firmly detected gamma-ray emission from HESS J1846-029, which is spatially coincident with Kes 75 (G29.7-0.3), one of the youngest composite supernova remnants in the Galaxy. This remnant contains the nebula of PSR J1846-0258, a glitching young pulsar with a particularly high spin-down luminosity that has manifested magnetar-like bursts in 2006. However, H.E.S.S. was not able to distinguish between shell and nebular emission. This source may also plausibly be associated with the HAWC-detected source 2HWC J1844-032. Recent *Chandra* observations revealed a rapid expansion of the embedded pulsar wind nebula over the past two decades and an X-ray flux decrease of 10% in 7 years. We apply a multi-zone spatio-temporal pulsar wind nebula model to the morphological and spectral data over several epochs, and find reasonable fits to the broadband radiation spectrum, X-ray surface brightness profile, expansion rate and photon spectral index in the X-ray energy range. Such spectral and morphological fitting constrains the model parameters, and may aid in clarifying the nature of the gamma-ray emission.'

Collaborations

Keywords and Comments
", "

Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

The Latin American Giant Observatory (LAGO) capabilities for detecting Gamma Ray Bursts

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 54 Gamma-Ray Bursts in the VHE regime | GAI
Presenter Forum Table

Presenter
Christian Sarmiento Cano
Author and Co-Author
Luis Otiniano | José Rodrigo Sacahuí Reyes | Christian Sarmiento Cano | Iván Sidelnik | Hernán Asorey | for the LAGO Collaboration,

Abstract
'The Latin American Giant Observatory (LAGO) consists of a network of small water Cherenkov detectors (WCD) located at different sites in Latin America. It is a large aperture observatory sensitive to high energy gamma rays and due to its high duty cycle, LAGO constitutes a facility to detect transient events from the ground. Gamma Ray Bursts (GRBs) are of the brightest transients detected, with typical energies in their prompt phase ranging from keV to MeV, but theoretical models predict emissions at higher energies in the early times of the afterglow emission, and recently GRB190114C was the first GRB detected at TeV energies by the MAGIC experiment. In this work, we present the results of the expected sensitivity of LAGO for possible events like GRB190114C. We performed simulations in three of the LAGO sites to assess the sensitivity of the Observatory for this kind of events, using the ARTI toolkit developed by LAGO. We simulate photon showers with different spectral slopes and energies from 200 GeV to 1TeV using the parameters presented by MAGIC for the recorded event.'

Collaborations
other (fill field below), LAGO

Keywords and Comments
'High energy gamma rays; GRBs; Detection methods', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Modeling Very-High-Energy Emission from Pulsars

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 50 Galactic Compact Objects: Pulsars, Binary Systems, Microquasars | GAD-GAI
Presenter Forum Table

Presenter
Alice Harding
Author and Co-Author
Alice Harding | Christo Venter | Constantinos Kalapotharakos,

Abstract
'Ground-based Air-Cherenkov telescopes have detected pulsations at energies above 50 GeV from a growing number of Fermi pulsars. These include the Crab, Vela, PSR B1706-44 and Geminga, with the first two having pulsed detections above 1 TeV. There appears to be VHE emission that is an extension of the Fermi spectra to high energies as well as additional higher-energy components that require a separate emission mechanism. We will present results of broad-band spectral modeling using global magnetosphere fields and multiple emission mechanisms that include synchro-curvature, synchrotron self-Compton (SSC) and inverse Compton (IC) radiation from both accelerated particles and lower-energy pairs. Our models predict two VHE components: SSC from pairs that can extend to several TeV and IC from particles accelerated in the current sheet, scattering pair synchrotron radiation, that appears beyond 10 TeV. Model spectra show a wide range of VHE flux, with detectable SSC and IC components expected for Crab-like pulsars and some millisecond pulsars but only a primary IC component for Vela. We argue that the IC component peaking above 10 TeV from Vela has been seen by H.E.S.S. Detection of this emission component from the Crab and other pulsars is possible with HAWC and CTA, and directly measures the maximum particle energy in pulsars.'

Collaborations

Keywords and Comments
'Pulsars; particle acceleration; VHE emission', ''

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

TeV Halos: A New Class of TeV Sources Powered by Pulsars

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 16 Cosmic Ray Antiparticles and Electrons | CRD-DM-GAD-MM
Presenter Forum Table

Presenter
Tim Linden
Author and Co-Author
Tim Linden,

Abstract
'Observations by the HAWC and HESS telescopes have found extended TeV emission consistent with a handful of young and middle-aged pulsars. In this talk, I will show that these detections have significant implications for our understanding of both pulsar emission and TeV astrophysics. First, the spectrum and intensity of these “TeV Halos” indicates that a large fraction of the pulsar spindown energy is efficiently converted into electron-positron pairs. This provides observational evidence necessitating pulsar interpretations of the rising positron fraction observed by PAMELA and AMS-02. Second, the isotropic nature of this emission provides a new avenue for detecting nearby pulsars with radio beams that are not oriented towards Earth. Third, these observations indicate that the total emission from unresolved pulsars produces the majority of the TeVgamma-ray flux observed from the Milky Way.'

Collaborations

Keywords and Comments
", "

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Branch GAI | Gamma Ray Indirect

Subcategory Theoretical Results

Ultra-high Energy Inverse Compton Emission from Galactic Electron Accelerators

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 254

Presenter
Mischa Breuhaus
Author and Co-Author
Mischa Breuhaus | Joachim Hahn | Carlo Romoli | Brian Reville | Gwenael Giacinti | Richard Tuffs | Jim Hinton,

Abstract
'With the High-Altitude Water Cherenkov Observatory (HAWC), the Large High Altitude Air Shower Observatory (LHAASO), and the future SWGO and CTA observatories, our view of the gamma-ray sky above 100 TeV energies will improve rapidly. It is generally held that emission at such high energies from astrophysical objects unambiguously demonstrates the presence of PeV protons or nuclei, due to the unavoidable Klein–Nishina suppression of inverse Compton (IC) emission from electrons. However, if the spectrum of accelerated electrons is hard enough in the Klein-Nishina regime, significant leptonic IC emission >100 TeV is possible. Such spectra occur as the result of equilibrium between particle injection and energy losses in IC cooling dominated environments. We show that the environmental requirements can naturally be met in spiral arms, and in particular in regions of enhanced star formation activity. These are also the natural locations for the most promising electron accelerators: powerful young pulsars. Regions with magnetic fields less than a few micro Gauss, for example associated to superbubbles, exhibit the required conditions irrespective of infrared or optical radiation fields due to the omnipresence of the cosmic microwave background. Our scenario suggests a population of hard ultra-high energy sources is likely to be revealed in future searches, and may also provide a natural explanation for the 100 TeV sources recently reported by HAWC.'

Collaborations

Keywords and Comments
'High energy astrophysics; Gamma-rays; Pulsars; Inverse Compton emission; Radiation dominated cooling; HAWC; Galactic', ''

Branch MM | Multi-Messenger

Subcategory Experimental Methods & Instrumentation

The AGILE real-time analysis pipelines in the multi-messenger era.

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Nicolò Parmiggiani
Author and Co-Author
Nicolò Parmiggiani | Andrea Bulgarelli | Alessandro Ursi | Valentina Fioretti | Leonardo Baroncelli | Antonio Addis | Ambra Di Piano | Simone Tampieri | Carlotta Pittori | Francesco Verrecchia | Fabrizio Lucarelli | Marco Tavani | Domenico Beneventano,

Abstract
"In the multi-messenger era, space and ground-based observatories usually develop real-time analysis (RTA) pipelines to rapidly detect transient events and share information with the scientific community as quickly as possible, allowing follow-up observations. These RTA pipelines can also react to science alerts shared by other observatories through networks such as the Gamma-Ray Coordinates Network (GCN). \r\n\r\nAGILE is a space mission launched in 2007 to study X-ray and gamma-ray phenomena. This work presents the technologies used to develop the AGILE RTA pipelines and an overview of the main scientific results. \r\n\r\nTwo types of AGILE RTA pipelines were developed using the RTApipe framework. The first type performs automated analyses on new AGILE data to detect transient events. Since May 2019, whenever the pipeline detects a transient event, it automatically sends an AGILE Notice to the GCN network. This RTA pipeline sent more than 40 Notices with a few minutes delay since the data arrival.\r\n\r\nThe second type of RTA pipeline reacts to multi-messenger external alerts (neutrinos, gravitational waves, GRBs, and other transients) received through the GCN network performing hundreds of analyses searching for counterparts in all AGILE instruments' data. \r\nThe AGILE Team uses these RTA pipelines to perform a fast follow-up of science alerts reported by others observatories and published several ATels and GCN Circulars. The main scientific results were also published in refereed journals.\r\n\r\nThe RTApipe framework will also be used to develop the Cherenkov Telescope Array and ASTRI Mini Array online analysis pipelines."

Collaborations
other (fill field below), AGILE

Keywords and Comments
'multi-messenger; real-time analysis pipeline; gamma-ray transients; gamma-ray bursts; real-time framework; neutrino; gravitational waves; online analysis;', ''

Branch MM | Multi-Messenger

Subcategory Experimental Methods & Instrumentation

Model independent search for transient multimessenger events with AMON using outlier detection methods

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Timothée Grégoire
Author and Co-Author
Timothée Grégoire,

Abstract
'The Astrophysical Multimessenger Observatory Network (AMON) receives subthreshold data from multiple observatories in order to look for coincidences. Combining more than two datasets at the same time is challenging because of the range of possible signals (time windows, energies, number of events…). However, outlier detection methods can circumvent this issue by identifying any signal divergent from the background (scrambled data).\r\nWe propose to use these methods to make a model independent combination of the subthreshold data of neutrino and gamma ray experiments. Using the python outlier detection (PyOD) package, it allows us to test several methods from a simple "k-nearest neighbours" algorithm to the most sophisticated GAAL (Generative Adversarial Active Learning) neural networks which generates data points to better identify them.'

Collaborations
other (fill field below), AMON

Keywords and Comments
'gamma rays; neutrinos; multi-messenger', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Methods & Instrumentation

Astro-COLIBRI: The coincidence library for real-time inquiry for multi-messenger astrophysics

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Fabian Schüssler
Author and Co-Author
Fabian Schüssler | Patrick Reichherzer | Atilla Alkan,

Abstract
"Flares of known astronomical sources and new transient phenomena occur on different timescales, from sub-seconds to several days or weeks. The discovery potential of both serendipitous observations and multi-messenger and multi-wavelength follow-up observations could be maximized with a tool which allows for quickly acquiring an overview over both persistent sources as well as transient events in the relevant phase space. We here present COincidence LIBrary for Real-time Inquiry (Astro-COLIBRI), a novel and comprehensive tool for this task.\r\n\r\nAstro-COLIBRI's architecture comprises a RESTful API, a real-time database, a cloud-based alert system and a website as well as apps for iOS and Android as clients for users. The structure of Astro-COLIBRI is optimized for performance and reliability and exploits concepts such as multi-index database queries, a global content delivery network (CDN), and direct data streams from the database to the clients to allow for a seemless user experience. Astro-COLIBRI evaluates incoming VOEvent messages of astronomical observations in real time, filters them by user specified criteria and puts them into their MWL and MM context. The clients provide a graphical representation with an easy to grasp summary of the relevant data to allow for fast identification of interesting phenomena and provides an assessment of observing conditions at a large selection of observatories around the world.\r\n\r\nIn this contribution, the key features of Astro-COLIBRI are presented. We'll outline the architecture, summarize the used data resources and provide examples for applications and use cases. Focussing on the high-energy domain, we'll for example illustrate the search for high-energy gamma-ray counterparts to high-energy neutrinos, gamma-ray bursts and gravitational waves."

Collaborations

Keywords and Comments
'software; multi-messenger; real-time; alerts; transients; GRB; neutrinos; gamma-rays; smartphone', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Methods & Instrumentation

The H.E.S.S. Gravitational Wave Rapid Follow-up Program during O2 and O3

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 27 GW Follow-Up Observation | MM
Presenter Forum Table

Presenter
Halim Ashkar
Author and Co-Author
Halim Ashkar, Francois Brun | Monica Seglar Arroyo | Matthias Fuessling | Clemens Hoischen | Fabian Schussler | Heike Prokoph | Patrick Reichherzer | Stefan Ohm

Abstract
'Since 2015, the direct detection of Gravitational Waves (GW) became possible with groundbased interferometers like LIGO and Virgo. GWs became the center of attention of the astronomical community and electromagnetic observatories took a particular interest in follow-up observations of such events. The main setback of these observations is the poor localization of GW events. In fact, GW localization uncertainties can span 10s to 100s of deg^{2} in the sky even with the advanced configurations of current GW interferometers. In this contribution, we present five follow-up algorithms developed for the High Energy Stereoscopic System (H.E.S.S.) and assess their performances. We show how a 2D and 3D galaxy targeted search approach exploiting the integral probability inside the instruments field of view are best suited for medium field of view instruments like H.E.S.S. We also develop an automatic response scheme within the H.E.S.S. Transient Follow-up system that is optimized for fast response and is capable of responding promptly to all kind of GW alerts. GW events are filtered by the developed scheme and prompt and afterglow observations are automatically scheduled. The H.E.S.S. response latency to prompt alerts is measured to be less than 1 minute. With this continually optimized GW response scheme, H.E.S.S. scheduled several GW follow-up observations during the second and third LIGO/Virgo observation runs.'

Collaborations

Keywords and Comments
'Gravitational Waves; Follow-up algorithm; H.E.S.S.', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Methods & Instrumentation

The Science Alert Generation system of the Cherenkov Telescope Array Observatory.

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Andrea Bulgarelli
Author and Co-Author
Andrea Bulgarelli | Thomas Vuillaume | Pierre Aubert | Leonardo Baroncelli | Sami Caroff | Giovanni De Cesare | Ambra Di Piano | Valentina Fioretti | Enrique Garcia | Gilles Maurin | Nicolò Parmiggiani | Igor Oya | Clemens Hoischen | for the CTA Consort,

Abstract
'The Cherenkov Telescope Array (CTA), with tens of telescopes located in both the northern and southern hemispheres, will be the largest ground-based gamma-ray observatory with an energy coverage from 20 GeV to 300 TeV. The large effective area and field-of-view, coupled with the fast slewing capability and unprecedented sensitivity, make CTA a crucial instrument for the future of ground-based gamma-ray astronomy. To maximise the scientific return, the array will send alerts on transients and variable phenomena (e.g. gamma-ray burst). Rapid and effective communication to the community requires a reliable and automated system to detect and issue candidate science alerts, accomplished by the Science Alert Generation (SAG) pipeline.\r\nSAG is part of the Array Control and Data Acquisition (ACADA) working group. The SAG working group develops the pipelines performing data reconstruction, data quality monitoring, science monitoring and real-time alert issuing during observations to the Transients Handling functionality of ACADA.\r\nSAG is the system that performs the first real-time scientific analysis after the data acquisition. The system performs analysis on multiple time scales (from seconds to hours). Alerts must be issued 20 seconds from the data taking and with sensitivity at least half of the CTA nominal sensitivity. These challenging requirements must be fulfilled managing trigger rates of tens of kHz from the arrays. Dedicated and highly optimised software and hardware architecture must thus be designed and tested. In this work, we present the general architecture of the ACADA-SAG system alongside a use case of the science alert management's general workflow.'

Collaborations
CTA,

Keywords and Comments
'gamma-ray astrophysics; transient; cherenkov telescope; real-time analysis', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Methods & Instrumentation

German-Russian Astroparticle Data Life Cycle Initiative to foster Big Data Infrastructure for Multi-Messenger Astronomy

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Victoria Tokareva
Author and Co-Author
Victoria Tokareva, For the GRADLCI Collaboration

Abstract
'Challenges faced by researchers in multi-messenger astroparticle physics include: computing-intensive search and preprocessing related to the diversity of content and formats of the data from different observatories as well as to data fragmentation over separate storage locations; inconsistencies in user interfaces for data retrieval; lack of the united infrastructure solutions suitable for both data gathering and online analysis, e.g. analyses employing deep neural networks. In order to address solution of these issues, the German-Russian Astroparticle Data Life Cycle Initiative (GRADLCI) project was created. In addition we support activities for communicating our research field to the public.\r\nThe approaches proposed by the project are based on the concept of data life cycle (DLC), which assumes a particular pipeline of data curation used for every unit of the data from the moment of its retrieval or creation through the stages of data preprocessing, analysis, publishing and archival. The movement towards unified data curation schemes is essential to increase the benefits gained in the analysis of geographically distributed or content-diverse data. \r\nWithin the project, the datasets and user capabilities available for the KASCADE Cosmic-ray Data Center (KCDC) were expanded. As well, an infrastructure for effective astroparticle data storage system and data curation as well as online analysis was developed. Using this infrastructure, first results on deep-learning based analysis were obtained. \r\nThe contribution will provide an overview of the accomplished activities and outline possible trends of future developments.'

Collaborations
other (fill field below), GRADLCI

Keywords and Comments
'data curation; big data; deep learning; multi-messenger astroparticle physics; KCDC', ''

Branch MM | Multi-Messenger

Subcategory Experimental Methods & Instrumentation

Gravitational Wave Follow-Up Using Low Energy Neutrinos in IceCube DeepCore

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 27 GW Follow-Up Observation | MM
Presenter Forum Table

Presenter
Aswathi Balagopal V.
Author and Co-Author
Aswathi Balagopal V. | Raamis Hussain | Alex Pizzuto | For the IceCube Collaboration,

Abstract
'The IceCube DeepCore is a dense infill array of the IceCube Neutrino Observatory at the South Pole. While IceCube is best suited for detecting neutrinos with energies of several 100 GeV and above, DeepCore allows to probe neutrinos with lower energies. We focus on a sample of neutrinos with energies above approximately 10 GeV, which was originally optimised for oscillation experiments. Recently, it has been adapted to enable searches for transient sources of astrophysical neutrinos in the sky. In particular, this low-energy dataset can be used to conduct follow-up searches of gravitational wave transients detected by the LIGO-Virgo instruments. A study of this, which complements IceCube's follow-up of gravitational wave events using high-energy neutrino samples, will be discussed here.'

Collaborations
IceCube,

Keywords and Comments
'neutrino astronomy; gravitational wave follow-up; low-energy neutrinos; IceCube Deepcore', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Methods & Instrumentation

Search for high-energy neutrino sources from the direction of IceCube alert events

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Martina Karl
Author and Co-Author
Martina Karl | Philipp Eller | Anna Schubert | Lolian Shtembari | For the IceCube Collaboration,

Abstract
"IceCube is a cubic-kilometer scale neutrino detector instrumenting a gigaton of ice at the geographic South Pole in Antarctica. On average, 8 track-like high-energy neutrino events with a high probability of being of astrophysical origin are detected per year. These events produce an extended signal in the detector that allows the events to be reconstructed with good angular precision, making them ideal for searching for neutrino sources. We present a search for the production sites of these cosmic neutrinos and hence also of the closely connected high-energy cosmic-rays. We use IceCube's high-statistics, neutrino-induced through-going muon samples to search for sources specifically in the vicinity of the arrival directions of the single most energetic events. In a time-integrated search for sources with a constant flux, we did not find a significant signal. In this contribution we explore a time-dependent analysis, and present new approaches and preliminary sensitivity studies in the search for transient neutrino sources."

Collaborations
IceCube,

Keywords and Comments
'IceCube; transient neutrino sources; neutrino flares; IceCube high energy events; IceCube alert events', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Methods & Instrumentation

Real-time Multi-Messenger Analysis Framework of KM3NeT

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Feifei Huang
Author and Co-Author
Massimiliano Lincetto | Emmanuel Le Guirriec | William Assal | Damien Dornic | Feifei Huang,

Abstract
"KM3NeT is a multi-purpose cubic-kilometer neutrino observatory in construction in the Mediterranean Sea. It consists of ORCA and ARCA (for Oscillation and Astroparticle Research with Cosmics in the Abyss, respectively), currently both with a few detection lines in operation. Although having different primary goals, both detectors can be used for neutrino astronomy over a wide energy range, from a few tens of MeVs to a few tens of PeV. In view of the growing field of time-domain astronomy, it is crucial to be able to identify neutrino candidates in real-time. This online neutrino sample will allow trigger neutrino alerts that will be sent to the astronomy community and to look for time/space coincidence around external electromagnetic and multi-messenger triggers. These real-time searches can significantly increase the discovery potential of transient cosmic accelerators and refine the pointing directions in the case of poorly localized triggers, such as gravitational waves. In the field of core-collapse supernovae (CCSN), the detection of the MeV-scale CCSN neutrinos is crucial as an early warning of the electromagnetic follow-up. KM3NeT’s digital optical modules act as good detectors for these supernovae neutrinos. This poster presents the status of KM3NeT's real-time multi-messenger activities, including online event reconstruction, event classification and selection, alert distribution, and supernova monitoring."

Collaborations
KM3NeT,

Keywords and Comments
'neutrino astronomy; multi-messenger astronomy; real-time analysis; KM3NeT', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Methods & Instrumentation

Invitation to the Comic Ray Extremely Distributed Observatory

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 293

Presenter
Piotr Homola
Author and Co-Author
Piotr Homola, for the CREDO Collaboration

Abstract
'Cosmic Ray Ensembles (CRE) are very large, yet not observed particle cascades initiated above the Earth atmosphere. Such cascades could be formed both within classical models (e.g. products of photon-photon interactions) and exotic scenarios (e.g. result of decay of Super Heavy Dark Matter particles and subsequent interactions). Some of CRE might have a significant spatial extent which could serve as a unique signature detectable with the existing cosmic ray infrastructure taken as a network of detectors. This signature would be composed of a number of air showers with parallel axes. An obvious, although yet not probed, CRE „detection horizon" can be located somewhere between an air shower induced by an CRE composed of tightly collimated particles (preshower effect), and undetectable CRE composed of particles spread so widely that only one of them have a chance to reach Earth. Probing the CRE horizon with a global approach to the cosmic ray data, as proposed by the newly formed Cosmic Ray Extremely Distributed Observatory (CREDO), defines an extensive scientific program oriented on the search for physics manifestations at largest energies known, with potential impact on ultra-high energy astrophysics, the physics of fundamental particle interactions and cosmology. In this talk the current status and perspectives of CREDO will be summarized, with an open invitation for the colleagues interested in a global approach to cosmic ray studies, and in particular in observing and investigating multi-primary cosmic ray events such as CRE.'

Collaborations
other (fill field below), Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'cosmic ray ensembles; large scale cosmic ray correlations; extensive air showers', ''

Branch MM | Multi-Messenger

Subcategory Experimental Results

H.E.S.S. follow-up of BBH merger events

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 27 GW Follow-Up Observation | MM
Presenter Forum Table

Presenter
Halim Ashkar
Author and Co-Author
Halim Ashkar, Heike Prokoph | for the H.E.S.S. collaboration | Francois Brun | Ruslan Konno | Fabian Schussler | Clemens Hoischen | Monica Seglar Arroyo | Stefan Ohm | Sylvia Jiechen Zhu

Abstract
'Binary black hole (BBH) mergers are not obviously expected to emit electromagnetic radiation. However, hints of a short gamma-ray burst (GRB), temporally coincident with the GW150914 BBH merger event, sparked much interest and controversy, and inspired new models to explain a potential relation between BBH mergers and GRBs. To put these models to the test BBH follow-up observations across the full electromagnetic spectrum remain therefore interesting. BBH follow-up also are helpful for defining and improving GW follow-up strategies and analysis procedures. We present here, follow-up observations of four BBH events performed with the High Energy Stereoscopic System (H.E.S.S.) in the very-high-energy (VHE) gamma-ray domain during the second and third LIGO/Virgo observation runs. Detailed analyses of the obtained data did not show significant VHE emission. We derive integral upper limit maps considering a generic E^{-2} source spectrum in the most sensitive H.E.S.S energy interval ranging from 1 to 10 TeV. We also consider EBL absorption effects and derive integral upper limits over the full accessible energy range. We finally derive upper limits oft he VHE luminosity foreach event and compare them with the expected VHE emission from GRBs.'

Collaborations
H.E.S.S.,

Keywords and Comments
'Gravitational Waves; VHE gamma-rays; H.E.S.S.; BBH', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Results

Follow-up observations of GW170817 with the MAGIC telescopes

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 27 GW Follow-Up Observation | MM
Presenter Forum Table

Presenter
Antonio Stamerra
Author and Co-Author
Antonio Stamerra | Stefano Covino | Davide Miceli | Chiara Righi | Susumu Inoue | Alessio Berti | Lucio Angelo Antonelli | Ansoldi Stefano | Valerio D'Elia | Barbara De Lotto | Francesco Longo | Barbara Patricelli | Fabrizio Tavecchio | for the MAGIC co,

Abstract
'The discovery of the electromagnetic counterpart AT2017gfo and the GRB 170817A, associated to the binary neutron star merger GW170817, was one of the major advances in the study of gamma-ray bursts (GRBs) and the hallmark of the multi-messenger astronomy with gravitational waves. Another breakthrough in GRB physics is represented by the discovery of the highly energetic, teraelectronvolt (TeV) component in the GRB 190114C, possibly a universal component in all GRBs. This conclusion is also suggested by the hint of TeV emission in the short GRB 160821B. The missing observational piece is the joint detection of TeV emission and gravitational waves from a short GRB and its progenitor. \r\nMAGIC observed the counterpart AT2017gfo as soon as the visibility conditions allowed it, namely from January to June 2018. These observations correspond to the maximum flux level observed in the radio and X-ray bands. The upper limits derived from TeV observations are valuable constraining the modelling of the late non-thermal emission using the multi-frequency SED.'

Collaborations
MAGIC,

Keywords and Comments
'Gravitational waves; gamma-ray sources; GRB; non-thermal emission', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Results

VERITAS follow-up observation of the blazar TXS 0506+056

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 294

Presenter
Weidong Jin
Author and Co-Author
Weidong Jin,

Abstract
'The gamma-ray blazar TXS 0506+056 was found with an enhanced gamma-ray emission state in spatial and temporal coincidence with the IceCube high energy neutrino event IC170922A. This is the most significant association by far between a high-energy neutrino event and a blazar in a flaring state. Studying the time evolution and spectral behavior of the blazar emission may help in identifying the sources of the diffuse neutrino flux observed by IceCube and the origin of energetic cosmic rays. TXS 0506+056 was detected by the VERITAS gamma-ray observatory with a significance of 5.8 standard deviations above 110 GeV in a 35 hour data set collected between September 23, 2017 and February 6, 2018. This talk will present results from recent VERITAS observations and an associated multiwavelength campaign, collected between October 10, 2018 to March 1, 2021. A relatively quiet very high energy gamma-ray emission state was observed during this time period, and flux upper limits are used to constrain the potential variability of this blazar.'

Collaborations
VERITAS,

Keywords and Comments
'TXS 0506+056; VERITAS; Multiwavelength campaign', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Results

Multi-messenger and real-time astrophysics with the Baikal-GVD telescope

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Olga Suvorova
Author and Co-Author
Olga Suvorova,

Abstract
'The Baikal-GVD deep underwater neutrino experiment participates in the international multi-messenger program on discovering the astrophysical sources of high energy fluxes of cosmic particles, while being at the stage of deployment with a gradual increase of its effective volume to the scale of a cubic kilometer. The effective volume of the detector has been reached 0.35 km3 for cascade events with energy above 100 TeV generated by neutrino interactions in Lake Baikal. The alarm system in real-time monitoring of the celestial sphere was launched at the beginning of 2021, that allows to form the alerts of two ranks like “muon neutrino” and “VHE cascade”. Recent results of fast follow-up searches for coincidences of Baikal-GVD high energy cascades with ANTARES/TAToO high energy neutrino alerts and IceCube GCN messages will be presented, as well as preliminary results of searches for high energy neutrinos in coincidence with the magnetar SGR 1935+2154 activity in period of radio and gamma burst in 2020.'

Collaborations
other (fill field below), Baikal-GVD

Keywords and Comments
'neutrino; high energy; alerts', 'on behalf of the Baikal-GVD Collaboration'

Branch MM | Multi-Messenger

Subcategory Experimental Results

Follow-up of GWTC-2 Gravitational Wave events with neutrinos from the Super-Kamiokande detector

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 27 GW Follow-Up Observation | MM
Presenter Forum Table

Presenter
Mathieu Lamoureux
Author and Co-Author
Mathieu Lamoureux | For the Super-Kamiokande collaboration,

Abstract
'Super-Kamiokande (SK) is a 50-kt water Cherenkov detector, instrumented with ~13k photomultipliers and running since 1996. It is sensitive to neutrinos with energies ranging from 4.5 MeV to several TeV. A new framework has been developed for the follow-up of gravitational wave (GW) alerts issued by the LIGO-Virgo collaboration (LVC). Neutrinos are searched for, using a 1000-second time window centred on the alert time and in both SK low-energy and high-energy samples.\r\n\r\nSuch observation can then be used to constrain the neutrino emission from the GW source. The significance of potential signals has been obtained by comparing neutrino direction with the localisation of the GW. The computation of limits on incoming neutrino flux and on the total energy emitted in neutrinos by the source has been performed for the different neutrino flavours.\r\n\r\nThe results using the LVC GWTC-2 catalogue (covering O3a period) will be presented, as well as the plans for the future real-time public release of follow-ups for the O4 period (in 2022) and beyond.'

Collaborations
other (fill field below), Super-Kamiokande

Keywords and Comments
'gravitational waves; binary merger; black hole; neutrino star; Cherenkov; coincidence', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Results

An Archival Search for Neutron-Star Mergers with Gravitational Waves and Very-High-Energy Gamma Rays

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 27 GW Follow-Up Observation | MM
Presenter Forum Table

Presenter
Colin Adams
Author and Co-Author
Colin Adams, for the VERITAS collaboration | Szabolcs Márka | Zsuzsanna Márka | Doğa Veske | Imre Bartos

Abstract
'The recent discovery of electromagnetic signals in coincidence with gravitational waves from neutron-star mergers has solidified the importance of multimessenger campaigns for studying the most energetic astrophysical events. Pioneering multimessenger observatories, such as the LIGO/Virgo gravitational wave detectors and the IceCube neutrino observatory, record many candidate signals that fall short of the detection significance threshold. These sub-threshold event candidates are promising targets for multimessenger studies, as the information provided by these candidates may, when combined with time-coincident gamma-ray observations, lead to significant detections. In this contribution, I describe our use of sub-threshold binary neutron star merger candidates identified in Advanced LIGO's first observing run to search for transient events in very-high-energy gamma rays using archival observations from the VERITAS imaging atmospheric Cherenkov telescope array. I describe the promise of this technique for future joint sub-threshold searches.'

Collaborations
VERITAS,

Keywords and Comments
'gamma rays; gravitational waves; multi-messenger; gamma-ray bursts: GRB 090510; sub-threshold;', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Results

Testing the AGN Radio and Neutrino correlation using the MOJAVE catalog and 10 years of IceCube Data

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Abhishek Desai
Author and Co-Author
Abhishek Desai, Justin Vandenbrouck | Alex Pizzuto | For the IceCube Collaboration

Abstract
'On 22 September 2017 IceCube reported a high-energy neutrino event which was found to be coincident with a flaring blazar, TXS 0506+056. This first multi-messenger observation hinted at blazars being sources of observed high-energy astrophysical neutrinos and raised a need for extensive correlation studies. Recent work shows that the internal absorption of gamma rays, and their interactions intrinsic to the source and with the extragalactic background, will cause a lack of energetic gamma-ray and neutrino correlation while hinting towards a correlation between neutrinos and lower photon energy observations in the X-ray and radio bands. Studies based on published IceCube alerts and radio observations, report a possible radio-neutrino correlation in both gamma-ray bright and gamma-ray dim active galactic nuclei (AGN). However, they have marginal statistical significance due to limited available data. We present a correlation analysis between 15 GHz radio observations of AGN reported in the MOJAVE XV catalog and 10 years of IceCube detector data and discuss the results derived from a time averaged stacking analysis.'

Collaborations
IceCube,

Keywords and Comments
'AGN; IceCube; Neutrino; Radio; MOJAVE; multi-messenger; TXS0506+056;', ''

Branch MM | Multi-Messenger

Subcategory Experimental Results

Multi-messenger searches via IceCube's high-energy neutrinos and gravitational-wave detections of LIGO/Virgo

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 27 GW Follow-Up Observation | MM
Presenter Forum Table

Presenter
Doğa Veske
Author and Co-Author
Doğa Veske, Raamis Hussain | Zsuzsanna Márka | Stefan Countryman | Alex Pizzuto | Yasmeen Asali | Ana Silva Oliveira | Imre Bartos | Justin Vandenbroucke | Szabolcs Márka | For the IceCube Collaboration

Abstract
'Detecting astrophysical events through multiple messengers improves our understanding of underlying sources. In addition to probing different physics, multi-messenger observations can provide improved localization in low latency, guiding astronomers who perform follow-up observations. We will present the real-time and offline searches for high-energy neutrinos associated with gravitational-wave events via IceCube's neutrinos and LIGO/Virgo's public announcements and detections.'

Collaborations
IceCube,

Keywords and Comments
'Gravitational-waves; high-energy neutrinos; multi-messenger astronomy', ''

Branch MM | Multi-Messenger

Subcategory Experimental Results

Search for nanosecond-fast optical transients with TAIGA-HiSCORE array.

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Alexander Panov
Author and Co-Author
Alexander Panov | For the TAIGA Collaboration,

Abstract
'The open air, wide-angle integrating Cerenkov array TAIGA-HiSCORE (FOV ~0.6 ster) is part of the TAIGA installation for high-energy gamma-ray astronomy and cosmic ray physics. Today this array includes nearly 100 optical detector stations distributed over an area of ~1 km^2 in Tunka Valley near lake Baikal, Siberia, Russia. Due to high accuracy and stability of time synchronization of the optical stations (~1 ns), the arrival direction of EAS from the primary particle can be reconstructed to a precision of 0.1°. This array is used to search for nanosecond astrophysical transients in the optical range. This report discusses the method of searching for astrophysical transients using the HiSCORE array and demonstrates its performance on the example of detecting laser pulses from an Earth-bound satellite mission. Search for optical transients in the HiSCORE data of 2018-2019 winter season has been carried out. One candidate for recurrent transient has been detected, but the estimated probability of random chance by fluctuation of background EAS is at least 10%. An upper bound on the event frequency of optical transients will be presented.'

Collaborations
TAIGA,

Keywords and Comments
'Cerenkov array; optical nanosecond transient', ''

Branch MM | Multi-Messenger

Subcategory Experimental Results

Realtime follow-up of astrophysical transients with the IceCube Neutrino Observatory

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Alex Pizzuto
Author and Co-Author
Alex Pizzuto | Justin Vandenbroucke | Raamis Hussain,

Abstract
'Realtime analyses are necessary to identify the source of high energy neutrinos. As an observatory with a 4π steradian field of view and near-100% duty cycle, the IceCube Neutrino Observatory is a unique facility for investigating transients. In 2016, IceCube established a pipeline that uses low-latency data to rapidly respond to astrophysical events that were of interest to the multi-messenger observational community. Here, we describe this pipeline and summarize the results from all of the analyses performed since 2016. We focus not only on those analyses which were performed in response to transients identified using other messengers such as photons, but also on how this pipeline can be used to constrain populations of astrophysical neutrino transients by following up high-energy neutrino alerts.'

Collaborations
IceCube,

Keywords and Comments
'Realtime; neutrino astronomy', ''

Branch MM | Multi-Messenger

Subcategory Experimental Results

HESS J1858+020: A GeV-TeV source possibly powered by CRs from SNR G35.6-0.4

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Yuliang Xin
Author and Co-Author
Yudong Cui | Yuliang Xin | Siming Liu | P.H.T. Tam | G. Pühlhofer | Hui Zhu,

Abstract
'The supernova remnant (SNR) G35.6−0.4 shows a non-thermal radio shell, however, no gamma-ray or X-ray counterparts have been found for it thus far. One TeV source, HESS J1858+020, was found near the SNR and this source is spatially associated with some clouds at 3.6 kpc. With the Fermi-LAT analysis, we found a hard GeV source (SrcX2) that is spatially coincident with both HESS J1858+020 and a molecular cloud complex at 3.6 kpc. In addition, a soft GeV source (SrcX1) was found at the northern edge of the SNR. The GeV spectrum of SrcX2 connects well with the TeV spectrum of HESS J1858+020. The entire gamma-ray spectrum ranges from several GeV up to tens of TeV and it follows a power-law with an index of ~2.15. We discuss several pieces of observational evidence to support the middle-aged SNR argument. Using runaway CRs from the SNR, our hadronic model explains the GeV-TeV emission at HESS J1858+020, with a diffusion coefficient that is much lower than the Galactic value.'

Collaborations

Keywords and Comments
", "

Branch MM | Multi-Messenger

Subcategory Experimental Results

Multi-Messenger observations of the Fermi-LAT blazar 4FGL J0658.6+0636 consistent with an IceCube high-energy neutrino

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 296

Presenter
Raniere de Menezes
Author and Co-Author
Raniere de Menezes | Sara Buson, Simone Garrappa | Marcos Santander | Uwe Bach | Yvonne Becherini | Elisa Bernardini | Alessio Berti | Mieke Bouwhuis | Matteo Cerruti | Florian Eppel | Marcello Giroletti | Andrea Gokus | Paul Hancock | Jonas Heßdörfer | Clancy James | Weidong Jin | Matth

Abstract
'The detection of cosmic neutrinos raised many new questions in astroparticle physics, the most important of which is the identification of the neutrino emitters. After more than a decade of IceCube operations, the most promising neutrino astrophysical association remains the very-high-energy (VHE, >100 GeV) blazar TXS 0506+056.\r\n\r\nRecently, on November 14, 2020 the IceCube observatory reported the detection of a well-reconstructed high-energy neutrino event, IceCube-201114A, with a high probability of being astrophysical. Within the 90% IC201114A localization region only one known gamma-ray (>100 MeV) source is found. This is 4FGL J0658.6+0636, associated with the active galaxy NVSS J065844+063711.\r\n\r\nIn this contribution, we will present results from the rich multi-messenger campaign triggered by the IceCube-201114A neutrino detection which has allowed us to collect simultaneous and quasi-simultaneous data for the gamma-ray source potentially associated with the neutrino. We find that NVSS J065844+063711 is a blazar and that its broadband properties resemble those of a high-synchrotron peaked object, making it a promising TeV emitter. Indeed, the detection of VHE photons (> 100 GeV) by the Fermi-LAT provides the first evidence of such emission from this object, making this blazar only the second VHE object found within the 90% confidence region of a well-reconstructed, high-energy IceCube event.'

Collaborations
Ferrmi-LAT, VERITAS, H.E.S.S., MAGIC, MWA, TELAMON

Keywords and Comments
'blazar; neutrino; IceCube; Fermi-LAT', 'On behalf of the Fermi-LAT, VERITAS, H.E.S.S., MAGIC, MWA, TELAMON collaborations'

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Branch MM | Multi-Messenger

Subcategory Experimental Results

Fermi-LAT realtime follow-ups of high-energy neutrino alerts

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Simone Garrappa
Author and Co-Author
Simone Garrappa, Sara Buson | Anna Franckowiak | Marcello Giroletti | Ioannis Liodakis | Cristina Nanci

Abstract
'The detection of the flaring gamma-ray blazar TXS 0506+056 in spatial and temporal coincidence with the high-energy neutrino IC-170922A represents a milestone for multi-messenger astronomy. The prompt multi-wavelength coverage from several ground- and space-based facilities of this special event was enabled thanks to the key role of the Fermi-Large Area Telescope (LAT), continuously monitoring the gamma-ray sky. Exceptional variable and transient events, such as bright gamma-ray flares of blazars, are regularly reported to the whole astronomical community to enable prompt multi-wavelength observations of the astrophysical sources. As soon as real-time IceCube high-energy neutrino event alerts are received, the relevant positions are searched, at multiple timescales, for gamma-ray activity from known sources and newly detected emitters positionally consistent with the neutrino localization.\r\nIn this contribution, we present an overview of follow-up activities and strategies for the real-time neutrino alerts with the Fermi-LAT, focusing on some interesting observed coincidences with gamma-ray sources. We will also discuss future plans and improvements in the strategies for the identification of gamma-ray counterparts of single high-energy neutrinos.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'gamma-rays; neutrinos; AGN; blazars;', 'on behalf of the Fermi-LAT Collaboration'

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Branch MM | Multi-Messenger

Subcategory Experimental Results

Gamma-ray burst observation & gravitational wave event follow-up with CALET on the International Space Station

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 27 GW Follow-Up Observation | MM
Presenter Forum Table

Presenter
Yuta Kawakubo
Author and Co-Author
Yuta Kawakubo | for the CALET Collaboration,

Abstract
'The CALorimetric Electron Telescope (CALET) has been observing high energy cosmic rays and gamma-rays on the International Space Station since October 2015. The Calorimeter (CAL), the primary instrument of the CALET, has been collecting high-energy gamma-ray data above 1 GeV. The CALET gamma-ray burst monitor (CGBM), utilizing bismuth germanate and lanthanum bromide scintillation detectors, is mounted on the CALET for gamma-ray burst (GRB) observation. CGBM has detected more than 230 GRBs in five years of observation since October 2015. In this work, we summarize the GRB observations with CGBM in the five years of the operation and the search for high energy gamma-rays from the CGBM GRBs with the CAL. Since CALET had been in operation during the LIGO/Virgo third observation run (O3 run), we also present the results of the CALET follow-up search for gravitational wave events in the O3 run associated with GRBs.'

Collaborations
CALET,

Keywords and Comments
'GRB; gravitational wave;', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Results

Multimessenger NuEM Alerts with AMON

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Hugo Ayala
Author and Co-Author
Hugo Ayala | for the AMON Team | for the HAWC Collaboration | for the IceCube Collaboration | for the ANTARES Collaboration,

Abstract
'The Astrophysical Multimessenger Observatory Network (AMON), has developed a real-time multi-messenger alert program. The system performs coincidence analyses of datasets from gamma-ray and neutrino detectors, making the Neutrino-Electromagnetic (NuEM) alert channel. For these analyses, AMON takes advantage of sub-threshold events, i.e., events that by themselves are not significant in the individual detectors. The main purpose of this channel is to search for gamma-ray counterparts of neutrino events. We will describe the different analyses that make-up this channel and present a selection of recent results.'

Collaborations
HAWC, IceCube, ANTARES, AMON

Keywords and Comments
'Multi-messenger; gamma rays; neutrinos', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Results

Starburst Galaxies as possible sources of UHECRs and neutrinos

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 26 Galactic Sources & Winds | MM
Presenter Forum Table

Presenter
Antonio Condorelli
Author and Co-Author
Antonio Condorelli | Denise Boncioli | Enrico Peretti | Sergio Petrera,

Abstract
'The coexistence of powerful accelerators of cosmic rays with intense background radiation fields creates unique conditions in astrophysical sources, where the Ultra-High-Energy-Cosmic-Rays (UHECRs) interactions could take place copiously and produce several secondary particles. \r\nIn particular, such phenomena could explain the features observed in the UHECR spectrum measurements. \r\nWe explore this scenario extending SimProp, a simulation code for UHECR extra-galactic propagation, allowing us to compute the interactions inside and outside the source. \r\nInspired by recent results on the anisotropy in the arrival directions of the highest energy cosmic-rays, we perform our simulations in the context of Starburst Galaxies, one of the most promising candidate sources. \r\nWe model the interactive and diffusive processes in the region surrounding the Starburst Nucleus, taking into account interactions with background photons and the interstellar medium. The escaping cosmic-ray flux is then propagated to the Earth and compared with the experimental spectrum and composition measured by the Pierre Auger Observatory.\r\nThe proposed method could be used to connect the features of the UHECR spectrum and composition at Earth to the parameters describing Starburst Galaxies. \r\nIn addition, neutrinos directly produced in these sources can be compared with the measured IceCube flux, thus providing an additional way to constrain some source parameters.'

Collaborations

Keywords and Comments
'"Starburst galaxies; Cosmic rays interaction; High energy neutrinos; Ultra High Energy Cosmic Rays; "', "

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Branch MM | Multi-Messenger

Subcategory Experimental Results

Searching for VHE gamma-ray emission associated with IceCube neutrino alerts using FACT, H.E.S.S., MAGIC, and VERITAS

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Konstancja Satalecka
Author and Co-Author
Konstancja Satalecka | Elisa Bernardini | Daniela Dorner | Fabian Schussler | Mohanraj Senniappan | Yvonne Becherini | Weidong Jin | Marcos Santander | for the IC, FACT, H.E.S.S, MAGIC and VERITAS Collaborations,

Abstract
'The real-time follow-up of high energy events from neutrino observatories is a promising approach to identify their astrophysical origin. So far, it has provided compelling evidence for a neutrino counterpart: the flaring gamma-ray blazar TXS 0506+056 observed in coincidence with the high-energy neutrino IC170922A detected by IceCube. The detection of very-high-energy (VHE, E > 100 GeV) gamma rays from this source supported the association and constrained the modeling of the blazar emission at the time of the IceCube event. The four imaging atmospheric Cherenkov telescope experiments (IACTs) - FACT, H.E.S.S., MAGIC, and VERITAS - operate an active follow-up program of target-of-opportunity observations of neutrino alerts sent by IceCube. This program has two main components: the follow-up of single high-energy neutrino candidate events of potential astrophysical origin, such as IC170922A, and the observation of known gamma-ray sources around which IceCube has identified a cluster of candidate neutrino events. IceCube recently upgraded this second gamma-ray follow-up (GFU) component in collaboration with the IACT groups. We present results from the IACT follow-up program of IceCube neutrino alerts and a description of the upgraded GFU system.'

Collaborations
IceCube, FACT, H.E.S.S., MAGIC, VERITAS

Keywords and Comments
", "

Branch MM | Multi-Messenger

Subcategory Experimental Results

X-ray emission study of extreme Blazars using AstroSat data

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 297

Presenter
Pranjupriya Goswami
Author and Co-Author
Pranjupriya Goswami | Ranjeev Misra | Atreyee Sinha | Rupjyoti Gogoi,

Abstract
'The X-ray spectral curvature in high energy peaked BL Lac (HBL) sources has been interpreted in terms of either shock acceleration, where accelerated electrons attain maximum energy (Lorentz factor, $\\gamma_{max}$) (Kirk et al.1998,A$\\&$A,333,452) and consequently emit synchrotron radiation, or due to energy-dependent electron diffusion from the acceleration regions (Goswami et al.2018,MNRAS,480, 2046). However, the X-ray emission features in the extreme class of blazars (EHBLs) are difficult to interpret due to insufficient data at these energies. The high cadence blazar monitoring programme of the *AstroSat*, covering UV to X-ray energy range, has given us unprecedented simultaneous data from the SXT (0.3-10 keV) and the LAXPC (3-80 keV) instruments. This wideband data can be used to constrain a wide range of blazar emission mechanisms.\r\n\r\nIn this contribution, we present a detailed spectral and timing study of EHBLs, RGBJ0710+591, 1ES1741+196 and HBL 1ES2322-409 using data from *AstroSat* and simultaneous multi-frequency observations. The *AstroSat* observations of RGBJ0710+591, 1ES1741+196 and 1ES2322-409 were made during 2016, 2019 and 2020 respectively (each with 40ks exposure). The results highlight their X-ray spectral curvature features and the observed considerable shifts in their synchrotron spectral peak energies between different flux states. For RGBJ0710+591, the SXT/LAXPC spectrum shows unusually strong curvature than earlier quasi-simultaneous analysis of *Swift-XRT/NuSTAR* data. We show such a strong curvature can be an outcome of a change in maximum electron energy of the accelerated electrons (Goswami et al. 2020,MNRAS,492,796). We further quantify the X-ray variability of these sources and observe significant variability at longer scales, shown by combined *Swift-XRT* and AstroSat data.'

Collaborations

Keywords and Comments
'AGNs; BL Lacs; Particle acceleration', ''

Branch MM | Multi-Messenger

Subcategory Experimental Results

Search for correlations between high-energy gamma rays and neutrinos with the HAWC and ANTARES detectors

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 26 Galactic Sources & Winds | MM
Presenter Forum Table

Presenter
Giovanna Ferrara
Author and Co-Author
Giovanna Ferrara | for the ANTARES Collaboration | for the HAWC Collaboration, Luigi Antonio Fusco

Abstract
'ANTARES is an underwater neutrino detector in the Mediterranean Sea. Its location, reconstruction accuracy for all-flavor neutrino interactions, and low energy threshold, make it the most sensitive neutrino observatory for searches below 100 TeV over large parts of the sky. The HAWC experiment is a water Cherenkov gamma-ray detector located in Mexico. Thanks to its large field of view it is an excellent instrument to observe the very-high energy gamma-ray sky and perform high-sensitivity surveys of the Galactic Plane.\r\nThe 10-year ANTARES data set and 3-year HAWC point source surveys are used to search for all- flavor neutrino emission in correlation with the highly-significant observations by HAWC in the gamma-ray sky by means of a maximum-likelihood template search. No significant observation for a correlation has been identified and upper limits on the neutrino flux from the HAWC observations have been set.'

Collaborations
Antares, HAWC

Keywords and Comments
'', 'on behalf of the ANTARES and HAWC Collaborations'

Branch MM | Multi-Messenger

Subcategory Experimental Results

NuSTAR broad-band X-ray observation campaign of energetic pulsar wind nebulae in synergy with VERITAS, HAWC and Fermi gamma-ray telescopes

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 26 Galactic Sources & Winds | MM
Presenter Forum Table

Presenter
Kaya Mori
Author and Co-Author
Kaya Mori | Hongjun An | Brenda Dingus | Charles Hailey | Brian Humensky | Kelly Malone | Reshmi Mukherjee | Stephen Reynolds | Samar Safi-Harb,

Abstract
'We will report recent progress on the on-going NuSTAR observation campaign of 8 TeV-detected pulsar wind nebulae (PWNe). This campaign (to be completed by June 2021) constitutes a major part of our NuSTAR study of some of the most energetic TeV sources in our galaxy detected by VERITAS and HAWC. NuSTAR is the only focusing X-ray telescope operating above 10 keV in space with sub-arcminute angular resolution. Broad-band X-ray morphology and spectroscopy data, obtained by NuSTAR, allow us to probe sub-PeV electron populations through detecting synchrotron X-ray radiation. Our targets include PeVatron candidates detected by HAWC, the Boomerang nebula, PWNe crushed by supernova remnant shocks (or else relic PWNe) and G0.9+0.1 in the Galactic Center. Combined with our Fermi-LAT data analysis and available TeV data, we aim to provide a complete, multi-wavelength view of a diverse class of middle-aged (~10-100 kyrs old) PWNe. Our NuSTAR analysis detected hard X-ray emission from the Eel and Boomerang PWNe and characterized their broad-band X-ray spectra most accurately. We plan to apply both time-evolution and multi-zone PWNe models to multi-wavelength spectral energy distribution (SED) data over the radio, X-ray, GeV and TeV bands. In this presentation, we will review our observation campaign and discuss the results for several PWNe in more detail.'

Collaborations

Keywords and Comments
'pulsar wind nebulae; multi-wavelength observations; NuSTAR X-ray telescope; VERITAS; HAWC; Fermi; PeVatron', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Results

Constraining the contribution to Gamma-Ray Bursts to the high-energy diffuse neutrino flux with 10 years of ANTARES data

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Angela Zegarelli
Author and Co-Author
Angela Zegarelli, Silvia Celli

Abstract
'Addressing the origin of the observed diffuse astrophysical neutrino flux is one of the main challenges in the context of the neutrino astronomy nowadays. Among several astrophysical sources, Gamma-Ray Bursts (GRBs) are considered interesting candidates to be explored. Indeed, being the most powerful explosions observable in the Universe, they are potentially able to achieve the energetics required to reproduce the neutrino flux and, thus, they are expected to give at least some contribution to the astrophysical neutrino flux. Within the framework of the fireball model, mesons can be produced during photo-hadronic interactions occurring in the internal shocks between shells emitted by the central engine; from their decays, high-energy gamma rays and neutrinos are expected to be generated. Within this context, the results of a stacked search for muon astrophysical neutrinos performed in coincidence with 784 GRBs in the period 2007-2017 using ANTARES data are presented. The neutrino flux expectation from each GRB detectable in ANTARES was calculated in the framework of the classical internal shock model. Given the absence of coincident neutrinos, the contribution of the detected GRB population to the neutrino diffuse flux is constrained to be less than 10% around 100 TeV. In addition, the systematic uncertainties are computed on the diffuse flux, propagating the uncertainties on the not well characterized GRB parameters of each individual burst to the stacked limit.'

Collaborations
Antares,

Keywords and Comments
'GRB; astrophysical neutrinos; neutrino detection; neutrino telescopes; ANTARES; multi-messenger astrophysics; astroparticle physics', ''

Branch MM | Multi-Messenger

Subcategory Experimental Results

Magnetic field structure in halos of star-forming disk galaxies

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 01 Magnetic Fields and CR Propagation | CRI
Presenter Forum Table

Presenter
Ralf-Jürgen Dettmar
Author and Co-Author
Ralf-Jürgen Dettmar, Volker Heesen | Judith Irwin | Yelena Stein

Abstract
'The CHANG-ES (Continuum HAlos in Nearby Galaxies - an EVLA Survey) project has observed a sample of 35 edge-on spiral galaxies with the JVLA in C- and L-band. The observations in all Stokes parameters provide polarization information and for 16 galaxies with extended emission it is possible to describe the large scale magnetic field structure in their halos. We exemplify a few of these objects and demonstrate the properties of the mean large-scale magnetic field structure as a result from a stacking experiment. We briefly compare the results with the Milky Way and discuss implications for the transport of cosmic ray electrons.'

Collaborations
other (fill field below), CHANG-ES

Keywords and Comments
'radiocontinuum polarization; magnetic fields; disk galaxy; CRE transport', ''

Branch MM | Multi-Messenger

Subcategory Experimental Results

Radio astronomy locates the neutrino origin in bright blazars

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Alexander Plavin
Author and Co-Author
Alexander Plavin | Yuri Kovalev | Yuri Kovalev | Sergey Troitsky,

Abstract
'High-energy astrophysical neutrinos have been observed by multiple telescopes in the last decade, but their sources still remained unknown. We address the problem of locating astrophysical neutrinos' sources in a statistical manner. We show that blazars positionally associated with IceCube neutrino detections have stronger parsec-scale radio cores than the rest of the sample. The probability of a chance coincidence is only 4×10^-5 corresponding to a significance of 4.1σ. We explicitly list five strong radio blazars as highly probable sources of neutrinos above 200 TeV: 3C 279, NRAO 530, TXS 1308+326, PKS 1741-038, and PKS 2145+067. Turns out that there are at least 70 more radio-bright blazars that emit neutrinos of lower energies starting from TeVs. Moreover, we utilize continuous RATAN-600 monitoring of VLBI-selected blazars to find that radio flares at frequencies above 10 GHz coincide with neutrino arrival dates. The most pronounced example of such behavior is PKS 1502+106 that experienced a major flare in 2019. We conclude that the entire IceCube astrophysical neutrino flux derived from muon-track analyses may be explained by blazars, that is AGNs with bright Doppler-boosted jets. High-energy neutrinos can be produced in photohadronic interactions within parsec-scale relativistic jets. Radio-bright blazars associated with neutrino detections have very diverse gamma-ray properties, which suggests that gamma-rays and neutrinos may be produced in different regions of blazars and not directly related. A narrow jet viewing angle is, however, required to detect either of them.'

Collaborations

Keywords and Comments
'AGN; blazar; neutrinos; relativistic jets; radio emission; VLBI', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Results

Combined Search for UHE Neutrinos from Binary Black Hole Mergers with the Pierre Auger Observatory

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 27 GW Follow-Up Observation | MM
Presenter Forum Table

Presenter
Michael Schimp
Author and Co-Author
Michael Schimp,

Abstract
'We present searches for ultra-high energy (UHE) neutrinos (> 0.1 EeV) with the Pierre Auger Observatory, following up binary black hole (BBH) mergers detected by the LIGO and Virgo detectors via gravitational waves. In this work, the so-far published BBH mergers are combined as variable standard candles with a hypothetical isotropic UHE neutrino luminosity $L(t-t_0)$ as a function of the time after the respective merger, $t-t_0$. The UHE neutrino emission spectrum is assumed to follow a power law distribution $\\propto{}E^{-2}$. Using these assumptions, $L(t-t_0)$ is probed, taking into account the instantaneous effective area of the Pierre Auger Observatory to UHE neutrinos and the 3D sky localizations of the sources. No UHE neutrino candidates have been found and upper limits on $L(t-t_0)$ are obtained for the hypothetical cases of emissions lasting 24 hours and 60 days after the merger, respectively. The corresponding upper limit on the total energy per source emitted in UHE neutrinos does not depend on the emission duration and demonstrates the competitiveness of the Pierre Auger Observatory with dedicated neutrino telescopes.'

Collaborations
Auger,

Keywords and Comments
'ultra-high energy neutrinos; neutrino astronomy; multi-messenger; gravitational waves; binary black hole mergers; follow-up search', ''

Branch MM | Multi-Messenger

Subcategory Experimental Results

The Neutrino Contribution of Gamma-Ray Flares from Fermi Bright Blazars

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Kenji Yoshida
Author and Co-Author
Kenji Yoshida | Maria Petropoulou Petropoulou | Kohta Murase | Foteini Oikonomou,

Abstract
'High-energy neutrinos are expected to be produced during gamma-ray flares of blazars through\xa0the interaction of high-energy cosmic rays in the jet with photons. As a matter of fact, a\xa0high-energy neutrino event, IC-170922A, was detected at the time of a gamma-ray flare from blazar TXS\xa00506+056 at the level of 3 sigma significance. In this work, we present a statistical study of blazar gamma-ray\xa0 flares aiming to constrain their contribution to the blazar neutrino output. We selected 145 gamma-ray bright blazars listed in the Fermi Large Area Telescope (LAT) monitored list and constructed their weekly binned light curves. Using a Bayesian Blocks algorithm to the light curves, we determined the fraction of time spent in the flaring state (flare duty cycle) and the fraction of energy\xa0released during each flare. Furthermore, we estimated the neutrino energy flux of each gamma-ray flare by using the general scaling relation $L_\\nu \\propto (L_\\gamma)^\\gamma$, $\\gamma=1.5-2$, normalized to the quiescent X-ray flux of each blazar. Comparison of the estimated neutrino energy flux with the declination-dependent IceCube\xa0sensitivity enables us to constrain the standard neutrino emission models of gamma-ray flares. We also provide the upper-limit contribution of flares of gamma-ray bright blazars to the isotropic diffuse neutrino flux.'

Collaborations

Keywords and Comments
'AGN; Blazar gamma-ray flares; Isotropic neutrino background', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Results

Galactic Bulge VHE tau-neutrino and gamma-ray Monitor with Ashra-1 and NTA detectors

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 298

Presenter
Satoru Ogawa
Author and Co-Author
Satoru Ogawa | Makoto Sasaki | for the ashra NTA collaboration,

Abstract
'The Ashra-1 detector has been developed to efficiently take fine images of air-shower (AS) Cherenkov (CE) and fluorescence (FL) light induced by the Earth-skimming $\\nu_{\\tau}$ and $\\gamma$-ray ASs. Based on Ashra-1, we have planned a new extension, i.e. Neutrino Telescope Array (NTA), an AS imaging $\\nu$ and $\\gamma$-ray observation system for "Clear Discovery and Identification of Non-thermal Hadronic Processes in the Universe.", consisting of four NTA stations deployed at 3000-3500~m a.s.l. on Mauna Loa. NTA can watch the air volume surrounding Mauna Loa including the surface of Mauna Loa, the largest volcano, Hawaii Island and sea around it to efficiently detect CE and FL light from $\\nu_{\\tau}$ ASs with both short and long decay lengths and $\\gamma$-ray ASs. The NTA $\\nu_{\\tau}$ sensitivity is sufficient to probe Pevatrons, an extension of the IceCube detected astrophysical neutrino flux and predictions of the cosmogenic neutrino flux.The point-back accuracy is evaluated to be within 0.2$^{\\circ}$ with respect to the original direction of the PeV-scale ES $\\nu_{\\tau}$\'s. As the first step observation with the minimal systematic deployment, we propose to monitor 10 TeV-10PeV $\\gamma$-rays from the Galactic bulge with Ashra-1 as well as Earth-skimming $\\nu_{\\tau}$\'s with NTA simultaneously to clearly identify the Pevatrons and comprehensively understand the emission process there. The effective detection area of Ashra-1 and NTA for the Galactic bulge $\\gamma$-rays with the energies around 1~PeV is more than 10 and 100 times respectively larger than that of a ground array with 500m scale.'

Collaborations
other (fill field below), Ashra NTA

Keywords and Comments
'VHE neutrino; tau neutrino; gamma-ray; galactic bulge; origin of cosmic ray; heavy dark matter', ''

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Branch MM | Multi-Messenger

Subcategory Experimental Results

A model-independent analysis of neutrino flares detected in IceCube from X-ray selected blazars

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 299

Presenter
Ankur Sharma
Author and Co-Author
Ankur Sharma | Erin O'Sullivan,

Abstract
'Blazars are among the most powerful steady sources in the Universe. Multi-messenger searches for blazars have traditionally focused on their gamma-ray emission, which can be produced simultaneously with neutrinos in photohadronic interactions. However, X-ray data can be equally vital to constrain the SED of these sources, since the hadronically co-produced gamma-rays could get absorbed by the ambient photon fields and cascade down to X-ray energies before escaping. In this work, we present an untriggered, time-dependent analysis of neutrino flares from the direction of X-ray selected blazars using 10 years of IceCube data. A binomial test is performed on the population to reveal if a subcategory of sources has statistically significant emission. The sources are selected from RomaBZCat, and the p-values and best-fit flare parameters are obtained for each source using the method of unbinned likelihood maximisation.'

Collaborations
IceCube,

Keywords and Comments
'AGN; Blazars; IceCube; X-rays from blazars; Neutrino flares; multi-messenger', ''

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Subcategory Experimental Results

ANTARES search for neutrino flares from the direction of radio-bright blazars

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 300

Presenter
Giulia Illuminati
Author and Co-Author
Giulia Illuminati | for the ANTARES Collaboration,

Abstract
'In 2017, a high-energy muon neutrino detected by IceCube was found positionally coincident with the direction of a known blazar, TXS 0506+056, in a state of enhanced $\\gamma$-ray emission. Soon after, IceCube reported a compelling evidence for an earlier neutrino flare from the same direction found in the archival data, this time not accompanied by any observed electromagnetic activity. \r\nThe IceCube findings suggest searching for flaring neutrino emissions from astrophysical sources, not necessarily accompanied by flares detected in $\\gamma$-rays. The analysis presented in this contribution scans the events collected by the ANTARES neutrino telescope in 13 years of data taking in a search for clustering in space and time. The analysis method is based on an unbinned maximum likelihood approach. A generic Gaussian profile is assumed for the signal time emission, with both the Gaussian mean (time of the peak of the flare) and sigma (duration of the flare) being free parameters in the likelihood maximization. The time-dependent approach is applied to the catalog of radio-bright blazars for which a promising directional correlation with IceCube muon tracks was recently reported [ApJ 894 (2020) 101, ApJ 908 (2021) 157].'

Collaborations
Antares,

Keywords and Comments
'ANTARES; neutrino; blazars', ''

Branch MM | Multi-Messenger

Subcategory Experimental Results

Follow-up Search for UHE Photons from Gravitational Wave Sources with the Pierre Auger Observatory

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 27 GW Follow-Up Observation | MM
Presenter Forum Table

Presenter
Philip Ruehl
Author and Co-Author
Philip Ruehl | for the Pierre Auger Collaboration,

Abstract
'The field of multimessenger astronomy has become increasingly important during the past decade. Some astronomical objects have already been successfully observed in the light of multiple messenger signals, allowing for a much deeper understanding of their physical properties. The Pierre Auger Observatory has taken part in multimessenger astronomy with an exhaustive exploration of the ultra-high-energy (UHE) sky.\r\nIn this contribution, for the first time, a search for UHE photons from the sources of gravitational waves (GWs) is presented. This study complements the dedicated search for UHE neutrinos, which has already been established at the Pierre Auger Observatory. While the Observatory has a much larger exposure to primary photons than to neutrinos, interactions with the cosmic background radiation fields are expected to attenuate any possible flux of UHE photons from distant sources. In addition, a non-negligible background of air shower events with hadronic origin makes an unambiguous identification of primary photons a challenging task.\r\nIn the analysis presented here, a sophisticated selection strategy is applied to both GW sources and air shower events aiming to provide maximum sensitivity to a possible photon signal. At the same time, a window is kept open for hypothetical processes of new physics, which might allow for much larger interaction lengths of photons in the extragalactic medium. Preliminary results on the UHE photon fluence from a selection of GW sources, including the binary neutron star merger GW170817 are presented.'

Collaborations
Auger,

Keywords and Comments
'UHE photons; multimessenger; gravitational waves; Pierre Auger Observatory', ''

Branch MM | Multi-Messenger

Subcategory Experimental Results

TELAMON: Monitoring of AGN with the Effelsberg 100-m Telescope in the Context of Astroparticle Physics

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Matthias Kadler
Author and Co-Author
Matthias Kadler, Uwe Bach | Daniela Dorner | Phil Edwards | Florian Eppel | Marcello Giroletti | Andrea Gokus | Jonas Heßdörfer | Shoko Koyama | Alex Kraus | Thomas Krichbaum | Elina Lindfors | Karl Mannheim | Roopesh Ojha | Georgios Filippos Paraschos | Florian Rösch | E

Abstract
'We introduce the TELAMON program, which is using the Effelsberg 100-m telescope to monitor the radio spectra of active galactic nuclei (AGN) under scrutiny in astroparticle physics, namely TeV blazars and neutrino-associated AGN. Thanks to its large dish aperture and sensitive instrumentation, the Effelsberg telescope can yield superior radio data over other programs in the low flux-density regime down to several 10mJy. This is a particular strength in the case of TeV-emitting blazars, which are often comparatively faint radio sources of the high-synchrotron peaked type. We perform high-cadence high-frequency observations every 2-4 weeks at multiple frequencies up to 44GHz. This setup is well suited to trace dynamical processes in the compact parsec-scale jets of blazars related to high-energy flares or neutrino detections. Our sample currently covers about 40 sources and puts its focus on the high-peaked BL Lac objects and extreme blazars most frequently observed by TeV telescopes. Here, we introduce the TELAMON program characteristics and present first results obtained since fall 2020.'

Collaborations
other (fill field below), TELAMON

Keywords and Comments
'AGN; Blazars; AGN monitoring; Radio flux density measurements', ''

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Branch MM | Multi-Messenger

Subcategory Future projects

Sensitivity of the Cherenkov Telescope Array to emission from the gamma-ray counterparts of neutrino events

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Olga Sergijenko
Author and Co-Author
Olga Sergijenko | Anthony Brown | Alberto Rosales de Leon | Konstancja Satalecka | for the CTA Consortium | Chun Fai Tung | René Reimann | Theo Glauch | Ignacio Taboada | for the FIRESONG Team,

Abstract
'Astrophysical sources capable of hadronic acceleration to relativistic energies have long been believed to be sources of high-energy astrophysical neutrinos. The lack of significant indication of point sources in the long-exposure neutrino sky map may point to a large population of faint, steady sources or flaring objects as the origin of the diffuse flux. The spatially and temporaly correlated observations of the flaring gamma-ray blazar TXS 0506+056 and a high-energy neutrino detected by IceCube are the most compelling evidence for a high-energy neutrino point source so far.\r\n\tWe investigate the detection probability for the VHE gamma-ray counterparts to neutrino sources from the populations simulated by the FIRESONG software to resemble the diffuse astrophysical neutrino flux measured by IceCube. For different zenith angles and geomagnetic field configurations we scan over parameters describing the populations – luminosity and density (density rate) for steady (flaring) objects. For steady sources following both flat and star formation rate redshift evolution the populations with $\\rho\\geq10^{-7}Mpc^{-3}$ and $L<10^{53}erg/yr$ are detected for 30 minutes of observation for the baseline CTA layout. The difference in detectability of sources between CTA-N and CTA-S for the average magnetic field is not large. We investigate the effect of higher night sky background and the reduced CTA Phase-I layout on the detection probability. For the blazar flares resembling the neutrino flare of TXS 0506+056 in 2014-2015, CTA will detect more than 40% of the sources in 30 minutes of observation. We propose the optimal strategy for the follow-up observations of neutrino alerts from IceCube.'

Collaborations
CTA,

Keywords and Comments
'neutrino alerts; gamma-ray counterparts; follow-up observations', ''

Branch MM | Multi-Messenger

Subcategory Future projects

The Roadmap to the POEMMA Mission

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 15 Future instrumentation | CRD-MM
Presenter Forum Table

Presenter
Angela V. Olinto
Author and Co-Author
Angela V. Olinto | John F. Krizmanic | for the POEMMA Collaboration,

Abstract
'The Probe Of Extreme Multi-Messenger Astrophysics (POEMMA) is designed to observe ultrahigh-energy cosmic rays (UHECRs) and cosmic neutrinos from space with sensitivity over the full celestial sky. Developed as a NASA Astrophysics Probe-class mission, POEMMA consists of two identical telescopes orbiting the Earth in a loose formation that observe extensive air showers (EAS) via air fluorescence and Cherenkov emissions. UHECRs and UHE neutrinos above 20 EeV are observed with the stereo fluorescence technique, while tau neutrinos above 20 PeV are observed via the optical Cherenkov signals produced by up-going EAS produced by the decay of Earth-emerging tau-leptons. The POEMMA satellites are designed to quickly re-orientate to follow up transient cosmic neutrino sources and obtain unparalleled neutrino flux sensitivity. \r\nBoth observation techniques and the instrument design are being validated by current and upcoming missions, such as Mini-EUSO and EUSO-SPB as part of the JEM-EUSO program, and Terzina SmallSat mission. We will discuss the POEMMA science performance and the current roadmap to the POEMMA mission.'

Collaborations
, POEMMA

Keywords and Comments
'ultrahigh energy cosmic rays; high energy neutrinos; space mission;', ''

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Branch MM | Multi-Messenger

Subcategory Future projects

Astrophysical Implications of Neutrino Target-of-Opportunity Observations with Space-based and Suborbital Optical Cherenkov Detectors

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 301

Presenter
Tonia Venters
Author and Co-Author
Tonia Venters | Mary Hall Reno | John Krizmanic | For the EUSO-SPB2 and POEMMA Collaborations,

Abstract
'Cosmic-ray accelerators capable of reaching ultra-high energies are expected to also produce very-high energy neutrinos via hadronic interactions within the source or its surrounding environment. Many of the candidate astrophysical source classes are either transient in nature or exhibit flaring activity. Leveraging the Earth as a neutrino converter, suborbital and space-based optical Cherenkov detectors will be able to detect upward-moving extensive air showers induced by decay tau-leptons generated from cosmic tau neutrinos (with energies ~ 10 PeV and above), reaching sensitivities at the level of modeled neutrino fluences for several classes of astrophysical transients. We discuss the astrophysical implications of neutrino Target-of-Opportunity observations with the super-pressure balloon mission EUSO-SPB2 and the proposed satellite-based mission POEMMA.'

Collaborations
other (fill field below), EUSO-SPB2; POEMMA

Keywords and Comments
'Astrophysical transients; Neutrino detection; Multimessenger; Space-based experiments; Suborbital Experiments', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Methods

CRPropa 3.2: a framework for high-energy astroparticle propagation

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 01 Magnetic Fields and CR Propagation | CRI
Presenter Forum Table

Presenter
Rafael Alves Batista
Author and Co-Author
Rafael Alves Batista | Julia Becker Tjus | Julien Dörner | Andrej Dundovic | Björn Eichmann | Antonius Frie | Christopher Heiter | Mario Hörbe | Karl-Heinz Kampert | Lukas Merten | Gero Müller | Patrick Reichherzer | Andrey Saveliev | Leander Schlegel | G,

Abstract
'The landscape of high- and ultra-high-energy astrophysics has changed in the last decade, in large part owing to the inflow of data collected by cosmic-ray, gamma-ray, and neutrino observatories. At the dawn of the multimessenger era, the interpretation of these observations within a consistent framework is important to elucidate the open questions in this field. CRPropa 3.2 is a Monte Carlo code for simulating the propagation of high-energy particles in the Universe. This new version represents a step further towards a more complete simulation framework for multimessenger studies. Some of the new developments include: cosmic-ray acceleration, support for particle interactions within astrophysical sources, full Monte Carlo treatment of electromagnetic cascades, improved ensemble-averaged Galactic propagation, and a number of technical enhancements. Here we present some of these novel features and some applications to gamma- and cosmic-ray propagation.'

Collaborations

Keywords and Comments
", "

Branch MM | Multi-Messenger

Subcategory Theoretical Methods

The Blazar Hadronic Code Comparison Project

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 302

Presenter
Matteo Cerruti
Author and Co-Author
Matteo Cerruti | Michael Kreter | Maria Petropoulou | Annika Rudolph | Foteini Oikonomou | Markus Böttcher | Stavros Dimitrakoudis | Anton Dmytriiev | Shan Gao | Susumu Inoue | Apostolos Mastichiadis | Kohta Murase | Anita Reimer | Joshua Robinson | Xavi,

Abstract
'Blazar hadronic models have been developed in the past decades as an alternative to leptonic ones. In hadronic models the gamma-ray emission is associated with synchrotron emission by protons, and/or secondary leptons produced in proton-photon interactions. Together with photons, hadronic emission models predict the emission of neutrinos that are therefore the smoking gun for acceleration of relativistic hadrons in blazar jets. The simulation of proton-photon interactions and all associated radiative processes is a complex numerical task, and different approaches to the problem have been adopted in the literature. So far, no systematic comparison between the different codes has been performed, preventing a clear understanding of the underlying uncertainties in the numerical simulations. To fill this gap, we have undertaken the first comprehensive comparison of blazar hadronic codes, and the results from this effort will be presented in this contribution.'

Collaborations

Keywords and Comments
'Blazar ; Hadronic models; Neutrino; Gamma-rays; AGN; Numerical simulations', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Methods

UHECRs in harmonic space

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Stefano Camera
Author and Co-Author
Stefano Camera,

Abstract
'I shall review our recent proposal of the use of the harmonic-space cross-correlation power spectrum between the arrival directions of ultra-high energy cosmic rays (UHECRs) and the distributions of galaxies in the Universe, as observed by cosmological surveys of the large-scale structure (LSS). We expect the two observables to correlate, due to both galaxies and UHECR sources being hosted within dark matter haloes, which constitute the very LSS. This cross-correlation has not yet been considered in the literature. We formalise analytically such a cross-correlation and show how, if the distribution of UHECR sources trace indeed the LSS, that the combination of auto- and cross-correlation greatly helps to detect UHECR anisotropies with current data, even with current data. We show that the cross-correlation is more sensitive to UHECR anisotropies on smaller angular scales, more robust to systematic uncertainties, and it could be used to determine the redshift distribution of UHECR source.'

Collaborations
other (fill field below), Euclid Consortium; SKA Observatory.

Keywords and Comments
'multi-messenger astronomy; cosmology; cross-correlations; large-scale cosmic structure.', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Methods

Evaluating cosmic coincidences in the context of astrophysical source populations

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Francesca Capel
Author and Co-Author
Francesca Capel,

Abstract
'The multi-messenger era is now well underway, with high-energy neutrinos providing a unique opportunity to study particle acceleration. Recent reports describe possible coincident detections of single IceCube neutrinos with both a flaring blazar and a tidal disruption event. While compelling, these sources cannot be considered in isolation. I will present various strategies to put these associations into the context of the relevant astrophysical source populations. Firstly, we can use the non-observation of point sources in IceCube searches to place constraints on the high-level properties of the unknown source population. In particular, current measurements disfavour populations of rare and bright sources. Secondly, multi-messenger simulations of proposed populations and their transient behaviour can be used to evaluate the probability of chance coincident detections in a principled manner. Finally, these simulations can also be harnessed to predict the contribution to the overall neutrino flux that is consistent with an assumed source-neutrino association. I will demonstrate the application of these methods, using the proposed detections as a case study. The results raise further questions for the bigger picture of neutrino astrophysics.'

Collaborations

Keywords and Comments
'Neutrinos; blazars; Tidal disruption events; Source detection; Population; Simulation; Inference; Statistics', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Non-thermal radio supernova remnants of exiled Wolf-Rayet stars

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Dominique Meyer
Author and Co-Author
Dominique Meyer | Martin Pohl | Lida Oskinova | Mykola Petrov,

Abstract
'A signification fraction of Galactic massive stars ($\\ge 8\\,\\rm M_{\\odot}$) are ejected from their parent cluster and supersonically sail away through the interstellar medium (ISM). The winds of these fast-moving stars blow asymmetric bubbles thus creating a circumstellar environment in which stars eventually die with a supernova explosion. The morphology of the resulting remnant is largely governed by the circumstellar medium of the defunct progenitor star. In this paper, we present 2D magneto-hydrodynamical simulations investigating the effect of the ISM magnetic field on the shape of the supernova remnants of a $35\\, \\mathrm M_{\\odot}$ star evolving through a Wolf-Rayet phase and running with \r\nvelocity 20 and $40\\, \\rm km\\, \\rm s^{-1}$, respectively. A $7\\, \\mu \\rm G$ ambient magnetic field is sufficient to modify the properties of the expanding supernova shock front and in particular to prevent the formation of filamentary structures. Prior to the supernova explosion, the compressed magnetic field in the circumstellar medium stabilises the wind/ISM contact discontinuity in the tail of the wind bubble. A consequence is a reduced mixing efficiency of ejecta and wind materials in the inner region of the remnant, where the supernova shock wave propagates. Radiative transfer calculations for synchrotron emission reveal that the non-thermal radio emission has characteristic features reflecting the asymmetry of exiled core-collapse supernova remnants from Wolf-Rayet progenitors. Our models are qualitatively consistent with the radio appearance of several remnants of high-mass progenitors, namely the bilateral G296.5+10.0 and the shell-type remnants CTB109 and Kes~17, respectively.'

Collaborations

Keywords and Comments
'Supernova remnant', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

Wind nebulae and supernova remnants of very massive stars

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 46 Supernova Remnants | GAD-GAI-CRD
Presenter Forum Table

Presenter
Dominique Meyer
Author and Co-Author
Dominique Meyer | Mykola Petrov | Martin Pohl,

Abstract
'A very small fraction of (runaway) massive stars have masses exceeding 60-$70\\, \\rm M_{\\odot}$ and are predicted to evolve as Luminous-Blue-Variable and Wolf-Rayet stars before ending their lives as core-collapse supernovae. Our 2D axisymmetric hydrodynamical simulations explore how a fast wind ($2000\\, \\rm km\\, \\rm s^{-1}$) and high mass-loss rate ($10^{-5}\\, \\rm M_{\\odot}\\, \\rm yr^{-1}$) can impact the morphology of the circumstellar medium. It is shaped as 100 pc-scale wind nebula which can be pierced by the driving star when it supersonically moves with velocity 20-$40\\, \\rm km\\, \\rm s^{-1}$ through the interstellar medium (ISM) in the Galactic plane. The bow shock nebulae of such runaway stars have large ($5-10\\, \\rm pc$) termination shocks which may be substantial cosmic-ray accelerators prior to the supernova explosion. The motion of such runaway stars displaces the position of the supernova explosion out of their bow shock nebula, imposing asymmetries to the eventual shock wave expansion and engendering Cygnus-loop-like supernova remnants. \r\nWe conclude that the size (up to more than $200\\, \\rm pc$) of the filamentary wind cavity in which the chemically enriched supernova ejecta expand, mixing efficiently the wind and ISM materials by at least $10\\%$ in number density, can be used as a tracer of the runaway nature of the very massive progenitors of such $0.1\\, \\rm Myr$ old remnants. Our results motivate further observational campaigns devoted to the bow shock of the very massive stars BD+43 3654 and to the close surroundings of the synchrotron-emitting Wolf-Rayet shell G2.4+1.4.'

Collaborations

Keywords and Comments
'', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

Interpretation of blazar flares of various types in a unified model

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 303

Presenter
Ze-Rui Wang
Author and Co-Author
Ze-Rui Wang | Ruo-Yu Liu | Maria Petropoulou | Foteini Oikonomou | Rui Xue | Xiang-Yu Wang,

Abstract
'Blazars have very complex variability properties. They sometimes exhibit multi-wavelength and other times "orphan" flares in specific wavelength. Different models have been proposed to explain specific flares. In this paper, we propose a unified model to explain different blazar flares in the same framework naturally. We consider a model in which the emission of a blazar consists of two components during the flare period. One arises from a strong dissipation zone that may occur randomly along the jet. This component is responsible for the sudden enhancement of the blazar\'s flux. The other is a quasi-stable component, which results from the superposition of numerous but comparatively weak dissipation zones, which constitute background emission or the low state emission of the blazar. The spectral feature of a flare depends on the position where the strong dissipation occurs. Generally speaking, if the strong dissipation occurs at a small/large distance from the SMBH, the inverse Compton/synchrotron radiation dominates and an orphan $\\gamma$-ray/optical flare tends to appear. On the other hand, we may expect a multiwavelength flare if the dissipation occurs at a moderate distance. The model can be successfully applied to reproduce the spectral energy distribution of different flares from the flat spectrum radio quasar 3C 279 and the BL Lac object PKS 2155-304, respectively.'

Collaborations
other (fill field below), Nanjing University

Keywords and Comments
'blazar; orphan flare; leptonic model', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

A Two-zone Blazar Radiation Model for “Orphan” Neutrino Flares

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Rui Xue
Author and Co-Author
Rui Xue | Ruo-Yu Liu | Ze-Rui Wang | Nan Ding | Xiang-Yu Wang,

Abstract
'In this work, we investigate the 2014–2015 neutrino flare associated with the blazar TXS 0506+056 and a recently discovered muon neutrino event IceCube-200107A in spatial coincidence with the blazar 4FGL J0955.1+3551, under the framework of a two-zone radiation model of blazars where an inner/outer blob close to/far from the supermassive black hole is invoked. An interesting feature that the two sources have in common is that no evidence of GeV gamma-ray activity is found during the neutrino detection period, probably implying a large opacity for GeV gamma rays in the neutrino production region. In our model, continuous particle acceleration/injection takes place in the inner blob at the jet base, where the hot X-ray corona of the supermassive black hole provides target photon fields for efficient neutrino production and strong GeV gamma-ray absorption. We show that this model can self-consistently interpret the neutrino emission from both blazars in a large parameter space. In the meantime, the dissipation processes in outer blob are responsible for the simultaneous multiwavelength emission of both sources. In agreement with previous studies of TXS 0506+056, an intense MeV emission from the induced electromagnetic cascade in the inner blob is robustly expected to accompany the neutrino flare in our model and could be used to test the model using the next-generation MeV gamma-ray detector in the future.'

Collaborations

Keywords and Comments
'Blazars; Neutrino astronomy; High-energy cosmic radiation; Gamma-ray sources', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

FR-0 jetted active galaxies: extending the zoo of candidate sites for UHECR acceleration

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 02 Constraining UHECR sources | CRI
Presenter Forum Table

Presenter
Lukas Merten
Author and Co-Author
Lukas Merten | Margot Boughelilba | Anita Reimer | Paolo Da Vela | Serguei Vorobiov | Fabrizio Tavecchio | Giacomo Bonnoli | Jon Paul Lundquist | Chiara Righi,

Abstract
'Fanaroff Riley (FR) 0 radio galaxies form a low luminosity extension of the well established ultrahigh energy cosmic ray (UHECR) candidate accelerators FR-1 and FR-2 galaxies. Their much higher number density – up to a factor 5 more numerous compared to FR-1 with $z<= 0.05$ – makes them good candidate sources for an isotropic contribution to the observed UHECR flux. Here, acceleration and survival of UHECR in prevailing conditions of the FR-0 environment are discussed.\r\n\r\nFirst an average spectral energy distribution (SED) is compiled based on the FR0CAT. These photon fields, composed of a jet and a host galaxy component, form a minimal target field for the UHECR, which will suffer from electromagnetic pair production, photo disintegration, photo-meson production losses, and synchrotron radiation. The two most promising acceleration scenarios based on Fermi-I order and gradual shear acceleration are discussed as well as different escape scenarios.\r\n\r\nWhen gradual shear acceleration is preceded by an efficient acceleration mechanism, e.g., Fermi-I or others, FR-0 galaxies are likely UHECR accelerators. This scenario requires a jet Lorentz factor of $\\gamma>1.6$ to yield gradual shear acceleration which is faster than the corresponding escape. In less optimistic models a contribution to the cosmic-ray flux between knee and ankle is expected relatively independent of the realized turbulence and acceleration.'

Collaborations

Keywords and Comments
'acceleration of particles; radiation mechanisms: nonthermal;\r\ngalaxies: jets; galaxies: active; cosmic rays', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

Time-dependent treatment of cosmic-ray spectral steepening due to turbulence driving

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Martin Pohl
Author and Co-Author
Martin Pohl,

Abstract
"Cosmic-ray acceleration at non-relativistic shocks relies on scattering by turbulence that the cosmic rays drive upstream of the shock. We explore the rate of energy transfer from cosmic rays to non-resonant Bell modes and the spectral softening it implies. Accounting for the finite time available for turbulence driving yields a much smaller spectral impact than found earlier with steady-state considerations. Generally, for diffusion scaling with the Bohm rate by a factor $\\eta$, the change in spectral index is at most $\\eta$ divided by the Alfv\\'enic Mach number of the thermal sub-shock. For small $M_\\mathrm{A}$ it is well below this limit. Only for very fast shocks and very efficient cosmic-ray acceleration the change in spectral index may reach 0.1. For standard SNR parameters it is negligible."

Collaborations

Keywords and Comments
'Gamma-ray astronomy ; cosmic rays ; supernova remnants ; spectral index', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

PARTICLE ACCELERATION IN SUPERNOVA REMNANT EXPANDING INSIDE WIND-BLOWN BUBBLE

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 12 Galactic Particle Acceleration, including PIC | CRI-CRD-MM
Presenter Forum Table

Presenter
Samata Das
Author and Co-Author
Samata Das, Robert Brose | Dominique M.-A. Meyer | Martin Pohl | Iurii Sushch | Pavlo Plotko

Abstract
'**Context.** Supernova Remnants (SNRs) are considered as the primary sources of galactic cosmic rays (CRs), where CRs are assumed to be accelerated by diffusive shock acceleration (DSA) mechanism, specifically at SNR shocks. The SNR shocks expand in the complex ambient environment, particularly in the core-collapse scenarios as the core-collapse SNRs evolve inside wind-blown bubbles created by the mass-loss of massive stars during their different evolutionary stages. Therefore, the evolution of core-collapse SNRs, as well as cosmic ray acceleration is expected to be considerably different from SNR evolution in a uniform environment.\r\n**Aims.** The aim is to observe the influence of different ambient medium of core-collapse SNR shock on the particle spectra. Furthermore, the interactions of SNR shock with fluctuations in density within the wind-blown bubble generate several transmitted and reflected shocks. So, the impact of SNR shock interactions with different discontinuities, on particle spectra, and finally the effect on emission from the remnant are also the areas of focus.\r\n**Methods.** The hydrodynamic structures of wind-blown bubbles at pre-supernova stages formed by 20$M_\\odot$, 35$M_\\odot$, and 60$M_\\odot$ stars have been used to create the ambient environment for supernova explosion. Stars, with those particular masses, evolve through different stages from Zero Age Main Sequence (ZAMS) to the pre-supernova stage, therefore the wind bubbles formed by them should be structurally different. Then, the transport equation for cosmic rays, and the hydrodynamic equations have been solved simultaneously in 1-D spherical symmetry.\r\n**Result.** Evolution of core-collapse SNRs inside complex wind-blown bubbles, modifies the particle spectra and emission from the remnant.'

Collaborations

Keywords and Comments
'Supernova Remnants; Wind-Blown Bubbles; Hydrodynamics; Cosmic Rays', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

Extrapolating FR-0 radio galaxy source properties from the propagation of multi-messenger ultra-high-energy cosmic rays

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Jon Paul Lundquist
Author and Co-Author
Jon Paul Lundquist, Lukas Merten | Serguei Vorobiov | Margot Boughelilba | Anita Reimer | Paolo Da Vela | Fabrizio Tavecchio | Giacomo Bonnoli | Chiara Righi

Abstract
'Recently, it has been shown that relatively low luminosity Fanaroff-Riley type 0 (FR-0) radio galaxies are a good candidate source class for a predominant fraction of cosmic rays (CR) accelerated to ultra-high energies (UHE, E>10^18 eV). FR-0s can potentially provide a significant fraction of the UHECR energy density as they are much more numerous in the local universe (up to a factor of ~5 with z<= 0.05) than more energetic radio galaxies such as FR-1s or FR-2s.\r\n \r\nIn the present work, UHECR mass composition and energy spectra at the FR-0 sources are estimated by fitting simulation results to the published Pierre Auger Observatory and Telescope Array data. This fitting is done using a simulated isotropic sky distribution extrapolated from the measured FR-0 galaxy properties and propagating CRs in plausible extragalactic magnetic field configurations using the CRPropa3 framework. In addition, we present estimates of the fluxes of secondary photons and neutrinos created in UHECR interactions with cosmic photon backgrounds during CR propagation. With this approach, we aim to investigate the properties of the sources with the help of observational multi-messenger data.'

Collaborations

Keywords and Comments
'UHECR; cosmic rays; active galaxies; radio galaxies; FR-0; multi-messenger; energy spectrum; composition', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Suppression of the TeV pair-beam plasma instability by a weak intergalactic magnetic field

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 304

Presenter
Mahmoud Al-Awashra
Author and Co-Author
Mahmoud Al-Awashra | Martin Pohl,

Abstract
"Several gamma-ray observations from distant blazars show a suppressed GeV band emission of the inverse Compton cascade of the blazar-induced pair beams. There are two possible justifications, the first one is the deflections of the pair beam electrons and positrons by magnetic fields in the intergalactic medium. The second one is the drain of the pair energy by plasma beam instabilities resulting in heating the cold intergalactic plasma. Commonly, the analytical studies of the plasma instabilities of blazar-induced pair beams in the literature assume a non-magnetized intergalactic medium. However, the existence of an intergalactic magnetic field with sufficient strength suppresses the plasma instabilities as we show in this paper. In this work, we investigate the effect of a weak intergalactic magnetic field, with a spatial scale much smaller than the pair beam energy loss scale, on the plasma instability. We found that such weak fields, even if they don't modify the dispersion relation describing the electrostatic waves, they increase the angular distribution of the particles in the beam, which in turn reduce the linear growth rate of the electrostatic instability. Taking into account two damping processes of the electrostatic waves, we approximate the energy loss time scale for the beam instability for each IGMF strength and spatial scale. Comparing this time with that for the inverse - Compton scattering, we found the limit in the ($B_\\text{IGM},$ $\\lambda_\\text{B}$) parameter space where the growth of the plasma oscillations starts to be suppressed."

Collaborations

Keywords and Comments
'gamma rays: general - BL Lacertae objects: general - plasma instabilities - intergalactic magnetic fields', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Neutrino Emission from Supermassive Binary Black Hole Mergers

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 305

Presenter
Ilja Jaroschewski
Author and Co-Author
Ilja Jaroschewski, Oliver de Bruijn | Julia Becker Tjus | Peter L. Biermann | Imre Bartos | Wolfgang Rhode

Abstract
'The first high-probability association of an extragalactic neutrino to the blazar TXS 0506+056 in 2017 identified such active galaxies as potential high-energy neutrino emitters.Two distinct episodes of neutrino emission were detected within 3 years, indicating a possible periodicity. Such periodic behavior is explainable by a supermassive binary black hole system close to its merger as a result of jet precession and jet interactions with surrounding molecular clouds.\r\nWe present a model for predicting the arrival times of neutrino flares and gravitational waves for such systems and apply it on TXS 0506+056 assuming that it is an ongoing binary merger. We conclude that the next neutrino emission could already have occurred, possibly still hidden in IceCube's not-yet-analyzed data, and deliver binary properties for a successful detection of its gravitational waves by LISA.\r\nAs supermassive black hole mergers could occur more frequently due to merging of\r\ntheir host galaxies, we further investigate a possible connection between their radiated gravitational wave energy and the diffuse astrophysical neutrino flux that is measured by IceCube. We estimate the contributions of these mergers and binary stellar mass black hole mergers in starburst galaxies on top to the diffuse neutrino flux.'

Collaborations

Keywords and Comments
'AGN; Neutrinos; Gravitational Waves', ''

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Subcategory Theoretical Results

Coincident neutrino and gamma-ray emission from blazars

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 306

Presenter
Marcel Schroller
Author and Co-Author
Marcel Schroller, Julia Becker Tjus | Patrick Reichherzer | Ilja Jaroschewski | Mario Hörbe | Wolfgang Rhode

Abstract
'Active galactic nuclei (AGN), and the accompanied AGN jets, are some of\r\nthe most fascinating and luminous objects in the observable Universe.\r\nBoth the active cores and their jets are candidates for the engine of\r\ncosmic rays, gamma rays, and neutrinos with the highest energies measured at Earth.\r\nA deep understanding of the processes related to jets will not only\r\nfuel the field of high energy cosmic rays, but will also give insights in\r\nfundamental plasma, astro, and particle physics. The physical and\r\nmathematical modeling of an AGN jet is challenging, with ambiguous\r\nsignatures that need to be understood by numerical simulations of\r\ncosmic ray transport and interactions. Based on the work of Hoerbe et al.\r\n(MNRAS 2020), a simulation framework for hadronic constituents and\r\ntheir interactions inside of a plasmoid, propagating along the AGN jet\r\naxis, was made. The final goal of the simulation is to give\r\npredictions in the context of multimessenger astrophysics. This talk will present\r\nthe first results, discuss the question of diffusivity of the particles and examine the scenario, where neutrino and gamma-ray flares coincide.'

Collaborations

Keywords and Comments
'AGN; AGN jets; Blazar; Neutrino; Gamma-rays; numerical', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

High-Energy Neutrinos from NGC 1068

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Luis Anchordoqui
Author and Co-Author
Luis Anchordoqui | John Krizmanic | Floyd Stecker,

Abstract
'IceCube has observed an excess of neutrino events over expectations from the isotropic background from the direction of NGC 1068. The excess is inconsistent with background expectations at the level of 2.9σ after accounting for statitsical trials. Even though the excess is not statistical significant yet, it is interesting to entertain the possibility that it corresponds to a real signal. Assuming a single power-law spectrum, the IceCube Collaboration has reported a best-fit flux ∼ 3 × 10^{−11} (E/TeV)^{−3.2} (TeV cm^2 s)^{−1} , where E is the neutrino energy. Taking account of new physics and astronomy developments we give a revised high-energy neutrino flux for the Stecker-Done-Salamon-Sommers AGN core model and show that it can accommodate IceCube observations.'

Collaborations

Keywords and Comments
'AGN as neutrino sources', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

Multimessenger Constraints on Intergalactic Magnetic Fields from Flaring Objects

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 307

Presenter
Andrey Saveliev
Author and Co-Author
Andrey Saveliev | Rafael Alves Batista,

Abstract
'The origin of magnetic fields in the universe is an open problem. Seed magnetic fields possibly produced in early times may have survived up to the present day close to their original form, providing an untapped window to the primeval universe. The recent observations of high-energy neutrinos from the blazar TXS 0506+056 in association with an electromagnetic counterpart in a broad range of wavelengths can be used to probe intrinsic properties of this object and the traversed medium. Here we show that intergalactic magnetic fields (IGMFs) can affect the intrinsic spectral properties of this object reconstructed from observations. In particular, we point out that the reconstructed maximum gamma-ray energy of TXS 0506+056 can be significantly higher if IGMFs are strong. Finally, we use this flare to constrain both the magnetic-field strength and the coherence length of IGMFs.'

Collaborations

Keywords and Comments
'blazars; TXS 0506+056; intergalactic magnetic fields; gamma rays; neutrinos', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Exploring galactic wind superbubbles by multimessenger observations

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 26 Galactic Sources & Winds | MM
Presenter Forum Table

Presenter
Enrico Peretti
Author and Co-Author
Enrico Peretti, Giovanni Morlino | Pasquale Blasi | Pierre Cristofari | Markus Ahlers

Abstract
'Galactic winds are one of the most spectacular phenomena we observe in the Universe. \r\nThey are common in active galaxies, and can be powered either by stellar feedback typical of star forming galaxies or by active galactic nuclei (AGN).\r\nThese winds have a bubble structure characterized by an external forward shock expanding in the circumgalactic medium and an internal reverse shock separating the cool and fast wind from the hot shocked wind.\r\nWhile the forward shock is unlikely to be able to accelerate particles efficiently for a long time, at the reverse shock the necessary conditions for efficient acceleration may be present.\r\nThe power of these outflows ranges from \$10^{39} \\, \\rm erg \\, s^{-1}\$ up to \$10^{45} \\, \\rm erg \\, s^{-1}\$ making galactic wind bubbles powerful particle accelerators.\r\n\r\nWe develop a model for particle acceleration at the termination shock of such superbubbles analysing the differences between AGN-driven and starburst-driven scenarios.\r\nThis is done solving the transport equation in the entire wind bubble structure accounting for diffusion, advection and energy losses.\r\nWe show that the maximum energy in these systems can be larger than \$10^2\$ PeV. \r\nWe finally explore the associated multimessenger observables both in terms of escaping particles and hadronic byproducts such as gamma-rays and neutrinos produced via \$pp\$ and \$p \\gamma\$ interactions.'

Collaborations

Keywords and Comments
'Particle acceleration; galactic winds; multi-messenger', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Predicting Neutrino Emission for the Sources in the H.E.S.S. Galactic Plane Survey

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 26 Galactic Sources & Winds | MM
Presenter Forum Table

Presenter
Rowan Batzofin
Author and Co-Author
Rowan Batzofin, Nukri Komin

Abstract
'The H.E.S.S. Galactic Plane Survey has detected very-high-energy (VHE) gamma-ray emission from 78 sources in the Milky Way. These sources belong to different object classes (pulsar wind nebulae, supernova remnants or binary systems) and some of these sources remain unidentified. The gamma-ray emission of these objects may be of leptonic or hadronic origin and gamma-ray observations alone cannot distinguish between these two scenarios. The detection of neutrino emission would provide evidence for a hadronic scenario in these objects.\r\n\r\nBased on the observed gamma-ray spectra we predict the neutrino emission of these sources under the hypothesis that the emission is solely of hadronic origin. This prediction relies entirely on observation and is independent of the source class, the distance or the ambient target material. We use these predictions to create an empirical model for the neutrino emission of the Milky Way. This model can be used to search for neutrino emission from individual gamma-ray sources as well as testing for neutrino emission from potential source populations in the Milky Way.'

Collaborations

Keywords and Comments
'gamma rays; neutrinos; Milky Way', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Theoretical interpretation of the observed neutrino emission from Tidal Disruption Events

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Walter Winter
Author and Co-Author
Walter Winter | Cecilia Lunardini,

Abstract
'The observation of a neutrino (IC 191001A) in association with the Tidal Disruption Event (TDE) AT2019dsg has revealed a new source class producing astrophysical neutrinos. We discuss the theoretical modeling of this multi-messenger observation in a jetted concordance scenario, highlighting the connection with X-ray observations. We illustrate how the late-term neutrino observation about 150 post peak can be naturally described by the model, and we predict what it means for further possible neutrino-TDE associations.'

Collaborations
other (fill field below), Theory

Keywords and Comments
'Neutrino; Tidal Disruption Event', 'Based on work published in Nature Astronomy https://www.nature.com/articles/s41550-021-01305-3 and work in preparation.'

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Subcategory Theoretical Results

Searching for very-high-energy electromagnetic counterparts to gravitational-wave events with the Cherenkov Telescope Array

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 27 GW Follow-Up Observation | MM
Presenter Forum Table

Presenter
Barbara Patricelli
Author and Co-Author
Barbara Patricelli | Alessandro Carosi | Lara Nava | Monica Seglar Arroyo | Fabian Schussler | Antonio Stamerra | Andrea Adelfio | Halim Ashkar | Andrea Bulgarelli | Tristano Di Girolamo | Ambra Di Piano | Thomas Gasparetto | Jarred Green | Francesco Long,

Abstract
'The detection of electromagnetic (EM) emission following the gravitational wave (GW) event GW170817 opened the era of multi-messenger astronomy with GWs and provided the first direct evidence that at least a fraction of binary neutron star (BNS) mergers are progenitors of short Gamma-Ray Bursts (GRBs). GRBs are also expected to emit very-high energy (VHE, > 100 GeV) photons, as proven by the recent MAGIC and H.E.S.S. observations and one of the challenges for future multi-messenger observations will be the detection of such VHE emission from GRBs in association with GWs. In the next years, the Cherenkov Telescope Array (CTA) will be a key instrument for the EM follow-up of GW events in the VHE range, owing to its unprecedented sensitivity, rapid response and capability to monitor a large sky area via scan-mode operation. We present the CTA GW follow-up program, with a focus on the searches for short GRBs possibly associated with BNS mergers. We investigate the possible observational strategies and we outline the prospects for joint GW and VHE EM detection rates.'

Collaborations
CTA,

Keywords and Comments
'Gravitational Waves; BNS mergers; Gamma-ray Bursts', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

A hot spot in the neutrino flux created by cosmic rays fromCygnus loop

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 26 Galactic Sources & Winds | MM
Presenter Forum Table

Presenter
makarim bouyahiaoui
Author and Co-Author
makarim bouyahiaoui | Dmitri Semikoz | Michael Kachelriess,

Abstract
'An analysis of 7.5 years of data in the high-energy starting event sample has been recently published by the IceCube collaboration. The hottest spot in a search for neutrino sources was found far above the Galactic plane and is thus, at first sight, difficult to reconcile with a Galactic origin. In this work, we calculate the cosmic ray (CR) density around nearby, young supernova remnants, assuming anisotropic diffusion. Combining these CR densities with dust maps, we find two prominent hot spots: One, produced by CRs from Vela interacting with gas close to the wall of the Local Bubble, is absent in the IceCube high-energy starting event sample. The other one, produced by CRs from the Cygnus loop agrees in position with the hottest spot in the IceCube neutrino data.'

Collaborations

Keywords and Comments
'', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

UHECR from high- and low-luminosity GRBs

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 02 Constraining UHECR sources | CRI
Presenter Forum Table

Presenter
Annika Rudolph
Author and Co-Author
Anatoli Fedynitch | Annika Rudolph | Denise Boncioli | Walter Winter | Jonas Heinze | Iftach Sadeh | Zeljka Bosnjak | Daniel Biehl,

Abstract
'We discuss the production of multiple messengers including UHECR, EM radiation and neutrinos in Gamma-Ray Bursts in models with multiple interaction regions.\r\nWe demonstrate that standard high-luminosity bursts can explain the UHECR spectrum as as measured by the Pierre Auger Observatory, and derive the required source injection composition for different engine realisations. We discuss how multi-messenger observations can be used to discriminate between models by explicitly calculating the expected source and cosmogenic neutrino fluxes as well as the photon light curves. In addition, a separate population of LL-GRBs may exist, for which we show that different nuclei can indeed reach UHECR energies. For this purpose, we self-consistently model the radiation fields in prototypes inspired by real GRBs. We connect the maximal energies attainable for cosmic-ray nuclei to a possible VHE and HE component in the SED.'

Collaborations

Keywords and Comments
'', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

Possible photohadronic origin of the IC-201114A alert

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 308

Presenter
Alberto Rosales de Leon
Author and Co-Author
Alberto Rosales de Leon | Anthony M. Brown | Paula M. Chadwick,

Abstract
'The Icecube neutrino observatory is a cubic-kilometer particle detector located at the South Pole. A system of public real-time alerts on neutrino candidate events likely to be of astrophysical origin has been operating since 2016. On November 14th 2020, a track-like event with a high probability of being of astrophysical origin (IC-201114A) was reported. 4FGL J0658.6+0636, a source of the blazar type, was identified inside the 90% localisation region of the alert 0.8° from the best-fit event position by the Fermi-LAT collaboration. In this work, we analyse 12.3 years of Fermi-LAT data from 4FGL J0658.6+0636. No indication of significant gamma-ray activity was found around the time of the alert, however, two periods in which the source was detected significantly were identified and studied considering a lepto-hadronic scenario. We investigate a possible photohadronic origin for high energy neutrinos and calculate the gamma-ray contribution to the spectral energy distribution (SED). The predicted neutrino flux and the expected time for a neutrino detection from the source during a flaring state were calculated for the periods of significant activity. Assuming the historical behaviour of the source, an approximation of the gamma-ray and neutrino flux coming from photohadronic interactions around the IC-alert is also given.'

Collaborations

Keywords and Comments
'Gamma-rays; Blazars; Neutrinos; High energy astrophysics', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Ultrahigh-energy cosmic-ray interactions as the origin of VHE gamma-rays from BL Lacs

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 02 Constraining UHECR sources | CRI
Presenter Forum Table

Presenter
Saikat Das
Author and Co-Author
Saikat Das, Nayantara Gupta | Soebur Razzaque

Abstract
'We explain the observed multiwavelength photon spectrum of a number of BL Lac objects detected at very high energy (VHE, $E > 30$ GeV), using a lepto-hadronic emission model. The one-zone leptonic emission is employed to fit the synchrotron peak. Subsequently, the SSC spectrum is calculated, such that it extends up to the highest energy possible for the jet parameters considered. The data points beyond this energy, and also in the entire VHE range are well explained using a hadronic emission model. The ultrahigh-energy cosmic rays (UHECRs, $E> 0.1$ EeV) escaping from the source interact with the extragalactic background light (EBL) during propagation over cosmological distances to initiate electromagnetic cascade down to $\\sim1$ GeV energies. The resulting photon spectrum peaks at $\\sim1$ TeV energies. We consider a random turbulent extragalactic magnetic field (EGMF) with a Kolmogorov power spectrum to find the survival rate of UHECRs within 0.1 degrees of the direction of propagation in which the observer is situated. We restrict ourselves to an RMS value of EGMF, $B_{\\rm rms}\\sim 10^{-5}$ nG, for a significant contribution to the photon spectral energy distribution (SED) from UHECR interactions. We found that UHECR interactions on the EBL and secondary cascade emission can fit gamma-ray data from the BL Lacs we considered at the highest energies. The required luminosity in UHECRs and corresponding jet power are below the Eddington luminosities of the super-massive black holes in these BL Lacs.'

Collaborations

Keywords and Comments
'Ultrahigh-energy cosmic rays; Blazars; Gamma-rays; Extragalactic magnetic fields', 'Journal Ref:\r\nThe Astrophysical Journal 889, 149 (2020)\r\n\r\nDOI:\r\n10.3847/1538-4357/ab6131'

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Subcategory Theoretical Results

PeV-EeV neutrinos from gamma-ray blazars due to ultrahigh-energy cosmic-ray propagation

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 309

Presenter
Saikat Das
Author and Co-Author
Saikat Das, Nayantara Gupta | Soebur Razzaque

Abstract
'Blazars are potential candidates of cosmic-ray acceleration up to ultrahigh energies ($E > 10^{18}$ eV). For an efficient cosmic-ray injection from blazars, $p\\gamma$ collisions with the extragalactic background light (EBL) and cosmic microwave background (CMB) can produce neutrino spectrum with peaks near PeV and EeV energies, respectively. We analyze the contribution of these neutrinos to the diffuse background measured by the IceCube neutrino observatory. The fraction of neutrino luminosity originating from individual redshift ranges is calculated using the distribution of BL Lacs and FSRQs provided in the \\textit{Fermi}-LAT 4LAC catalog. Furthermore, we use a luminosity dependent density evolution to find the neutrino flux from unresolved blazars. The results obtained in our model indicate that as much as $\\approx10\\%$ of the flux upper bound at a few PeV energies can arise from cosmic-ray interactions on EBL. The same interactions will also produce secondary electrons and photons, initiating electromagnetic cascades. The resultant photon spectrum is limited by the isotropic diffuse $\\gamma$-ray flux measured between 100 MeV and 820 GeV. The latter, together with the observed cosmic-ray flux at $E>10^{16.5}$ eV, can constrain the baryonic loading factor depending on the maximum cosmic-ray acceleration energy.'

Collaborations

Keywords and Comments
'Gamma-Rays; Blazars; Neutrino Astronomy; High-energy cosmic rays', 'Accepted for Publication in \r\nThe Astrophysical Journal\r\narXiv e-print: https://arxiv.org/abs/2012.13877'

Branch MM | Multi-Messenger

Subcategory Theoretical Results

Study of the production of high-energy neutrinos in the environment of binary-neutron-star mergers.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 310

Presenter
Simone Rossoni
Author and Co-Author
Simone Rossoni, Denise Boncioli | Guenter Sigl

Abstract
'Gamma-rays and neutrinos are important probes of astrophysical sources and acceleration mechanisms of ultra-high energy cosmic rays (UHECRs). UHECRs can interact with the radiation field and the baryonic material within the source and produce neutrinos in pion decay chains. These neutrinos are subject mostly to redshift and flavour oscillation during their propagation to Earth and contain information on sources otherwise not accessible.\r\nWe focus on compact objects surrounded by an accretion disk, of the type that are likely end states of a binary-neutron-star (BNS) merger. We model the target photon field in the source as a black body, using a modified version of the code SimProp v2r4 to simulate the propagation and interactions of UHECRs in this environment. We explore various combinations for composition, spectral index, high-energy cutoff of the UHECR primaries.\r\nThe neutrino fluxes arriving at Earth are compared to the astrophysical IceCube flux, and some constraints on the BNS merger rate can be deduced.'

Collaborations

Keywords and Comments
'''High-energy neutrinos;Binary-neutron-star merger;Cosmic ray interactions''', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

Improved Limits on Cosmogenic Fluxes from Ultra-High Energy Cosmic Rays

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 311

Presenter
Kathrine Mørch Groth
Author and Co-Author
Kathrine Mørch Groth, Yoann Génolini | Markus Ahlers

Abstract
'Ultra-high energy cosmic rays (UHE CRs) interacting with the cosmic radiation background produce two cosmogenic messengers: neutrinos with energies in the EeV range and gamma rays accumulating in the GeV-TeV range. The most optimistic scenario for cosmogenic fluxes assumes the dominance of protons above the Greisen-Zatsepin-Kuzmin threshold of resonant scattering with photons in the cosmic microwave background. Whereas these optimistic cosmogenic fluxes are testable with present observatories, the corresponding predictions of heavier UHE CR composition models are orders of magnitude smaller, falling within the domain of more sensitive future detectors. In this study we use the latest results of the Pierre Auger observatory for the UHE CR spectrum and chemical composition to derive conservative lower limits on the cosmogenic neutrino and gamma ray fluxes. We investigate the prospects and requirements of future large-scale neutrino and CR observatories to observe these fluxes.'

Collaborations

Keywords and Comments
'Ultra-high energy cosmic rays; Cosmogenic neutrinos; Cosmogenic gamma-rays; High energy neutrino astronomy', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

An AGN-starburst composite multi-messenger model of NGC 1068

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 312

Presenter
Björn Eichmann
Author and Co-Author
Björn Eichmann, Ralf-Jürgen Dettmar

Abstract
'Recent multi-wavelength observations indicate that some starburst galaxies show a dominant nonthermal contribution from its central region. These active galactic nuclei (AGN)-starburst composites are of special interest, as both phenomena on their own are potential sources of high-energetic cosmic rays. In this presentation we will focus on NGC 1068, which is known since several years from its atypical radio-gamma-ray correlation. Recently this source has also shown strong indications of high energy neutrino emission. We present a first semi-analytical, two-component multi-messenger model that gives some constraints on the AGN-starburst composite characteristics of NGC 1068.'

Collaborations

Keywords and Comments
'NGC 1068; starburst; AGN', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Multi-zone model as origin of hard gamma-rays spectrum in extreme BL Lacs

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 313

Presenter
Edilberto Aguilar
Author and Co-Author
Edilberto Aguilar | Nissim Fraija,

Abstract
"The emission of the so-called extreme blazars challenges the particle acceleration models. The hardness of its spectrum, <2, demands extreme parameters using the standard one-zone SSC model in the high energy band. Some authors use both two-zone or hadronic/leptohadronic models to relax these extreme values. In this work, we present a leptohadronic multi-zone model to explain the broadband emission, where the contribution of two components forms the hard-spectrum in the $\\gamma$-rays band. The first is produced by the photopion process, where accelerated protons in an inner blob located close to the core interact with the X-ray photons coming from a pair plasma. This mechanism will be responsible for $\\gamma$-rays in the TeV's energies range. The second component is produced by an outer blob, which corresponds to the source of X-rays and $\\gamma$-rays via the standard SSC model. Additionally, neutrinos with $\\sim$ TeV's energies are expected and could be restricted by IceCube's observations."

Collaborations

Keywords and Comments
'Blazar emission; gamma rays; Cosmic Rays; Astrophysical Neutrinos.', ''

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Subcategory Theoretical Results

Probing Neutrino Emission from X-ray Blazar Flares observed with Swift-XRT

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Stamatios Ilias Stathopoulos
Author and Co-Author
Stamatios Ilias Stathopoulos, Maria Petropoulou | Paolo Giommi | Apostolos Mastichiadis | Paolo Padovani

Abstract
"Blazars are a subclass of active galaxies with jets closely aligned to the observer's line of sight. In addition, they are the most powerful persistent sources across the electromagnetic spectrum in the universe. The detection of a high-energy neutrino from the flaring blazar TXS 0506+056 and the subsequent discovery of a neutrino excess from the same direction have naturally strengthened the hypothesis that blazars are cosmic neutrino sources. The lack, however, of gamma-ray flaring activity during the latter period challenges the standard scenario of correlated gamma-ray and high-energy neutrino emission in blazars. Motivated by a novel theoretical scenario where neutrinos are produced by energetic protons interacting with their own X-ray synchrotron photons, we make neutrino predictions for X-ray flaring blazars. Our sample consists of all blazars observed with the X-ray Telescope (XRT) on board Swift more than 50 times from November 2004 to November 2020. To statistically identify an X-ray flaring state we apply the Bayesian Block algorithm to the 1 keV XRT light curves of frequently observed blazars. Using X-ray spectral information during the flaring states, we compute for each flare the 1-10 keV energy fluence, which is a good proxy for the all-flavor neutrino fluence in the adopted theoretical scenario. We present the expected number of muon neutrino events with IceCube for each source as well as the stacked signal from all X-ray flares of the selected sample. We discuss the implications of our results for IceCube and IceCube Gen-2."

Collaborations

Keywords and Comments
'AGN; Blazars; High energy neutrinos; X-ray flares; IceCube', ''

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Subcategory Theoretical Results

Testing high energy neutrino emission from the Fermi Gamma-ray Space Telescope Large Area Telescope (4LAC) sources.

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Antonio Galván
Author and Co-Author
Antonio Galván | Nissim Fraija, Edilberto Aguilar | Jagdish C. Joshi | José Antonio De Diego Onsurbe | Antonio Marinelli

Abstract
'The detection of the high-energy neutrino IC-170822A in spatial (within the error region) and temporal flare activity correlation with the blazar TXS 0506+056 allowed these objects to be considered as progenitor sources of neutrinos. Besides this, no more detection of this kind was reported. Some other neutrinos detected by IceCube show a spatial correlation (within the error region) from other Fermi-LAT detected sources. However, these objects did not show a flare activity like TXS 0506+056. Assuming a lepto-hadronic scenario through pɣ interactions, this work describes the SED in some objects from the fourth catalog of active galactic nuclei (AGNs) detected by the Fermi Gamma-ray Space Telescope Large Area Telescope (4LAC) sources, which are in spatial correlation with neutrinos detected by IceCube. Additionally, we estimate the corresponding neutrino flux counterpart from these sources.'

Collaborations

Keywords and Comments
", "

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Subcategory Theoretical Results

Probing the particle acceleration at trans-relativistic shocks with gamma-ray burst afterglows

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Kazuya Takahashi
Author and Co-Author
Kazuya Takahashi | Kunihito Ioka | Yutaka Ohira | Hendrik van Eerten,

Abstract
'The detail of the particle acceleration at trans-relativistic shocks is still under debate. We propose a way to probe the particle acceleration at trans-relativistic shocks with observations of gamma-ray burst (GRB) afterglows. In the afterglow phase, the shock wave launched in a GRB is gradually decelerated from the relativistic to non-relativistic regimes by sweeping up the ambient interstellar matter. If the electron power-law index depends on the shock Lorentz factor, it is reflected to the evolution of the afterglow spectrum. \r\nWe theoretically study the time evolution of the electron power-law index imprinted in GRB afterglow spectra. We introduce a particle acceleration model by a trans-relativistic shock into the standard GRB afterglow model and apply the formulation to structured jet models that are consistent with GRB 170817A, which is the counterpart of the neutron-star merger detected by the gravitational wave signal, GW170817. \r\nAs a result, we find that it is possible to observe the transition of the electron acceleration from the relativistic phase to the non-relativistic phase in the evolution of the afterglow spectrum, if GRBs similar to GRB 170817A take place in a dense environment at 200 Mpc. \r\nThe detection number of short GRBs will increase in the era of the multi-messenger astronomy including gravitational waves. Thus, we expect that future GRBs can give a constraint on particle acceleration models as proposed in our study. In the presentation, we will discuss the detail of our model and results.'

Collaborations

Keywords and Comments
'GRB afterglows; Particle acceleration; Multiband spectrum; Multi-messenger including gravitational wave signals', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

Black-hole X-ray binaries in the new era of multi-messenger astronomy

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 314

Presenter
Dimitrios Kantzas
Author and Co-Author
Dimitrios Kantzas, Sera Markoff | Matteo Lucchini | Atul Chhotray | Chiara Ceccobello

Abstract
'Since their discovery, cosmic rays (CRs) remain among the most mysterious phenomena of modern physics. The dominant sources, as well as the exact acceleration mechanisms, remain unknown. The CRs up to the knee, are considered to originate in the shock waves of supernova remnants, however, due to the lack of a “smoking-gun” TeV counterpart in many cases, this scenario has been recently questioned. In this talk, I will motivate how the small-scale analogues of active galactic nuclei (AGN), namely black-hole X-ray binaries (BHXBs), can potentially contribute to the Galactic CR spectrum. To investigate this idea, I developed a new, multi-zone, lepto-hadronic jet model to take advantage of the entire broadband multiwavelength spectra observed by BHXBs. I applied this model to the first-ever simultaneous radio-to-X-ray spectrum of Galactic BHXB Cygnus X-1 obtained in 2016 (via the CHOCBOX program), and to a quasi-simultaneous dataset of another Galactic BHXB, GX339-4, during a bright outburst in 2010. In this talk, I will discuss how the different assumptions on proton acceleration affect both the jet properties and the observed spectrum. In particular, I will focus on the GeV-to-TeV regime and discuss its strong dependence on the rest of the multiwavelength spectrum. Finally, I will discuss the implication of my results for the next-generation gamma-ray facilities, such as the Cherenkov Telescope Array (CTA), as well as next-generation neutrino detectors, such as KM3NeT, concluding how they can help to constrain the potential BHXB contribution to the Galactic CR spectrum.'

Collaborations

Keywords and Comments
'XRBs; gamma-rays; Galactic sources; black holes;', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Cosmographic model of the astroparticle skies

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 02 Constraining UHECR sources | CRI
Presenter Forum Table

Presenter
Jonathan Biteau
Author and Co-Author
Jonathan Biteau,

Abstract
'Modeling the extragalactic astroparticle skies involves reconstructing the 3D distribution of the most extreme sources in the Universe. Full-sky tomographic surveys at near-infrared wavelengths have already enabled the astroparticle community to bind the density of sources of astrophysical neutrinos and ultra-high cosmic rays (UHECRs), constrain the distribution of binary black-hole mergers and identify some of the components of the extragalactic gamma-ray background. This contribution will present the efforts of cleaning and complementing the stellar mass catalogs developed by the gravitational-wave and near-infrared communities, in order to obtain a cosmographic view on stellar mass (M_*) and star formation rate (SFR). Unprecedented cosmography is offered by a sample of about 400,000 galaxies within 350 Mpc, with a 50-50 ratio of spectroscopic and photometric distances, M_*, SFR and corrections for incompleteness with increasing distance and decreasing Galactic latitude. The inferred 3D distribution of M_* and SFR is consistent with cosmic flows. The M_* and SFR densities converge towards values compatible with deep-field observations beyond 100 Mpc, suggesting a close-to-isotropic distribution of more distant sources. In addition to discussing relevant applications for the four astroparticle communities, this contribution will highlight the distribution of magnetic fields at Mpc scales deduced from the 3D distribution of matter, which is believed to be crucial in shaping the ultra-high-energy sky. These efforts provide a new basis for modeling UHECR anisotropies, which bodes well for the identification of their long-sought sources.'

Collaborations

Keywords and Comments
'galaxy masses; large-scale structure of the universe; particle astrophysics; scaling relations; sky surveys', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

High-energy neutrinos and gamma-rays from the AGN-driven wind in NGC 1068

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Susumu Inoue
Author and Co-Author
Susumu Inoue, Matteo Cerruti | Kohta Murase | Ruoyu Liu

Abstract
'Various observations are revealing the widespread occurrence of fast and powerful winds in active galactic nuclei (AGN) that are distinct from relativistic jets, likely launched from accretion disks. Such winds can harbor collisionless shocks at different locations that may induce acceleration of protons and electrons and consequent nonthermal emission. We focus on the inner regions of the winds, where interactions of accelerated protons with the nuclear radiation field and/or ambient gas can induce emission of high-energy neutrinos and gamma-rays. In particular, we address the case of NGC 1068, a nearby Seyfert galaxy bearing a powerful wind, which is a known source of GeV gamma rays as well as a tentative source of sub-PeV neutrinos. Tests and further implications of this scenario are discussed.'

Collaborations

Keywords and Comments
'neutrinos; gamma rays; AGN; wind', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Modelling TXS0506+056 with internal $\gamma - \gamma$ secondaries

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 315

Presenter
sunanda .
Author and Co-Author
sunanda . | Reetanjali Moharana,

Abstract
'A flare in 2017 from TXS0506+056 has 3.5$\\sigma$ spatial as well as temporal correlation with IceCube-170922A neutrino event above energy 290 TeV. The multi-wavelength modeling of the source is one of the viable way to figure out its energetics to produce neutrino. Several models on considering lepto -hardronic channels to produce the gamma rays and neutrino from this blazar has already been done. We report here the secondary contribution resulted from the $\\gamma -\\gamma \\rightarrow e^+e^-$ interaction between self synchrotron (SSC) and synchrotron photon in the blazar TXS0506+056. This study would help in understanding the maximum energy of the electrons produced at the source.'

Collaborations

Keywords and Comments
'AGNs; Neutrinos; Gamma rays', 'Presenter Sunanda'

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Rigorous theory for the spectrum of secondary cosmic-ray electrons

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 316

Presenter
Alexei Ivlev
Author and Co-Author
Alexei Ivlev | Kedron Silsbee | Marco Padovani | Daniele Galli,

Abstract
'CRs interacting with the gas generate electron-ion pairs, with electrons having sufficient energy to produce further ionization. These processes of primary and secondary ionization are characterized by the respective ionization rates, $\\zeta_p$ and $\\zeta_{\\rm sec}$. While $\\zeta_p$ can be straightforwardly derived for a given CR spectrum, computing $\\zeta_{\\rm sec}$ is a much more subtle task.\r\n\r\nWe derive a balance equation for the energy spectrum of secondary electrons, which is similar to the degradation equation by Spencer & Fano. This allows us to rigorously compute the spectrum of electrons produced in molecular gas by interstellar CRs as a function of gas column density N traversed by the CRs, and thus accurately calculate characteristics of various important processes driven by CRs, such as the generation of UV and X-ray photons, gas heating, production of atomic hydrogen, etc.\r\n\r\nIn particular, we compute the local value of the secondary ionization rate of molecular hydrogen, $\\zeta_{\\rm sec}(N)$, as a function of the local primary ionization rate, $\\zeta_p(N)$. We show that the ratio $\\zeta_{\\rm sec}/\\zeta_p$ increases monotonically with N, and can considerably exceed the value of $\\approx0.67$ commonly adopted in the literature. The dependence $\\zeta_{\\rm sec}/\\zeta_p$ versus N is practically insensitive to the particular shape of the interstellar CR spectrum, and thus is a general characteristic of the secondary CR ionization in dense gas.'

Collaborations

Keywords and Comments
'', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Monte Carlo Simulations of Propagation and Emissison of CR protons from Magnetic Reconnection in Poynting Flux Dominated Jets.

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Juan Carlos Rodríguez-Ramírez
Author and Co-Author
Juan Carlos Rodríguez-Ramírez | Elisabete Maria de Gouveia dal Pino | Rafael Alves Batista | Pankaj Kushwaha,

Abstract
'Neutrino-emitting blazars may accelerate cosmic ray (CR) protons at the inner regions of the jet, where most of the magnetic energy is likely to be dissipated. In this picture, the spectrum of neutrinos and gamma-rays that leave the source is shaped by the soft photon fields that the parent hadrons encounter before leaving the source. We perform simulations of CR propagation, where protons emit by interactions within the acceleration region in the jet as well as with the external photon fields produced in the nucleus of the host galaxy. The jet acceleration region is modelled with 3D relativistic magnetohydrodynamics (MHD) and we base our analysis on previous results of particle acceleration by magnetic reconnection in Poynting flux-dominated MHD jets, where reconnection is driven by kink instability. The resulting spectra of CR, gamma-rays, and neutrinos that leave the source are discussed in the context of flat-spectrum radio quasars and BL Lac objects.'

Collaborations

Keywords and Comments
'AGN; Particles acceleration; Neutrino emission; Magnetic reconnection', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Active galactic nuclei as neutrino sources in the PeV and EeV regimes

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 02 Constraining UHECR sources | CRI
Presenter Forum Table

Presenter
Xavier Rodrigues
Author and Co-Author
Xavier Rodrigues,

Abstract
'Active galactic nuclei (AGNs) are amongst the most promising neutrino source candidates, due to their potential to accelerate cosmic rays in their relativistic jets. The IceCube observatory has already detected several events from the direction of known gamma-ray blazar AGNs, like TXS 0506+056 and, more recently, PKS 1502+106. Through numerical modeling, we can show that neutrino emission is compatible with the available multi-wavelength observations from these sources. By generalizing these models, we can show that the diffuse IceCube flux can, under certain conditions, be fully explained by low-luminosity BL Lacs, while the contribution from bright gamma-ray quasars is severely constrained by the IceCube limits. On the other hand, it is also possible that AGNs accelerate cosmic rays up to ultra-high energies. In that scenario, detailed modeling shows that the AGN population can produce large fluxes EeV neutrinos, while still obeying the current IceCube stacking limits in the PeV regime. I will also argue that the flux of EeV neutrinos produced inside AGN jets can outshine the cosmogenic contribution, which has important implications for the search strategy of future radio neutrino telescopes.'

Collaborations

Keywords and Comments
'AGN; blazars; IceCube neutrinos; leptohadronic models; multi-messenger connection; TXS 0506+056; PKS 1502+106', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

Multi-wavelength and neutrino emission from blazar PKS 1502+106

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 25 Blazars, AGN | MM
Presenter Forum Table

Presenter
Xavier Rodrigues
Author and Co-Author
Xavier Rodrigues | Simone Garrappa | Shan Gao | Vaidehi Paliya | Anna Franckowiak | Walter Winter,

Abstract
'In July of 2019, the IceCube experiment detected a high-energy neutrino from the direction of the powerful quasar PKS 1502+106. I discuss the results of multi-wavelength and multi-messenger modeling of this source, using a fully self-consistent one-zone model that includes the contribution of radiation fields external to the jet. Three distinct activity states of the blazar can be identified: one quiescent state and two flaring states with hard and soft gamma-ray spectra. All three states ca be described by the same leptohadronic model, which also predicts a substantial neutrino flux. These results are compatible with the detection of a neutrino during the quiescent state, based on event rate statistics. The soft X-ray spectra observed during bright flares strongly suggest a hadronic contribution, which can be interpreted as additional evidence for cosmic ray acceleration in the source independently of neutrino observations.'

Collaborations

Keywords and Comments
'PKS 1502+106; blazars; AGN; IceCube; leptohadronic modeling', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

Detection prospects for low-energy neutrinos from collisionally heated GRBs with current and future neutrino telescopes

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 28 Searches for Transients | MM
Presenter Forum Table

Presenter
Angela Zegarelli
Author and Co-Author
Angela Zegarelli | Silvia Celli,

Abstract
'Neutrino emission from Gamma-Ray Bursts (GRBs) has been heavily investigated in the last decades providing a wealth of models which, under different physical conditions, are able to reproduce the observed electromagnetic gamma-ray emission. Among these, the most exploited ones in terms of multi-messenger signals involve neutrinos produced in the optically thin region of the jet, which are expected to be emitted in the TeV-PeV energy range. To date, no successful detection of such high-energy neutrinos from GRBs has been realized. However, within the framework of the so-called ‘inelastic collision model’, also lower energy neutrinos (GeV and sub-TeV ranges) could be produced from a dissipation mechanism through hadronic collisions (pp or pn) around or below the photosphere, where the jet is still optically thick. So far, dedicated searches for such low-energy neutrinos have not been undertaken yet. In the present work, we report preliminary detection prospects for such neutrinos, produced in collisionally heated GRBs, with KM3NeT and IceCube, considering also their low-energy extensions (ORCA and DeepCore, respectively). In addition, we compare such predictions with the performances that the large volume neutrino telescopes are expected to achieve towards more classical models (e.g. internal shocks), which produce neutrinos with higher energies.'

Collaborations

Keywords and Comments
'GRB; neutrinos; low-energy neutrinos; neutrino telescopes; astrophysics', ''

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Branch MM | Multi-Messenger

Subcategory Theoretical Results

Millisecond Pulsars Modify the Radio-SFR Correlation

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 317

Presenter
Takahiro Sudoh
Author and Co-Author
Takahiro Sudoh | Tim Linden | John Beacom,

Abstract
'The observed correlation between the far-infrared and radio luminosities of galaxies illustrates the close connection between star formation and cosmic-ray production. Intriguingly, recent LOFAR observations find a peculiar radio excess in galaxies with low star-formation rates and high stellar masses. We show that recycled/millisecond pulsars (MSPs) can dominate the nonthermal emission in these massive quiescent galaxies and explain the excess. This is in line with recent gamma-ray observation suggesting that MSPs may also efficiently accelerate cosmic-ray electrons. We find that MSP-based models provide a significantly improved fit to the LOFAR data. We discuss the implications for the radio and gamma-ray excesses in M31 and local electron and positron observations.'

Collaborations

Keywords and Comments
'''Pulsars; cosmic-ray electrons; radio emission; galaxies''', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

Constraining the origin of UHECRs and astrophysical neutrinos

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 02 Constraining UHECR sources | CRI
Presenter Forum Table

Presenter
Marco Muzio
Author and Co-Author
Marco Muzio, Glennys Farrar | Michael Unger

Abstract
'We constrain properties of ultrahigh energy cosmic ray source environments (and potentially astrophysical neutrino sources), including their photon temperature, gas density, size, magnetic field strength and coherence length, using UHECR and neutrino spectra and composition. Our analysis represents a new type of information on UHECR sources, independent of the mechanism responsible for the UHECR acceleration. We also explore the possibility of a common origin of UHECRs and astrophysical neutrinos and further constrain sources which are consistent with this possibility. We show that the common origin hypothesis can only be satisfied for certain hadronic interaction models, showing that multimessenger analyses have the power to also constrain hadronic physics beyond LHC energies.'

Collaborations

Keywords and Comments
'Ultrahigh energy cosmic rays; astrophysical neutrinos; multimessenger astrophysics; cosmic ray sources', ''

Branch MM | Multi-Messenger

Subcategory Theoretical Results

An expanding hadronic supercritical model for gamma-ray burst emission

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 47 The central engines of fast transients: Gamma-Ray Bursts and Fast Radio Bursts | GAD-GAI-MM
Presenter Forum Table

Presenter
Ioulia Florou
Author and Co-Author
Ioulia Florou | Apostolos Mastichiadis | Petropoulou Maria,

Abstract
'Relativistic hadronic plasmas have an intriguing property known as hadronic supercriticality: they can, under certain conditions, abruptly and efficiently release the energy stored in protons through photon outbursts. These photon flares may have a direct analogy to those observed from compact astrophysical objects, such as Gamma Ray Bursts (GRBs). Here, we investigate for the first time the manifistation and properties of hadronic supercriticality in adiabatically expanding sources. We consider the injection of relativistic protons in an expanding spherical volume with a radially decaying magnetic field and seek the parameters (e.g., expansion velocity) that lead the system to supercriticality. We apply this idea to the GRB phenomenology by assuming that several such blobs are released consecutively from a central engine with random initial conditions that might bring some of them to supercriticality. We superimpose their lightcurves and photon spectra in order to construct a picture of a typical GRB prompt emission. We also provide the all flavour neutrino fluxes expected under the assumptions of this work and compare them with the standard neutrino models for GRBs.'

Collaborations

Keywords and Comments
'', '[Replacement for abstract #1439 due to technical difficulties]'

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

A calibration study of local ice and optical sensor properties in IceCube

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Dmitry Chirkin
Author and Co-Author
Dmitry Chirkin,

Abstract
'The optical sensors of the IceCube Neutrino Observatory are attached on vertical strings of cables. They were frozen into the ice in the deployment holes made by hot water drill. This hole ice, to the best of our knowledge, consists of a bubbly central column, with the remainder of the re-frozen volume being optically clear. The bubbly ice often blocks one or several of the calibration LEDs in every optical sensor and significantly distorts the angular profile of the calibration light pulses. It also affects the sensors' response to in-coming photons at different locations and directions. We present our modeling of the hole ice optical properties as well as optical sensor location and orientation within the hole ice. The shadowing effects of cable string and possible optical sensor tilt away from the nominal vertical alignment are also discussed.'

Collaborations
IceCube,

Keywords and Comments
'ice calibration', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Performance of a machine learning algorithm for predicting muon multiplicity

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Lakshmi Murgod
Author and Co-Author
Lakshmi Murgod, Deepak Samuel | SOURAV DUTTA

Abstract
'We present here the performance of a machine learning-based algorithm to predict the muon multiplicity using a simulated dataset in which the trigger condition was varied. We also show the performance of this algorithm is selecting interesting events in the prototype detector at TIFR.'

Collaborations

Keywords and Comments
", "

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Studying neutrinos at the LHC-FASER ~ its impact to the cosmic-ray physics

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Akitaka Ariga
Author and Co-Author
Akitaka Ariga,

Abstract
'Studies of high energy proton interactions have been basic inputs to understand the cosmic-ray spectra observed on the earth. Yet, the experimental knowledge with controlled beams has been limited. In fact, uncertainties of the forward hadron production are very large due to the lack of experimental data. The FASER experiment is proposed to measure particles, such as neutrinos and hypothetical dark-sector particles, at the forward location of the 14 TeV proton-proton collisions at the LHC. As it corresponds to 100-PeV proton interactions in fixed target mode, a precise measurement by FASER would provide information relevant for PeV-scale cosmic rays. By studying three flavor neutrinos with the dedicated neutrino detector (FASERnu), FASER will lead to a quantitative understanding of prompt neutrinos, which is an important background towards the astrophysical neutrino observation by neutrino telescopes such as IceCube. In particular, the electron and tau neutrinos have strong links with charmed hadron production. And, the FASER measurements may also shed light on the unresolved muon excess at the high energy. FASER is going to start taking data in 2022. We expect about 8000 numu, 1300 nue and 20 nutau CC interactions at the TeV energy scale during Run 3 of the LHC operation (2022-2024) with a 1.1 tons emulsion-based neutrino detector. We report here the overview and prospect of the FASER experiment in relation to the cosmic-ray physics, together with the first LHC neutrino candidates that we caught in the pilot run held in 2018.'

Collaborations
, FASER

Keywords and Comments
'LHC; high energy neutrinos; prompt neutrinos; muon; tau neutrino', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Direction reconstruction for the Radio Neutrino Observatory Greenland

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Ilse Plaisier
Author and Co-Author
Ilse Plaisier,

Abstract
'The Radio Neutrino Observatory Greenland (RNO-G) is planned to be the first large-scale implementation of the in-ice radio detection technique. It targets astrophysical as well as cosmogenic neutrinos with energies above 10 PeV. The deep component of a single RNO-G station consists of three strings with antennas to capture horizontal as well as vertical polarization. This contribution shows a model-based approach to reconstruct the direction of the neutrinos with an RNO-G station. The timing of the waveforms is used to reconstruct the vertex position and the shape and amplitude of the waveform are used to reconstruct the viewing angle as well as the polarization, which will add up to the zenith and azimuth direction of the neutrino. We present the achieved angular resolution and discuss implications for the science of RNO-G.'

Collaborations
other (fill field below), RNO-G

Keywords and Comments
'direction reconstruction; radio; in-ice detection; RNO-G; neutrinos', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Effects of raytracing on neutrino simulations using RadioPropa

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Bob Oeyen
Author and Co-Author
Bob Oeyen | Ilse Plaisier | Anna Nelles | Christian Glaser | Tobias Winchen,

Abstract
'The in-ice radio detection of the radio signals caused by the interaction of high energy neutrinos in vast natural media like polar ice, will be a promising technique to detect neutrinos of energies beyond the ones thus far measured. Because of the large attenuation length in ice for radio O(1km), sparse arrays can be built implying large effective volumes. \r\n\r\nThe simulations of effective volume calculations and reconstructions of the waveforms highly depend on the ice modelling. Thus far, for simplification, mainly analytically solvable exponential models of the ice are used. This allows for computationally fast raytracing. More elaborate methods, like FDTD (solving Maxwell equations on a full grid) can incorporate all ice properties. In particular, allowing for rays to reflect within the ice due to density discontinuities or allowing rays to travel horizontally through the firn (upper 200 m). However, this method is due to its heavy computing load impractical for large-scale simulations and reconstructions. \r\n\r\nRadioPropa is a numerical ray-tracer that was started to accommodate more complex ice models with acceptable speed. It is forked from the cosmic ray propagation code CRPropa. Presented here are waveform simulations and reconstructions (with respectively NuRadioMC and NuRadioReco) using RadioPropa. This contribution shows the effects of a non-exponential ice-model on the radio waveforms and the implications for reconstruction. Also, the implementation of horizontal propagation due to a non-smooth ice-model and its effect on the neutrino waveforms are shown.'

Collaborations
other (fill field below), RNO-G

Keywords and Comments
'raytracing; in-ice radio detection; neutrinos; ice properties', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Improving Radio Frequency Detectors using High Performance Programmable Logic Devices

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Cheng Xie
Author and Co-Author
Cheng Xie,

Abstract
'An increasing number of experiments are targeting GHz bandwidth impulsive radiation induced by high energy neutrinos in ice or high energy cosmic ray air showers. Beamforming triggers improve detection prospects at low signal-to-noise ratio (SNR), since effective SNR scales as the square root of the number of phased array antennas in a coherent sum. However, this also brings high technological requirements with an increasing number of narrower beams required, while sub-nanosecond synchronisation must be maintained across the antennas summed in each beam. A prototype digital beamforming trigger is developed using Radio-frequency-systems-on-a-chip (RFSoCs), an adaptable radio platform leveraging the advantages of Field Programmable Gate Arrays (FPGAs). Findings are presented including power consumption, number of beams that can be formed per chip, trade-offs between resource usage and trigger efficiency and using programmable logic for flexible digital filtering capabilities.'

Collaborations

Keywords and Comments
'FPGA; beamforming trigger; radio; ultra high energy neutrinos; digital signal processing; Askaryan effect; low-threshold trigger; coherent sum; interferometric phased array', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Discovering the Highest Energy Neutrinos with the Payload for Ultrahigh Energy Observations (PUEO)

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Abigail Vieregg
Author and Co-Author
Abigail Vieregg,

Abstract
'The Payload for Ultrahigh Energy Observations (PUEO) is a NASA Long-Duration Balloon Mission that has been selected for concept development. PUEO have unprecedented sensitivity to ultra-high energy neutrinos above 10^18 eV. PUEO will be sensitive to both Askaryan emission from neutrino-induced cascades in Antarctic ice and geomagnetic emission from upward-going air showers that are a result of tau neutrino interactions. PUEO is also especially well-suited for point source and transient searches. Compared to its predecessor ANITA, PUEO achieves better than an order-of-magnitude improvement in sensitivity and lowers the energy threshold for detection, by implementing a coherent phased array trigger, adding more channels, optimizing the detection bandwidth, and implementing real-time filtering. I will discuss the science reach and plans for PUEO, leading up to a 2024 launch.'

Collaborations
, PUEO

Keywords and Comments
'', 'for the PUEO collaboration'

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

TauRunner: A Monte Carlo for Very-High-Energy Tau Neutrino Propagation

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Oswaldo Vazquez
Author and Co-Author
Oswaldo Vazquez | Ibrahim Safa | Jeffrey Lazar | Alex Pizzuto | Carlos Arguelles | Ali Kheirandish | Justin Vandenbroucke,

Abstract
'Very-High-Energy (VHE) neutrinos are expected to be produced by cosmic-ray interactions with the Cosmic Microwave Background (CMB). In these photo-hadronic interactions, muon- and electron-neutrinos are produced. As these neutrinos traverse the cosmic void, they morph from one flavor to another, yielding, in the standard scenario, a democratic flavor composition at their arrival on Earth. This so-called cosmogenic flux of VHE neutrinos is a target of the next generation neutrino observatories: IceCube-Gen2, TAMBO, RNO, GRAND, POEMMA, and CHANT. In a recent publication, a novel detection strategy for these neutrinos has been put forward. This new technique relies on the observation of Earth-throughgoing tau-neutrinos at PeV energies. By measuring the flux at this energy, we can indirectly observe the flux at EeV energies since these two are related by the cascading down of the neutrinos. However, such a link demands an accurate simulation of the VHE tau neutrino transport. TauRunner is a Python Monte Carlo (MC) package specialized in EeV tau neutrino transport with the limitation of not accounting for secondary flavors produced in some tau decay channels. In this contribution, I will present the newest version of this MC, which now incorporates all the neutrino flavors in the propagation, and discuss its implication for EeV neutrino searches.'

Collaborations
IceCube,

Keywords and Comments
'', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Radio Simulations of Upgoing Extensive Air Showers Observed from Low-Earth Orbit

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Andres Romero-Wolf
Author and Co-Author
Andres Romero-Wolf | Jaime Alvarez-Muñiz | Yosui Akaike | Luis A. Anchordoqui | Douglas Bergman | Ike Buckland | Washington Rodrigues de Carvalho | Austin Cummings | Johannes Eser | Claire Guépin | John Krizmanic | Simon Mackovjak | Angela Olinto | Sameer,

Abstract
'Tau neutrinos interacting in the Earth can result in upgoing extensive air showers. These showers produce optical and radio emission that can be detected by orbital and suborbital platforms. As part of NASA's nuSpaceSim program, to develop a comprehensive end-to-end simulation package to model these signals, we present results of radio emission simulations using ZHAireS for observation from low -Earth orbit. Peculiar properties of the radio emission arise from the fact that these showers develop in extremely rarified portions of the Earth's atmosphere and, being observed from hundreds of kilometers distance, have distinct coherent emission features compared to ground observations.'

Collaborations

Keywords and Comments
'radio detection; ultra-high energy neutrinos; space-based observatories', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Simulation of the propagation of CR air shower cores in ice

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 318

Presenter
Simon De Kockere
Author and Co-Author
Simon De Kockere | Krijn de Vries | Nick van Eijndhoven,

Abstract
'Currently new techniques are being explored to detect astrophysical neutrinos beyond the PeV scale interacting in polar ice by means of the emitted radio waves. Due to the long attenuation length of radio waves in a medium, it can be expected that such instruments will also be sensitive to the in-air radio emission of cosmic ray air showers. Furthermore, cosmic ray air showers hitting a high-altitude layer of ice will initiate an in-ice particle cascade, also leading to radio emission. We present the first results of detailed simulations of these cosmic-ray induced particle cascades in ice, using a combination of the CORSIKA Monte Carlo code and the Geant4 simulation toolkit. We give an overview of the general features of such particle cascades and present a parameterization in terms of Xmax of the longitudinal and lateral particle distributions. We discuss the feasibility of observing the in-ice particle cascades, both through the detection of the Askaryan radio emission as well as by using RADAR reflection techniques. Based on these results we find that the expected signals from the in-ice cosmic-ray induced particle cascades will be very similar to neutrino signals. This means a thorough understanding of these events is necessary in the search for neutrino candidates, while it also promises an interesting in-situ natural calibration source.'

Collaborations
other (fill field below), ARA (Askaryan Radio Array); RNO-G (Radio Neutrino Observatory Greenland); RET (Radar Echo Telescope)

Keywords and Comments
'simulation; CORSIKA; Geant4; cosmic rays; ice; radio; RADAR; parameterization', 'We believe this subject is mostly of interest for people aiming to detect astrophysical neutrinos by means of the detection of emitted radio waves, and therefor indicate the "NU | Neutrinos & Muons" track. However, as the subject of the talk itself is co

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Energy reconstruction with the Radio Neutrino Observatory Greenland (RNO-G)

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 319

Presenter
Christoph Welling
Author and Co-Author
Christoph Welling,

Abstract
'Starting in summer 2021, the Radio Neutrino Observatory Greenland (RNO-G) will search for cosmic neutrinos with energies above 10PeV by detecting Askaryan radio emission from particle showers in the ice of Greenland. It will consist of 35 independent detector stations, each featuring 24 antennas deployed up to a depth of 100m. To cover a large volume, stations are spaced over 1km apart, so that in most cases, a detection will only be made by a single station. Combined with the low signal-to-noise ratio expected for most events, this makes their reconstruction challenging. On this poster, we show how the energy of a detected neutrino can still be reconstructed, which will be important in order to interpret any detected neutrinos and distinguish between astrophysical and cosmogenic neutrino flux.'

Collaborations
other (fill field below), RNO-G

Keywords and Comments
'radio; high-energy neutrinos; event reconstruction; RNO-G', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Monitoring of optical properties of deep lake water

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Evgenii Ryabov
Author and Co-Author
Evgenii Ryabov | Boris Tarashchansky,

Abstract
'We present the results of the one year monitoring of absorption and scattering lengths of light with wave length 375÷532nm within the effective volume deep of underwater neutrino telescope Baikal-GVD, which were measured by a device «BAIKAL-5D». The «BAIKAL-5D» was installed during the 2020y winter expedition at a depth 1250 m. The device has a shaded point-like isotropic light source with spectral resolution about 3nm. A wide angle light receiver is moved by a stepper motor so that the distance between the receiver and the light source changed between 0.9 and 7,4 m. Absorption and scattering lengths were measured every week in 6 spectral points. Shot-time variation of absorption and scattering length was estimated.'

Collaborations
other (fill field below), Baikal-collaboration

Keywords and Comments
'Baikal neutrino project; optical water property; absorption and scattering lengths.', 'For Baikal-collaboration'

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Self-trigger radio prototype array for GRAND

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table

Presenter
Yi Zhang
Author and Co-Author
Yi Zhang, Kumiko Kotera | Olivier Martineau

Abstract
'The GRANDProto300 (GP300) array is a pathfinder of the Giant Radio Array for Neutrino Detection (GRAND) project. The deployment of the array, consisting of 300 antennas, will start in 2021 in a radio-quiet area of ~200km^2 near Lenghu (~3000 m a.s.l.) in China. \r\n\r\nServing as a test bench, the GP300 array is expected to realise techniques of autonomous radio detection such as identification and reconstruction of nearly horizontal cosmic-ray (CR) air showers. In addition, the GP300 array is at a privileged position to study the transition between Galactic and extragalactic origins of cosmic rays, due to the large effective area and the precise measurements of both energy and mass composition for CRs with energies ranging from 30 PeV to 1 EeV. Using the GP300 array we will also investigate the potential sensitivity for radio transients such as Giant Radio Pulses and Fast Radio Bursts at 100-200 MHz range.'

Collaborations
other (fill field below), GRAND collaboration

Keywords and Comments
'Neutrino; Radio; Cosmic ray', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Horizontal muon track identification with neural networks in HAWC

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
José Roberto Angeles Camacho
Author and Co-Author
José Roberto Angeles Camacho | Hermes León Vargas,

Abstract
'Nowadays the implementation of artificial neural networks in high-energy physics has obtained excellent results on improving signal detection. In this work we propose to use neural networks (NNs) for event discrimination in HAWC. This observatory is a water Cherenkov gamma-ray detector that in recent years has implemented algorithms to identify horizontal muon tracks. However, these algorithms are not very efficient. In this work we describe the implementation of two NNs, the first one that focuses on image classification and the second one that is based on object detection. Using these algorithms we obtain an increase in the number of identified tracks. The results of this study could be used in the future to improve the performance of the Earth-skimming technique for the indirect measurement of neutrinos with HAWC.'

Collaborations
HAWC,

Keywords and Comments
'muons; neutrinos; convolutional neural networks; artificial neural networks;', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Supernova Neutrino Detection with LHAASO-MD

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 320

Presenter
Dong Liu
Author and Co-Author
Dong Liu | Jinfan Chang | Shaomin Chen | Hongliang Dai | Cunfeng Feng | Bo Gao | Guanghua Gong | Minhao Gu | Fei Li | Xinhua Ma | Xi Wang | Zhe Wang | Xiong Zuo | on behalf of the LHAASO collaboration,

Abstract
'The core-collapse supernova releases a tremendous number of neutrinos, which can provide insight into many research areas, including particle physics, astrophysics, nuclear physics, and cosmology. We can detect the signal through a positron produced from the inverse beta decay (IBD) interaction between the electron antineutrino and water. The Large High Altitude Air Shower Observatory Main detector (LHAASO-MD) with 51-kton water can serve this purpose. The MD detectors have been designed to have a scattered layout as well as spatial uniformity. We have designed a dedicated supernova trigger system in the data acquisition system to take advantage of these unique detector characteristics. The large numbers of MeV-scale supernova burst neutrinos can be observed from a collective rise in all photomultiplier rates on top of the dark noise. This system effectively suppresses the cosmic ray background, optimizes the neutrino detection sensitivity, and realizes the supernova neutrino detection by optimizing the online trigger, data acquisition, and offline data analysis at LHAASO. The trigger system is estimated to be fully sensitive to 1987A-type supernova bursts throughout most of the Milky Way and can eventually help LHAASO join the SuperNova Early Warning System (SNEWS).'

Collaborations
Lhaaso,

Keywords and Comments
'supernova; neutrino ; inverse beta decay ; LHAASO; trigger', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

The Wavelength-shifting Optical Module (WOM) for the IceCube Upgrade

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
John Rack-Helleis
Author and Co-Author
John Rack-Helleis | Anna Pollmann | For the IceCube collaboration,

Abstract
'The Wavelength-shifting Optical Module, or WOM, is a novel optical sensor that uses wavelength shifting and light guiding to substantially enhance the photosensitive area of UV optical modules. It has been designed for the IceCube Upgrade, a seven-string extension of the IceCube detector planned for the 2023/2024 South Pole deployment season, but its design can be applied to any large particle detector based on the detection of Cherenkov light. The WOM consists of a hollow quartz cylinder (detection area) coated in wavelength shifting paint with two PMTs attached to the end faces of the cylinder. The light-collecting quartz increases the effective photocathode area of the light sensors without producing additional dark current, making it suitable for low-signal, low-noise applications. For larger event distances where UV absorption shifts the spectrum to longer wavelengths, the design can be augmented with PMTs. We will report on the design and performance of the WOM with a focus on the 12 modules in production for deployment in the IceCube Upgrade.'

Collaborations
IceCube,

Keywords and Comments
'Photosensors; IceCube Upgrade', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Enhanced photon detection efficiency for next-generation neutrino telescopes using photon traps

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Koun Choi
Author and Co-Author
Koun Choi | Carsten Rott,

Abstract
'We propose a photon trap designed for improved photon detection efficiency in a cost-efficient way. Wavelength Shifting plastic sheets (WLS) are deployed at the bottom of a PMT, surrounded by dichroic film by which photons are efficiently trapped and guided to the PMT. We measured wave-length dependent transmittance of a commercially available dichroic film in water, a key variable determining photon trapping efficiency. We ran a Geant4 based simulation with the property of the commercially available dichroic film as a realistic case. We also ran a simulation with a hypothetical dichroic film whose bandpass is optimized to absorption and reemission spectra of the WLS and the quantum efficiency of the PMT, as an ideal case. The preliminary results of the photon collection and detection efficiency enhancements are computed, as well as timing distribution of the photons. We discuss how this new conceptual design can be applied to next-generation neutrino telescopes.'

Collaborations

Keywords and Comments
'Cherenkov detectors; Neutrino detectors; Detector design and construction technologies and materials; Detector simulation; Photon detectors for UV; visible and IR photons', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Automatic data processing for Baikal-GVD neutrino observatory

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Bair Shaybonov
Author and Co-Author
Bair Shaybonov,

Abstract
'Baikal-GVD is a gigaton-scale neutrino observatory under construction in Lake Baikal. It currently produces about 100GB of data every day. For their automatic processing, the Baikal Analysis and Reconstruction software (BARS) was developed. At the moment, it includes such stages as a hit extraction from PMT waveforms, assembling events from raw data, assigning timestamps to events, determining the position of the optical modules using an acoustic positioning system, data quality monitoring, muon track and cascade reconstruction, as well as the alert signal generation. These stages are implemented as C++ programs which are executed sequentially one after another and can be represented as a directed acyclic graph. The most resource-consuming programs run in parallel to speed up processing. A separate Python package based on the luigi package is responsible for program execution control. Additional information such as the program execution status and run metadata are saved into a central database and then displayed on the dashboard. Results can be obtained several hours after the run completion.'

Collaborations
, Baikal-GVD

Keywords and Comments
'data management; neutrino; Baikal-GVD; muon track; cascade', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Performance studies for a next-generation optical sensor for IceCube-Gen2

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Nobuhiro Shimizu
Author and Co-Author
Nobuhiro Shimizu | Aya Ishihara | Alexander Kappes,

Abstract
"We present performance studies of a segmented optical module for the IceCube-Gen2 detector. Based on the experience gained in sensor development for the IceCube Upgrade, the new sensor will consist of up to 18 4-inch PMTs housed in a transparent pressure vessel, providing homogeneous 4 pi coverage. The use of custom moulded optical gel 'pads' around the PMTs enhances the photon capture rate via total internal reflection at the gel-air interface. The contribution presents simulation studies of various sensor, PMT, and gel pad geometries aimed at optimizing the sensitivity of the optical module in the face of confined space and harsh environmental conditions."

Collaborations
IceCube-Gen2, IceCube

Keywords and Comments
'IceCube;IceCube-Upgrade;IceCube-Gen2;optical module;PMT', ''

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Subcategory Experimental Methods & Instrumentation

Performance of the D-Egg optical sensor for the IceCube-Upgrade

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Colton Hill
Author and Co-Author
Colton Hill | Aya Ishihara | Ken'ichi Kin | Maximilian Meier | Ryo Nagai | Nobuhiro Shimizu | Shigeru Yoshida | Tyler Anderson | Jim Braun | Aaron Fienberg | Jeff Weber,

Abstract
'New optical sensors called the "D-Egg" have been developed for cost-effective instrumentation for the IceCube Upgrade. With two 8-inch high QE photomultipliers, they offer increased effective photocathode area while retaining as much of the successful IceCube Digital Optical Module (DOM) design as possible. Mass production of D-Eggs has started in 2020. By the end of 2021, there will be 310 D-Eggs produced with 288 deployed in the IceCube Upgrade. The D-Egg readout system uses advanced technologies in electronics and computing power. Each of the two PMT signals is digitized using ultra-low-power 14-bit ADCs with a sampling frequency of 250-MSPS, enabling seamless and lossless event recording from single-photon signals to signals exceeding 200pe within 10ns, as well as flexible event triggering. In this paper, we report the single photon detection performance as well as the multiple photon recording capability of D-Eggs from the mass production line which have been evaluated with the built-in DAQ system.'

Collaborations
IceCube,

Keywords and Comments
'Optical sensor; photodetection; neutrino', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Exploring a PMT+SiPM hybrid optical module for next generation neutrino telescopes

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Fan Hu
Author and Co-Author
Fan Hu, Donglian Xu | Zhuo Li

Abstract
'Cosmic neutrinos are unique probes of the high energy universe. IceCube has discovered a diffuse astrophysical neutrino flux since 2013, but their origin remains elusive. The potential sources could include, for example, active galactic nuclei, gamma-ray bursts and star burst galaxies. To resolve those scenarios, higher statistics and better angular resolution of astrophysical neutrinos are needed. An optical module with larger photon collection area and more precise timing resolution in a next generation neutrino telescope could help. Silicon photon multipliers (SiPMs), with high quantum efficiency and fast responding time, combining with traditional PMTs, could boost photon detection efficiency and pointing capability. We will present a study on exploring the benefits of combining multiple PMTs and SiPMs in an optical module.'

Collaborations

Keywords and Comments
'neutrino telescope; optical module', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Reconstruction of Neutrino Events in IceCube using Graph Neural Networks

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Martin Ha Minh
Author and Co-Author
Martin Ha Minh,

Abstract
"The IceCube Neutrino Observatory is a cubic-kilometer scale neutrino detector embedded in the Antarctic ice of the South Pole. In the near future, the detector will be augmented by extensions, such as the IceCube Upgrade and the planned Gen2 detector. The sparseness of observed charge in the detector for low-energy events, and the irregular detector geometry, have always been a challenge to the reconstruction of the detected neutrino's parameters of interest. This challenge remains with the planned IceCube Upgrade, which introduces seven new detector strings with novel detector modules. The Upgrade modules will increase the detection rate of low-energy events and allow us to further constrain neutrino oscillation physics. However, the geometry of these modules render existing traditional reconstruction algorithms more difficult to use. We introduce a new reconstruction algorithm based on Graph Neural Networks, which we use to reconstruct neutrino events at speeds that are much faster than the traditional algorithms, while providing comparable resolution. We show that our algorithm is applicable not only to reconstructing data of the current IceCube detector, but also simulated events for next-generation extensions, such as the IceCube Upgrade."

Collaborations
IceCube,

Keywords and Comments
'machine learning; artificial intelligence; deep learning', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Studies of systematic uncertainty effects on IceCube's real-time angular uncertainty

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 321

Presenter
Cristina Lagunas Gualda
Author and Co-Author
Cristina Lagunas Gualda | Yosuke Ashida | Ankur Sharma,

Abstract
'Sources of astrophysical neutrinos can be potentially discovered through the detection of neutrinos in coincidence with electromagnetic or gravitational waves. Real-time alerts generated by IceCube play an important role in this search since they act as triggers for follow-up observations with instruments sensitive to other wavelengths. \r\n\r\nOnce a high-energy event is detected by the IceCube real-time program, a complex and time-consuming method is run in order to calculate an accurate localisation. To investigate the effect of systematic uncertainties on the uncertainty estimate of the location, we simulate a set of high-energy events with a wide range of directions for different ice model realisations. This makes use of a novel simulation tool, which allows the treatment of systematic uncertainties with multiple continuously varied nuisance parameters. These events are then reconstructed using various reconstruction methods. This study will enable us to include systematic uncertainties in a robust manner in the real-time direction and error estimates.'

Collaborations
IceCube,

Keywords and Comments
", "

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Low energy radioactivity BG model in Super-Kamiokande detector from SK-IV data

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 322

Presenter
Guillaume Pronost
Author and Co-Author
Guillaume Pronost,

Abstract
"The radioactivity background are among the main backgrounds (BGs) affecting low energy neutrino analysis in Super-Kamiokande (SK), like the solar neutrino analysis. Among them, the main contribution is coming from Rn-222, which is spread in the detector's water due to the water source and to the PMTs emanations. However, up to now, its exact distribution in the detector was not known. Using our knowledge of the radon concentration in the detector water, and the SK-IV solar data, we developed a model of the radon distribution in the detector. We also studied and modeled the impact of the Tl-208 decays from the PMTs, which affect the same energy region than Rn-222.\r\n\r\nThis model will allow to improve our understanding of the low energy BGs affecting the SK experiment, it could also be useful for future experiments like Hyper-Kamiokande."

Collaborations
, Super-Kamiokande

Keywords and Comments
'Neutrino; Radon; Model; Low background', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Deployment of the IceCube Upgrade Camera System in the SPICEcore hole

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Danim Kim
Author and Co-Author
Christoph Toennis | Danim Kim | Anna Pollmann | Carsten Rott,

Abstract
'IceCube is a cubic-kilometer scale neutrino telescope located at the geographic South Pole. The detector utilizes the extremely transparent Antarctic ice as a medium for detecting Cherenkov radiation from neutrino interactions. While the optical properties of the glacial ice are generally well modeled and understood, the uncertainties which remain are still the dominant source of systematic uncertainties for many IceCube analyses. A camera and LED system is being built for the IceCube Upgrade that will enable the observation of optical properties throughout the Upgrade array. The SPICEcore hole, a 1.7 km deep ice-core hole located near the IceCube detector, has given the opportunity to test the performance of the camera system ahead of the Upgrade construction. In this contribution, we present the results of the camera and LED system deployment during the 2019/2020 austral summer season as part of a SPICEcore luminescence logger system.'

Collaborations
IceCube,

Keywords and Comments
'IceCube; South Pole; Ice; Camera; Scattering', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Muon bundle reconstruction with KM3NeT/ORCA using graph convolutional networks

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Stefan Reck
Author and Co-Author
Stefan Reck,

Abstract
"KM3NeT/ORCA is a water-Cherenkov neutrino detector, currently under construction in the Mediterranean Sea at a depth of 2450 meters. The project's main goal is the determination of the neutrino mass hierarchy by measuring the energy- and zenith-angle-resolved oscillation probabilities of atmospheric neutrinos traversing the Earth. Additionally, the detector will observe a large amount of atmospheric muons, which can be used to study the properties of extensive air showers and cosmic ray particles.\r\n\r\nDeep Learning techniques provide promising methods to analyse the signatures induced by the particles traversing the detector. Despite being in an early stage of construction, the data taken so far provide large statistics to investigate the signatures from atmospheric muons. This contribution will cover a deep-learning based approach using graph convolutional networks. Reconstructions of the properties of atmospheric muons like the bundle multiplicity that can aid in studying the primary cosmic ray interactions are presented. Furthermore, the performances are compared to the ones of classical approaches."

Collaborations
KM3NeT,

Keywords and Comments
'Atmospheric muon; deep learning; graph; KM3NeT; Orca', ''

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Subcategory Experimental Methods & Instrumentation

POCAM in the IceCube Upgrade

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Nikhita Khera
Author and Co-Author
Nikhita Khera, Felix Henningsen | POCAM Team

Abstract
'The IceCube Neutrino Observatory at the geographic South Pole instruments a gigaton of glacial Antarctic ice with over 5000 photosensors. The detector, by now running for over a decade, will be upgraded with seven new densely instrumented strings. The project focuses on the improvement of low-energy and oscillation physics sensitivities as well as re-calibration of the existing detector. Over the last few years we developed a precision optical calibration module (POCAM) providing self-monitored isotropic nanosecond light pulses for optical calibration of large-volume detectors. Over 20 next-generation POCAMs will be calibrated and deployed in the IceCube Upgrade in order to reduce existing detector systematics. We report a general overview of the POCAM instrument, its performance and calibration procedures, as well as simulation studies to estimate its anticipated physics impact.'

Collaborations
IceCube,

Keywords and Comments
", "

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

An improved trigger for Askaryan radio detectors

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Christian Glaser
Author and Co-Author
Christian Glaser | Steven Barwick,

Abstract
'High-energy neutrinos with energies above a few $10^{16}~$eV can be measured efficiently with in-ice radio detectors which complement optical detectors such as IceCube at higher energies. Several pilot arrays explore the radio technology successfully in Antarctica. Because of the low flux and interaction cross-section of neutrinos it is vital to increase the sensitivity of the radio detector as much as possible. In this manuscript, different approaches to trigger on high-energy neutrinos are systematically studied and optimized. We find that the sensitivity can be improved substantially (by more than 50% between $10^{17}~$eV and $10^{18}~$eV) by simply restricting the bandwidth in the trigger to frequencies between 80 and 200 MHz instead of the currently used 80 to $1~$GHz bandwidth. We also compare different trigger schemes that are currently being used (a simple amplitude threshold, a high/low threshold trigger and a power-integration trigger) and find that the scheme that performs best depends on the dispersion of the detector. These findings inform the detector design of future Askaryan detectors and can be used to increase the sensitivity to high-energy neutrinos significantly without any additional costs. The findings also apply to the phased array trigger concept.'

Collaborations

Keywords and Comments
'Askaryan;UHE neutrinos;trigger optimization;in-ice radio detection;radio;', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Deep learning reconstruction of the neutrino energy with a shallow Askaryan detector

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Christian Glaser
Author and Co-Author
Christian Glaser | Stephen McAleer | Pierre Baldi | Steven Barwick,

Abstract
'Cost effective in-ice radio detection of neutrinos above a few $10^{16}~$eV has been explored successfully in pilot-arrays. A large radio detector is currently being constructed in Greenland with the potential to measure the first cosmogenic neutrino, and an order-of-magnitude more sensitive detector is being planned with IceCube-Gen2. We present the first end-to-end reconstruction of the neutrino energy from radio detector data. NuRadioMC was used to create a large data set of 40 million events of expected radio signals that are generated via the Askaryan effect following a neutrino interaction in the ice for a broad range of neutrino energies between 100PeV and 10EeV. We simulated the voltage traces that would be measured by the five antennas of a shallow detector station in the presence of noise. We trained a deep neural network to determine the shower energy directly from the simulated experimental data and achieve a resolution better than a factor of two (STD <0.3 in $\\log_{10}(E)$) which is below the irreducible uncertainty from inelasticity fluctuations. We present the model architecture and discuss the generalizability of the model in the presence of systematic uncertainties in the simulation code. This method will enable Askaryan detectors to measure the neutrino energy.'

Collaborations

Keywords and Comments
'deep learning;Askaryan;UHE neutrinos;in-ice radio detection;energy reconstruction;radio', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

KM3NeT Detection Unit Line Fit reconstruction using positioning sensors data

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Chiara Poirè
Author and Co-Author
Chiara Poirè | Dídac Diego Tortosa, For the KM3NeT Collaboration

Abstract
'KM3NeT is constructing two large neutrino detectors in the Mediterranean Sea: KM3NeT/ARCA, located near Sicily and aiming at neutrino astronomy, and KM3NeT/ORCA, located near Toulon and designed for neutrino oscillation studies. \r\nThe two detectors, together, will have hundreds of Detection Units (DUs) with 18 Digital Optical Modules (DOMs) maintained vertical by buoyancy, forming a large 3D optical array for detecting the Cherenkov light produced after the neutrino interactions. To properly reconstruct the direction of the incoming neutrino, the position of the DOMs must be known precisely with an accuracy of less than 10 cm, and since the DUs are affected by sea current the position will be measured every 10 minutes.\r\nFor this purpose, there are acoustic and orientation sensors inside the DOMs. An Attitude Heading Reference System (AHRS) chip provides the components values of the Acceleration and Magnetic field in the DOM, from which it is possible to calculate Yaw, Pitch and Roll for each floor of the line. A piezo sensor detects the signals from fixed acoustic emitters on the sea floor, so to position it by trilateration.\r\nData from these sensors are used as an input to reconstruct the shape of the entire line based on a DU Line Fit mechanical model. This poster presents an overview of the KM3NeT monitoring system, as well as the line fit model and its results.'

Collaborations
KM3NeT,

Keywords and Comments
'', 'on behalf of KM3NeT Collaboration'

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Reconstructing Neutrino Energy using CNNs for GeV Scale IceCube Events

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Jessie Micallef
Author and Co-Author
Jessie Micallef | For the IceCube Collaboration,

Abstract
'Measurements of neutrinos at and below 10 GeV provides unique constraints of neutrino oscillation parameters as well as probes of potential Non-Standard Interactions (NSI). The IceCube Neutrino Observatory's DeepCore array is designed to detect neutrinos down to GeV scales. This work uses convolutional neural networks (CNNs) to improve the energy reconstruction resolution and speed of reconstructing 10-GeV scale neutrino events in IceCube. Compared to past likelihood-based methods which take seconds to minutes, the CNN is expected to provide approximately a factor of 2 improvement in energy resolution and reconstructs in milliseconds which is a great advantage for large datasets.'

Collaborations
IceCube,

Keywords and Comments
'neural network; convolutional neutral network; CNN; machine learning; reconstruction', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Neutrino Direction Reconstruction using a CNN for GeV-Scale Neutrinos in IceCube

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Shiqi Yu
Author and Co-Author
Shiqi Yu | For the IceCube Collaboration,

Abstract
'The IceCube Neutrino Observatory is designed to observe neutrinos interacting deep within the South Pole ice. It consists of 5,160 digital optical modules, which are arrayed over a cubic kilometer from 1,450 m to 2,450 m depth. At the lower center of the array is the DeepCore subdetector. It has a denser configuration which lowers the observable energy threshold to the GeV scale and creates the opportunity to study neutrino oscillations with low energy atmospheric neutrinos. A precise reconstruction of neutrino direction is critical in the measurements of oscillation parameters. In this poster, I will present a method to reconstruct the zenith angle of GeV-scale events in IceCube by using a convolutional neural network (CNN) and compare the result to that of the current likelihood-based reconstruction algorithm.'

Collaborations
IceCube,

Keywords and Comments
'', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Neutrino direction and flavor-id reconstruction from radio detector data using deep learning

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Sigfrid Stjärnholm
Author and Co-Author
Sigfrid Stjärnholm | Oscar Ericsson | Christian Glaser,

Abstract
'With the construction of RNO-G and plans for IceCube-Gen2, neutrino astronomy at EeV energies is at the horizon for the next years. Here, we determine the neutrino pointing capabilities and explore the sensitivity to the neutrino flavor for an array of shallow radio detector stations. The usage of deep learning for event reconstruction is enabled through recent advances in simulation codes that allow the simulation of realistic training data sets. A large data set of expected radio signals for a broad range of neutrino energies between 100 PeV and 10 EeV is simulated using NuRadioMC. A deep neural network is trained on this low-level data and we find a direction resolution of a few degrees for all triggered events. We present the model architecture, how we optimized the model, and how robust the model is against systematic uncertainties. Furthermore, we explore the capabilities of a radio neutrino detector to determine the flavor id.'

Collaborations

Keywords and Comments
'deep learning; Askaryan; UHE neutrinos; in-ice radio detection; direction reconstruction; radio', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Design of an Efficient, High-Throughput Photomultiplier Tube Testing Facility for the IceCube Upgrade

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Lasse Halve
Author and Co-Author
Lasse Halve | For the IceCube Collaboration,

Abstract
'The IceCube Upgrade is an extension of the IceCube detector at the geographic South Pole. It consists of seven new strings with novel instrumentation. More than 430 multi-PMT optical modules called "mDOMs", housing 24 3-inch PMTs each, will be produced for the Upgrade. This will require testing and pre-calibration on a short timescale of more than 10,000 PMTs prior to assembly and deployment. We present the design of a PMT testing facility that enables simultaneous testing of roughly 100 PMTs per day at temperatures down to -20°C. The design is implemented at RWTH Aachen University and TU Dortmund University in parallel to achieve a throughput of up to 1,000 PMTs per week. This will enable a steady supply of tested PMTs to the production sites, which is critical for the Upgrade, as well as the future IceCube-Gen2 project.'

Collaborations
IceCube,

Keywords and Comments
'PMTs; Photomultiplier; Testing; Acceptance Tests; mDOM; IceCube Upgrade; Hamamatsu', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Design, performance, and analysis of a measurement of optical properties of antarctic ice below 400 nm

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Jannes Brostean-Kaiser
Author and Co-Author
Jannes Brostean-Kaiser,

Abstract
"The IceCube Neutrino Observatory, located at the geographic South Pole, is the world's largest neutrino telescope, instrumenting 1 km³ of Antarctic ice with 5160 photosensors to detect Cherenkov light. For the IceCube Upgrade, to be deployed during the 2022-23 polar field season, and the enlarged detector IceCube-Gen2 several new optical sensor designs are under development. One of these optical sensors, the Wavelength-shifting Optical Module (WOM), uses wavelength-shifting and light-guiding techniques to measure Cherenkov photons in the UV-range from 380 to 250 nm. In order to understand the potential gains from this new technology, a measurement of the scattering and absorption lengths of UV light was performed in the SPICEcore borehole at the South Pole during the winter seasons of 2018/2019 and 2019/2020. For this purpose, a calibration device with a UV light source and a detector using the wavelength shifting technology was developed. We present the design of the developed calibration device, its performance during the measurement campaigns, and the best fit comparing the data to a Monte Carlo simulation."

Collaborations
IceCube,

Keywords and Comments
'IceCube; Calibration; SPICEcore', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Hardware Development for the Radio Neutrino Observatory in Greenland (RNO-G)

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Daniel Smith
Author and Co-Author
Daniel Smith,

Abstract
"The Radio Neutrino Observatory in Greenland (RNO-G) is designed to make the first observations of ultra-high energy neutrinos at energies above 10 PeV, playing a unique role in multi-messenger astrophysics as the world's largest in-ice Askaryan radio detection array. The experiment will be composed of 35 autonomous stations deployed over a 5 x 6 km grid near NSF Summit Station in Greenland. The electronics chain of each station is optimized for sensitivity and low power, incorporating 100 - 600 MHz RF antennas at both the surface and in ice boreholes, low-noise amplifiers, custom RF-over-fiber systems, and an FPGA-based phased array trigger. Each station will operate at 25 W, allowing for a live time of ~70% from a solar power system. The communications system is composed of a high-bandwidth LTE network and an ultra-low power LoRaWAN network. I will also present on the calibration and DAQ systems, as well as status of the first deployment of 10 stations in Summer 2021."

Collaborations
other (fill field below), RNO-G

Keywords and Comments
'Neutrino Observatory; Hardware; Radio; Antenna; RF; Ice; Greenland', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

The Acoustic Module for the IceCube Upgrade

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Christoph Günther
Author and Co-Author
For the IceCube Collaboration, Dirk Heinen | Zierke Simon | Jürgen Borowka | Christoph Günther

Abstract
'The IceCube Neutrino Observatory will be upgraded with more than 700 additional optical sensor modules and new calibration devices. Improved calibration will enhance IceCube's physics capabilities both at low and high neutrino energies. An important ingredient for good angular resolution of the observatory is precise calibration of the positions of optical sensors. Ten acoustic modules, which are capable of receiving and transmitting acoustic signals, will be attached to the strings. These signals can additionally be detected by compact acoustic sensors inside some of the optical sensor modules. With this system we aim for calibration of the detectors' geometry with a precision better than 10 cm by means of trilateration of the arrival times of acoustic signals. This new method will allow for an improved and complementary geometry calibration with respect to previously used methods based on optical flashers and drill logging data. The longer attenuation length of sound compared to light makes the acoustic module a promising candidate for IceCube-Gen2, which may have optical sensors on strings with twice the current spacing. We present an overview of the technical design and tests of the system as well as analytical methods for determining the propagation times of the acoustic signals.'

Collaborations
IceCube,

Keywords and Comments
'Geometry calibration; Acoustic transducer; Trilateration; Glaciology; Applied acoustics; Sound absorption coefficient', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Method and device for tests of the laser optical calibration system for the Baikal-GVD underwater neutrino Cherenkov telescope

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Konrad Kopański
Author and Co-Author
Konrad Kopański, Wojciech Noga | Mateusz Wiśniewski | Dariusz Gora | Apoorva Bhatt | Paweł Malecki | Jaroslaw Stasielak

Abstract
'The large-scale deep underwater Cherenkov neutrino telescopes like Baikal-GVD, ANTARES or KM3NeT, require calibration and testing methods of their optical modules. These methods usually include laser-based systems which allow to check the telescope responses to the light and for real-time monitoring of the optical parameters of water such as absorption and scattering lengths, which show seasonal changes in natural reservoirs of water. We will present a testing method of a laser calibration system and a set of dedicated tools developed for BaikalGVD, which includes a specially designed and built, compact, portable, and reconfigurable scanning station. This station is adapted to perform fast quality tests of the underwater laser sets just before their deployment in the telescope structure. The testing procedure includes the energy stability test of the laser device, 3D scan of the light emission from the diffuser and attenuation test of the optical elements of the laser calibration system. The test bench consists primarily of an automatic mechanical scanner with a movable Si detector, beam splitter with a reference Si detector and, optionally, Q-switched diode-pumped solid-state laser used for laboratory scans of the diffusers. The presented test bench enables a three-dimensional scan of the light emission from diffusers, which are designed to obtain the isotropic distribution of photons around the point of emission. The results of the measurement can be easily shown on a 3D plot immediately after the test and may be also implemented to a dedicated program simulating photons propagation in water, which allows to check the quality of the diffuser in the scale of the Baikal-GVD telescope geometry.'

Collaborations
, Baikal-GVD

Keywords and Comments
'Baikal-GVD; BGVD; neutrino telescopes; Cherenkov telescopes; testing method; 3D scan; laser; test bench; optical diffuser; instrumentation; photon propagation', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

A next-generation optical sensor for IceCube-Gen2

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Vedant Basu
Author and Co-Author
Vedant Basu | Aya Ishihara | Markus Dittmer | Nobuhiro Shimizu | For the IceCube Collaboration,

Abstract
'For the in-ice component of the next generation neutrino observatory at the South Pole, IceCube-Gen2, a new sensor module is being developed, which is an evolution of the DEgg and mDOM sensors developed for the IceCube Upgrade. The sensor design features up to 18 4-inch PMTs distributed homogeneously in a borosilicate glass pressure vessel. Challenges arise for the mechanical design from the tight constraints on the bore hole diameter (which will be 2 inches smaller than for IceCube Upgrade) and from the close packing of the PMTs. The electronics design must meet the space constraints posed by the mechanical design as well as the power consumption and cost considerations from over 10,000 optical modules being deployed. This contribution presents forward-looking solutions to these design considerations. Prototype modules will be installed and integrated in the IceCube Upgrade.'

Collaborations
IceCube-Gen2, IceCube

Keywords and Comments
'''IceCube;IceCube-Upgrade;IceCube-Gen2; Optical Module; PMT''', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

An efficient hit finding algorithm for Baikal-GVD muon reconstruction

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Bair Shaybonov
Author and Co-Author
Bair Shaybonov,

Abstract
"The Baikal-GVD is a large scale neutrino telescope being constructed in Lake Baikal. The majority of the signals detected by the telescope's photosensors are noise hits, caused primarily by the luminescence in the Baikal water. Separating noise hits from the hits produced by Cherenkov light emitted from the muon track is a challenging part of the muon event reconstruction. We present an algorithm that utilizes a known directional hit causality criterion to construct a graph of hits and then use a clique-based technique to select the subset of signal hits. The algorithm was tested on realistic detector Monte-Carlo simulation for a wide range of muon energies and has proved to select a pure sample of PMT hits from Cherenkov photons while retaining above 90% of original signal."

Collaborations
, Baikal-GVD

Keywords and Comments
'neutrino; hit finding; muon track', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Camera Calibration for the IceCube Upgrade and Gen2

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Woosik Kang
Author and Co-Author
Woosik Kang | Carsten Rott | Christoph Toennis | Gerrit Roellinghoff | Jiwoong Lee, For the IceCube Collaboration

Abstract
'An upgrade to the IceCube Neutrino Telescope is currently under construction. For the Upgrade, seven new strings will be deployed in the central region of the 86 string IceCube detector to enhance the capability to detect neutrinos in the GeV range. One of the main science objectives of the Upgrade is an improved calibration of the IceCube detector to reduce systematic uncertainties related to the optical properties of the ice. We have developed a novel optical camera and illumination system that will be part of 700 newly developed optical modules to be deployed with the Upgrade. A combination of transmission and reflection photographic measurements will be used to measure the optical properties of bulk ice between strings and refrozen ice in the drill hole, to determine module positions, and to survey the local ice environments surrounding the sensor module. In this contribution, we present the production design, acceptance testing, and plan for post-deployment calibration measurements with the camera system.'

Collaborations
IceCube,

Keywords and Comments
'IceCube; IceCube Upgrade; Detector calibration; Camera system', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Combining Maximum-Likelihood with Deep Learning for Event Reconstruction in IceCube

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Mirco Hünnefeld
Author and Co-Author
Mirco Hünnefeld | For the IceCube Collaboration,

Abstract
'The field of deep learning has become increasingly important for particle physics experiments, yielding a multitude of advances, predominantly in event classification and reconstruction tasks. Many of these applications have been adopted from other domains. However, data in the field of physics are unique in the context of machine learning, insofar as their generation process and the law and symmetries they abide by are usually well understood. Most commonly used deep learning architectures fail at utilizing this available information. In contrast, more traditional likelihood-based methods are capable of exploiting domain knowledge, but they are often limited by computational complexity. In this contribution, a hybrid approach is presented that utilizes generative neural networks to approximate the likelihood, which may then be used in a traditional maximum-likelihood setting. Domain knowledge, such as invariances and detector characteristics, can easily be incorporated in this approach. The hybrid approach is illustrated by the example of event reconstruction in IceCube.'

Collaborations
IceCube,

Keywords and Comments
'deep learning; generative neural networks; maximum likelihood; reconstruction; IceCube', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Experimental string with fiber optic data acquisition for Baikal-GVD

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Vladimir Aynutdinov
Author and Co-Author
Vladimir Aynutdinov | For the Baikal-GVD Collaboration,

Abstract
'The first stage of the construction of the deep underwater neutrino telescope Baikal-GVD is planned to be completed in 2024. The second stage of the detector deployment is planned to be carried out using a data acquisition system based on fiber optic technologies, which will allow for an increased data throughput and looser, more flexible trigger conditions, thus maximizing the neutrino detection efficiency. A dedicated experimental string has been built and deployed at the Baikal-GVD site to test the new technological solutions. We present the principle of operation and the results of in-situ tests of the experimental string.'

Collaborations
, Baikal-GVD

Keywords and Comments
'Neutrino telescopes; data acquisition; optic fiber', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Time synchronization of Baikal-GVD clusters

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Vladimir Aynutdinov
Author and Co-Author
Vladimir Aynutdinov | For the Baikal-GVD Collaboration,

Abstract
'Currently, the Baikal-GVD neutrino telescope consists of 7 clusters of 288 photodetectors. Each cluster is a functionally complete detector which can register events in stand-alone mode and jointly with other clusters. Joint operation of the clusters requires time synchronization with nanosecond accuracy. This paper presents the methods of time synchronization of the clusters, the results of a study of the synchronization accuracy using laser beacons, and first results of combining events from several clusters.'

Collaborations
, Baikal-GVD

Keywords and Comments
'Neutrino telescopes; time synchronization; calibration', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Development of an in-situ calibration device of firn properties for Askaryan neutrino detectors

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Jakob Beise
Author and Co-Author
Jakob Beise | For the ARIANNA collaboration,

Abstract
"High energy neutrinos (E>10^{17} eV) are detected cost-efficiently via the Askaryan effect in ice, where a particle cascade induced by the neutrino interaction produces coherent radio emission that can be picked up by antennas installed below the surface. A good knowledge of the firn properties is required to reconstruct the neutrino properties. In particular, a continuous monitoring of the snow accumulation (which changes the depth of the antennas) and the index-of-refraction profile are crucial for an accurate determination of the neutrino's direction and energy. We present an in-situ calibration system that extends the radio detector station with a radio emitter to continuously monitor the firn properties by measuring time differences of direct and reflected (off the surface) signals (D'n'R). We optimized the station layout in a simulation study and quantified the achievable precision. We present 14 months of data of the ARIANNA detector on the Ross Ice Shelf, Antarctica, where a prototype of this calibration system was successfully used to monitor the snow accumulation with unprecedented precision of 1mm. We explore and test several algorithms to extract the D'n'R time difference from noisy data (including deep learning). This constitutes an in-situ test of the neutrino vertex distance reconstruction using the D'n'R technique which is needed to determine the neutrino energy."

Collaborations
other (fill field below), ARIANNA

Keywords and Comments
'Askaryan; UHE neutrinos; in-ice radio detection; energy reconstruction; radio; deep learning; in-situ detector calibration', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Design and performance of the multi-PMT optical module for IceCube Upgrade

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Lew Classen
Author and Co-Author
Lew Classen | Christopher Wendt Wendt | Sarah Mechbal | Martin Antonio Unland Elorrieta | Karl-Heinz Sulanke | Tyler Anderson | Aaron Fienberg | Judith Schneider | For the IceCube Collaboration,

Abstract
"The IceCube Upgrade is the first step towards the next-generation neutrino observatory at the South Pole, IceCube-Gen2, and will be installed in the central region of the existing array. The Upgrade will consist of 693 newly developed, densely spaced optical sensors and 50 standalone calibration devices, which will enhance IceCube's capabilities both at low and high neutrino energies. 402 of the new sensors will be multi-PMT Digital Optical Modules (mDOMs). Consisting of 24 small photomultipliers arranged inside a pressure vessel, the mDOM features a large sensitive area distributed nearly homogeneously over the full solid angle. The use of multiple, individually read-out PMTs allows directional information to be obtained for the registered photons and enables the use of multiplicity triggering within a single module, e.g., for background suppression. The challenges driving the mDOM development included tight restrictions on module size, data-transfer rate, and power consumption as well as the harsh environment in the deep ice at the South Pole. In this contribution we present the final mDOM design that meets these challenges."

Collaborations
IceCube,

Keywords and Comments
'neutrino telescopes; optical sensors;', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Short-Baseline neutrino oscillation searches with the ICARUS detector

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 324

Presenter
Umut Kose
Author and Co-Author
Alessandro Menegolli | Umut Kose,

Abstract
'The ICARUS collaboration employed the 760-ton T600 detector in a successful three-year physics run at the underground LNGS laboratories studying neutrino oscillations with the CNGS neutrino beam from CERN, and searching for atmospheric neutrino interactions. ICARUS performed a sensitive search for LSND-like anomalous $\\nu_e$ appearance in the CNGS beam, which contributed to the constraints on the allowed parameters to a narrow region around 1 eV^2, where all the experimental results can be coherently accommodated at 90% C.L. After a significant overhaul at CERN, the T600 detector has been installed at Fermilab. In 2020 cryogenic commissioning began with detector cool down, liquid Argon filling and recirculation. ICARUS has started operations and is presently in its commissioning phase with the aim of collecting the first neutrino events from the Booster Neutrino Beam and the NuMI off-axis beam. The main goal of the first year of ICARUS data taking will then be the definitive verification of the recent claim by NEUTRINO-4 short baseline reactor experiment both in the $\\nu_\\mu$ channel with the BNB and in the $\\nu_e$ with NuMI. After the first year of operations, ICARUS will commence its search for evidence of a sterile neutrino jointly with the SBND near detector, within the Short Baseline Neutrino (SBN) program. The ICARUS exposure to the NuMI beam will also give the possibility for other physics studies such as light dark matter searches and neutrino-Argon cross section measurements. The proposed contribution will address ICARUS achievements, its status and plans for the new run at Fermilab and the ongoing developments of the analysis tools needed to fulfill its physics program.'

Collaborations
other (fill field below), ICARUS

Keywords and Comments
'Sterile neutrinos; Liquid argon TPC;', "The abstract is being submitted by the chair of the Speaker's Board of the ICARUS Collaboration. Therefore the name is only a placeholder. The final name of the speaker will be communicated after the talk will be confirmed."

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Modeling and Validating RF-Only Interferometric Triggering with Cosmic Rays for BEACON

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table

Presenter
Andrew Zeolla
Author and Co-Author
Andrew Zeolla,

Abstract
'The Beamforming Elevated Array for COsmic Neutrinos (BEACON) is a novel detector concept that utilizes a radio interferometer atop a mountain to search for the radio emission from extensive air showers created by Earth-skimming tau neutrinos. The prototype, located at the White Mountain Research Station in California, consists of 4 crossed-dipole antennas operating in the 30-80 MHz range and uses a directional interferometric trigger for reduced thresholds and background rejection. The prototype will first be used to detect down-going cosmic rays to validate the detector model. Here, we present the methodology and results of a Monte-Carlo simulation developed to predict the acceptance of the prototype to cosmic rays. In this simulation, cosmic ray induced air showers are generated in an area around the prototype array. It is then determined if a given shower triggers the array using radio emission simulations from ZHAireS and antenna modelling from XFdtd. The time-domain waveforms, event rates, and angular distributions predicted by this simulation can then be compared with experimental data to validate the detector model.'

Collaborations
other (fill field below), BEACON

Keywords and Comments
'BEACON; radio; simulation; antenna array', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

The SkyLLH framework for IceCube point-source search

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Tomas Kontrimas
Author and Co-Author
Tomas Kontrimas | Martin Wolf | for the IceCube Collaboration,

Abstract
'Hypothesis tests based on unbinned log-likelihood (LLH) functions are a common technique used in multi-messenger astronomy, including IceCube\'s neutrino point-source searches. We present the general Python-based tool "SkyLLH", which provides a modular framework for implementing and executing log-likelihood functions to perform data analyses with multi-messenger astronomy data. Specific SkyLLH framework features for a new and improved time-integrated IceCube point-source analysis are highlighted, including the support for kernel density estimation (KDE) based probability density functions. In addition, the support for a variety of point-source analysis types, such as stacked and time-variable searches, will be presented.'

Collaborations
IceCube,

Keywords and Comments
'', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

A novel trigger based on neural networks for radio neutrino detectors

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Astrid Anker
Author and Co-Author
Astrid Anker | Manuel Paul | For the ARIANNA Collaboration,

Abstract
'The ARIANNA experiment is a proposed Askaryan detector designed to record radio signals induced by neutrino interactions in the Antarctic ice. Because of the low neutrino flux at high energies, the physics output is limited by statistics. Hence, an increase in sensitivity will significantly improve the interpretation of data and will allow us to probe new parameter spaces. The trigger thresholds are limited by the rate of triggering on unavoidable thermal noise fluctuations. Here, we present a real-time thermal noise rejection algorithm that will allow us to lower the thresholds substantially and increase the sensitivity by up to a factor of two compared to the current ARIANNA capabilities. A deep learning discriminator, based on a Convolutional Neural Network (CNN), was implemented to identify and remove a high percentage of thermal events in real time while retaining most of the neutrino signal. We describe a CNN that runs efficiently on the current ARIANNA microcomputer and retains 94% of the neutrino signal at a thermal rejection factor of 10^5. Finally, we report on the experimental verification from lab measurements.'

Collaborations
other (fill field below), ARIANNA

Keywords and Comments
'Askaryan; UHE neutrinos; in-ice radio detection; trigger optimization; radio; deep learning', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

CNN-based event filtering in the ICARUS T600 detector using PMT

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Marta Babicz
Author and Co-Author
Marta Babicz, Stephen Dolan | Saul Alonso Monsalve

Abstract
'The ICARUS T600 detector is the far detector for the Short-Baseline Neutrino (SBN) program at Fermilab, aiming to identify potential neutrino oscillations using the O(1 GeV) neutrino energy Booster Neutrino Beam (BNB). ICARUS is the largest Liquid Argon Time Projection Chamber (LAr-TPC) currently used in neutrino physics, containing 500 tons of Argon in its active volume. LAr-TPC technology offers precise spatial and energy measurements based on the electron drift signal from Argon ionisation, in addition to accurate timing measurements from a prompt scintillation signal. These prompt scintillation signals are detected by 360 Photomultiplier Tubes (PMTs) and are used for triggering purposes as well as in the determination of the interaction time, which is needed in conjunction with the electron drift signal for particle tracking. \r\nAs ICARUS is a large detector operating at shallow depths, it faces the considerable challenge of identifying genuine neutrino interactions on top of a pervading background from cosmic rays. Even within the short BNB neutrino production window, cosmic rays are expected to outnumber neutrino interactions by more than three to one. In this work we investigate the possibility of using a machine learning based approach to separate neutrino interactions from such cosmic backgrounds. We train a 3D convolutional neural network using low level timing and charge readout information from the PMTs. Preliminary simulated results suggest we are able to reduce cosmic background from 77% to 34% whilst maintaining a neutrino interaction selection efficiency of 91%.'

Collaborations
other (fill field below), ICARUS

Keywords and Comments
'machine learning; CNN; photodetectors; background rejection; LArTPC; event filtering', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Potential of Core-Collapse Supernova Neutrino Detection at JUNO

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Xin Huang
Author and Co-Author
Xin Huang,

Abstract
'JUNO is an underground neutrino observatory under construction in Jiangmen, China. It uses 20kton liquid scintillator as target, which enables it to detect supernova burst neutrinos of a large statistics for the next galactic core-collapse supernova (CCSN) and also pre-supernova neutrinos from the nearby CCSN progenitors. All flavors of supernova burst neutrinos can be detected by JUNO via several interaction channels, including inverse beta decay, elastic scattering on electron and proton, interactions on C12 nuclei, etc. This retains the possibility for JUNO to reconstruct the energy spectra of supernova burst neutrinos of all flavors. The real time monitoring systems based on FPGA and DAQ are under development in JUNO, which allow prompt alert and trigger-less data acquisition of CCSN events. The alert performances of both monitoring systems have been thoroughly studied using simulations. Moreover, once a CCSN is tagged, the system can give fast characterizations, such as directionality and light curve. This talk will give an overview of physics potential of CCSN neutrino detection in JUNO.'

Collaborations
other (fill field below), JUNO

Keywords and Comments
'supernova detection', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Sensitivity estimates for diffuse, point-like and extended neutrino sources with KM3NeT/ARCA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 325

Presenter
Rasa Muller
Author and Co-Author
Rasa Muller | Alfonso Garcia Soto | Aart Heijboer | Barbara Caiffi | Vladimir Kulikovskiy | Matteo Sanguineti,

Abstract
'The identification of cosmic objects emitting high energy neutrinos could provide new insights about the Universe and its active sources. The existence of these cosmic neutrinos has been proven by the IceCube collaboration, but the big question of which sources these neutrinos originate from, remains unanswered. The KM3NeT detector for Astroparticle Research with Cosmics in the Abyss (ARCA), with a cubic kilometer instrumented volume, is currently being built in the Mediterranean Sea. It will excel at identifying cosmic neutrino sources due to its unprecedented angular resolution for muon neutrinos (< 0.2 degree for E > 10 TeV events). KM3NeT has a view of the sky complementary to IceCube, and is sensitive to neutrinos across a wide range of energies. In order to identify the signature of cosmic neutrino sources in the background of atmospheric neutrinos and muons, statistical methods are being developed and tested with Monte-Carlo pseudo-experiments. This contribution presents the most recent sensitivity estimates for diffuse, point-like and extended neutrino sources with KM3NeT/ARCA.'

Collaborations
KM3NeT,

Keywords and Comments
'Sensitivity; high energy; cosmic neutrinos; diffuse flux; point sources; extended sources; astroparticle physics; KM3NeT; ARCA;', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Design of a Robust Fiber Optic Communications System for Future IceCube Detectors

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 327

Presenter
Robert Halliday
Author and Co-Author
Robert Halliday | Tyce DeYoung | Chris Ng | Darren Grant | Brian Ferguson | For the IceCube Collaboration,

Abstract
"In this work we discuss ongoing development of a hybrid fiber optic/electrical data and timing infrastructure for the future IceCube Gen2 detector. The IceCube Neutrino Observatory is a kilometer-scale detector operating with 86 strings of modules. These modules communicate and transfer time stamps utilizing a custom protocol to mitigate the challenges of multi-kilometer cables such as signal attenuation, crosstalk and power delivery. Moving past the limitations of a copper-based backbone will enable larger future IceCube detectors with sub-nanosecond timing and approximately six times IceCube's current per-sensor throughput to accommodate innovative future modules. To this end, the upcoming IceCube Upgrade offers an opportunity to deploy a pathfinder for the new fiber optic infrastructure, called the Fiber Test System. This design draws on experience from AMANDA and IceCube and incorporates recently matured technologies such as ruggedized fibers and White Rabbit timing to deliver robust and high-performance data and timing transfer."

Collaborations
IceCube,

Keywords and Comments
'IceCube; Fiber; White Rabbit; DAQ; Networking; Neutrinos; Astrophysics; Precision Timing', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Performance of the muon track reconstruction with the Baikal-GVD neutrino telescope

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Grigory Safronov
Author and Co-Author
Grigory Safronov,

Abstract
'Baikal-GVD is a cubic-kilometer scale neutrino detector being\r\nconstructed in Lake Baikal. After the deployment campaign in spring\r\n2020 the telescope includes over 2000 optical modules distributed\r\namong 56 strings. Effective volume for the detection of high-energy\r\ncharged particle cascades constitutes 0.35 km^3. Muon (anti)neutrino\r\ninteractions in the vicinity of the detector through the W boson\r\nexchange are accompanied by muon tracks. Reconstructed direction of\r\nthe muon track is the most precise probe of the neutrino direction\r\nattainable in Cerenkov neutrino telescopes. Reconstruction techniques\r\nadopted by Baikal-GVD include methods for the rejection of noise due\r\nto water chemilumenescence and track parameter reconstruction based on\r\nchi^2 minimisation. Muon reconstruction performance is discussed in the\r\npresent report. Performance metrics of the muon reconstruction are\r\nstudied using realistic Monte Carlo (MC) simulation of the detector.\r\nThe algorithms are applied to real data from Baikal-GVD and the\r\nresults are compared with simulations.'

Collaborations
, Baikal-GVD

Keywords and Comments
'neutrino telescopes; neutrinos; muons; reconstruction', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

In-situ gain calibration based on single byte PMT signals

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Bouke Jung
Author and Co-Author
Bouke Jung, Maarten de Jong | Paolo Fermani

Abstract
'Bouke Jung^1, Maarten de Jong^2, Paolo Fermani^3 \r\non behalf of the KM3NeT collaboration\r\n\r\n^1) University of Amsterdam, Nikhef\r\nbjung@nikhef.nl\r\n^2) Leiden University, Nikhef\r\nmjg@nikhef.nl\r\n^3) Sapienza Università di Roma \r\npaolo.fermani@roma1.infn.it\r\n\r\nPresent and foreseen neutrino observatories, such as IceCube, P-ONE, GVD, Antares and KM3NeT have to operate in challenging environments, where high count rates go hand in hand with limited bandwidths.\r\nTo keep the data rates in these experiments within the allowed range, rigorous data reduction is essential. \r\nAt the same time, sufficient information needs to be recorded to accurately measure the neutrino properties. \r\nThe KM3NeT collaboration has developed a novel data acquisition procedure, in which each PMT signal is reduced to a datapacket of 6 Bytes, containing the PMT identifier (1 B), the hit time (4 B) and the duration over which the associated PMT pulse exceeded the threshold (1B). \r\nThis talk highlights an analytical pulse-shape model which is used to perform in-situ calibrations of the gain and its spread, using only the time-over-threshold statistics associated with single photon hits.'

Collaborations
KM3NeT,

Keywords and Comments
'PMT; gain; calibration; in-situ; KM3NeT; neutrino telescope; neutrino; neutrino physics; neutrino astronomy; deep sea detector; neutrino observatory;', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

The Radar Echo Telescope for Cosmic Rays (RET-CR): Pathfinder Experiment for a Next-Generation Neutrino Observatory

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Steven Prohira
Author and Co-Author
Steven Prohira | Krijn de Vries, for the Radar Echo Telescope collaboration

Abstract
'The Radar Echo Telescope for Cosmic Rays (RET-CR) is a pathfinder experiment for the Radar Echo Telescope for Neutrinos (RET-N), a next-generation in-ice detection experiment for ultra high energy neutrinos. RET-CR will serve as the testbed for the radar echo method to probe high-energy particle cascades in nature, whereby a transmitted radio signal is reflected from the ionization left in its wake. This method, recently validated at SLAC experiment T576, shows promising preliminary sensitivity to neutrino-induced cascades above the energy range of optical detectors like IceCube. RET-CR intends to use an in-nature test beam: the dense, in-ice cascade produced when the air shower of an ultra high energy cosmic ray impacts a high-elevation ice sheet. This in-ice cascade, orders of magnitude more dense than the in-air shower that preceded it, is similar in profile and density to the expected cascade from a neutrino-induced cascade deep in the ice. RET-CR will be triggered using surface scintillator technology and will be used to develop, test, and deploy the hardware, firmware, and software needed for the eventual RET-N. We present the strategy, status, and design sensitivity of RET-CR, and discuss its application to eventual neutrino detection.'

Collaborations
other (fill field below), Radar Echo Telescope

Keywords and Comments
'radar; neutrino; radio; cosmic ray; UHE', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Positioning system for Baikal-GVD

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Alexander Avrorin
Author and Co-Author
Alexander Avrorin,

Abstract
'Baikal-GVD is a kilometre scale neutrino telescope currently under construction in Lake Baikal. Due to water currents in Lake Baikal, individual photomultiplier housings are mobile and can drift away from their initial position. In order to accurately determine the coordinates of the photomultipliers, the telescope is equipped with an acoustic positioning system. The system consists of a network of acoustic modems, installed along the telescope strings and uses acoustic trilateration to determine the coordinates of individual modems. This contribution discusses the current state of the positioning in Baikal-GVD, including the recent upgrade to the acoustic modem polling algorithm.'

Collaborations
other (fill field below), Baikal-GVD

Keywords and Comments
'neutrino telescopes; acoustic positioning;', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Searching for RF-Only Triggered Cosmic Ray Events with the High-Elevation BEACON Prototype

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Daniel Southall
Author and Co-Author
Daniel Southall | For the BEACON Collaboration,

Abstract
'The Beamforming Elevated Array for COsmic Neutrinos (BEACON) is a concept for a neutrino telescope designed to measure tau lepton air showers generated from tau neutrino interactions near the horizon. This detection mechanism provides a pure measurement of the tau flavor of cosmogenic neutrinos, which could be used to set limits on the observed flavor ratios for cosmogenic neutrinos in a manner complimentary to the all-flavor neutrino flux measurements made by other experiments. BEACON is expected to also be capable of detecting cosmic rays through RF-only triggers. BEACON aims to achieve this sensitivity by using mountaintop radio arrays of dual-polarized antennas operating in the 30-80 MHz which utilize directional interferometric triggering. BEACON stations are designed to efficiently use a small amount of instrumentation, allowing for deployment in a variety of high-elevation sites. The interferometric trigger provides a natural tool for directional-based anthropogenic RFI rejection at the trigger level, broadening the list for potential station sites. The BEACON prototype has seen continuous design advancements towards improving the mechanical durability and scientific capabilities since its initial deployment at White Mountain Research Station in 2018. Here we present the current prototype's sensitivity to RF-triggered cosmic-ray background signals. We also present the next generation prototype, which includes scintillating cosmic ray detectors, improved antennas, and refined calibration techniques. \r\n\r\n*We gratefully acknowledge the NSF CAREER Awards #1752922 and #2033500'

Collaborations
other (fill field below), BEACON

Keywords and Comments
'UHECR; UHE Neutrino; Neutrino; Radio; Askaryan; BEACON; interferometry; prototype; elevation; cosmic ray;', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

An End-to-End Test of the Sensitivity of IceCube to the Neutrino Burst from a Core-Collapse Supernova

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 328

Presenter
Spencer Griswold
Author and Co-Author
Spencer Griswold,

Abstract
'The next Galactic supernova presents a once-in-a lifetime opportunity to obtain detailed information about the explosion of a star and the extreme conditions found within its core. A core-collapse supernova will produce a neutrino burst visible up to half a day before electromagnetic radiation from the explosion, so the burst will provide an early warning for optical follow-up. Since local supernovae are exceedingly rare, it is critical that neutrino detectors provide prompt alerts after the arrival of a burst. The IceCube Neutrino Observatory operates with >99% uptime and is sensitive to a variety of supernova models at levels >10σ within the Milky way. Also, the IceCube Supernova Data Acquisition (SNDAQ) online triggering system is capable of issuing alerts within 7 minutes of a triggering event. IceCube’s high sensitivity, near perfect uptime, and ability to issue prompt alerts makes it a critical component of the worldwide network of detectors known as the SuperNova Early Warning System (SNEWS 2.0). A "fire drill" system was designed to inject false supernova signals into the IceCube online systems, upstream in the data pipeline from SNDAQ. We will discuss IceCube’s sensitivity to supernova near the Milky Way, and describe the data challenges used to ensure the readiness of SNDAQ, the IceCube Neutrino detector and its operators. We will also discuss coordination of IceCube alerts and data challenges with SNEWS 2.0.'

Collaborations
IceCube,

Keywords and Comments
'', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

The Calibration of the Geometry and Antenna Delay in Askaryan Radio Array Station 4 and 5

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Paramita Dasgupta
Author and Co-Author
Paramita Dasgupta, Kaeli Hughes | For the ARA Collaboration

Abstract
'The Askaryan Radio Array (ARA) at the South Pole is designed to detect the radio signals produced by ultra high-energy cosmic neutrino interactions in the ice. There are 5 independent ARA stations, one of which (ARA5) includes a low-threshold phased array trigger string. The Data Acquisition System in all ARA stations is equipped with the Ice Ray Sampler second generation (IRS2) chip, a custom-made, application-specific integrated circuit (ASIC) for high-speed sampling and digitisation. In this contribution, we describe the methodology used to calibrate the IRS2 chip and the geometry namely the relative timing between antennas and their geometrical positions, for ARA stations 4 and 5. Our calibration allows for proper timing correlations between incoming signals, which is crucial for radio vertex reconstruction and thus detection of ultra high-energy neutrinos. With this methodology, we achieve a signal timing precision on a sub-nanosecond level and an antenna position precision within 10 cm.'

Collaborations
other (fill field below), Askaryan Radio Array (ARA) Collaboration

Keywords and Comments
'Askaryan Radio Array;ARA;Calibration;Digitisation;IRS2 chip; ASIC;Station Geometry;Timing precision;Antenna Positioning;Data Acquisition System;Ultrahigh energy;Neutrino detection', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Testing the Pointing of IceCube Using the Moon Shadow in Cosmic-Ray-Induced Muons

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Saskia Philippen
Author and Co-Author
Saskia Philippen | Christopher Wiebusch | Sebastian Schindler | Thorsten Glüsenkamp,

Abstract
'The IceCube Neutrino Observatory is a cubic-kilometer-scaled detector located at the Geographic South Pole. The calibration of the directional reconstruction of neutrino-induced muons and the pointing accuracy of the detector has to be verified. For these purposes, the moon is used as a standard candle to not rely exclusively on simulated data: Cosmic rays get absorbed by the moon, which leads to a deficit of cosmic-ray-induced muons from the lunar direction that is measured with high statistics. The Moon Shadow Analysis uses an unbinned maximum-likelihood method, which has been methodically improved, and uses higher statistics and a larger detector compared to previous analyses. This allows to observe the shadow with a large significance per month. It also enables an experimentally-based testing of analysis methods and directional muon reconstruction algorithms.'

Collaborations
IceCube,

Keywords and Comments
'Moon shadow; cosmic-ray induced muons; directional reconstruction calibration', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

SK-Gd looks forward

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Lluis Marti Magro
Author and Co-Author
Lluis Marti Magro,

Abstract
'From new electronics to changes in the PMT configuration, Super-Kamiokande (SK) has undergone several major phases along its history. The latest one, SK-VI, has been the dissolution of 13 tons of gadolinium sulfate octa-hydrate in the hitherto ultra-pure water. The goal of this new phase is to achieve a high neutron efficiency detection. This new capability allows to distinguish different neutrino reactions, enhance signals and remove backgrounds more efficiently. In fact, it has the potential to improve all analyses at SK. This new phase was preceded by the refurbishment of the detector in summer 2018 and then, the dissolution of gadolinium sulfate in summer 2020.'

Collaborations
other (fill field below), Super-Kamiokande

Keywords and Comments
'neutrino; detector; gadolinium; neutron capture', 'on behalf of the Super-Kamiokande collaboration'

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

High-energy reconstruction for showers and tau neutrinos using the KM3NeT detector

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Thijs van Eeden
Author and Co-Author
Thijs van Eeden | Jordan Seneca, Aart Heijboer

Abstract
'The discovery of a high-energy cosmic neutrino flux has paved the way for the field of neutrino astronomy. High-energy neutrino sources are yet to be discovered; the KM3NeT detector, which is under construction in the Mediterranean sea, is designed to determine their origin. KM3NeT will instrument a cubic kilometre of seawater with photomultiplier tubes that detect Cherenkov radiation from neutrino interaction products with nanosecond precision. For single shower event topologies, traditional algorithms reconstruct the Cherenkov cone using the spatial distribution of photons, already achieving $\\sim2^\\circ$ median angular resolution. The arrival time of light can be used to improve the identification of double-shower topologies from tau neutrinos, and the angular resolution of both shower topologies. In this poster, we present new reconstruction algorithms that use the time information and discuss their performances. Sub-degree resolution can be achieved in both cases.'

Collaborations
KM3NeT,

Keywords and Comments
'shower; reconstruction; tau; timing information; double bang; electron; KM3NeT; angular resolution; tau neutrino; shower reconstruction; Cherenkov; pmt; photomultiplier; photons; neutrino telescope', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Exploring the Potential of Multi-Detector Analyses for Core-Collapse Supernova Neutrino Detection

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 329

Presenter
Meriem Bendahman
Author and Co-Author
Meriem Bendahman, Alexis Coleiro | Marta Colomer Molla | Jaime Dawson | Gwenhaël De Wasseige | Thierry Foglizzo | Davide Franco | Jérôme Guilet | Antoine Kouchner | Matteo Bugli | Jérôme Novak | Micaela Oertel | Aurélien Pascal | Thomas Patzak | Sabrina Sacerdoti | Yahy

Abstract
'The core-collapse supernova (CCSN) SN1987A has been the first extragalactic transient source observed in neutrinos, and the 25 events detected by the neutrino telescopes running at the time marked the beginning of neutrino astronomy. Despite the very large number of CCSNs detected in the electromagnetic spectrum since 1987, neutrino telescopes could not perform another observation due to the far distances of the sources. It is thus of primary importance to optimize the detection channel of sensitive detectors in anticipation of a forthcoming Galactic CCSN. Beyond being used as an early warning of a close-by CCSN, neutrinos can provide unique information on the explosion mechanisms, and can be used to probe neutrino flavor evolution in dense environments. In this contribution, we will present the potential of multi-detector analyses to enhance the scientific outputs from the next close-by CCSN. Combining the expected light curves in neutrino detectors sensitive to different flavors, we will study the constraints that could be set on the properties of the progenitor itself, such as its mass, as well as on the neutrino oscillation parameters. We will also present the results of a triangulation algorithm using a prior source map in the definition of the region of interest.'

Collaborations

Keywords and Comments
'Core-collapse supernova; Neutrino; Light curve', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

P-ONE second pathfinder mission: STRAW-b

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table 331

Presenter
Immacolata Carmen Rea
Author and Co-Author
Immacolata Carmen Rea, Kilian Holzapfel | Andrew Baron | For the P-ONE Collaboration

Abstract
'P-ONE (Pacific Ocean Neutrino Explorer) collaboration was born with the aim of building a new large-scale neutrino telescope in the Pacific Ocean, at 2600 m b.s.l. in Cascadia Basin, off Vancouver Island.\r\nThe first steps aimed at the feasibility study and the characterization of the optical properties of the site with a first pathfinder project named STRAW (STRing for Absorption length in Water), deployed in 2018.\r\nDuring the last two years a second pathfinder project has been developed: STRAW-b.\r\nThe main goal of STRAW-b is to validate the attenuation length already measured by STRAW and to add new information on the background characterization with the study of the deep sea diffused light spectrum. It consists of a 500 m mooring (electrical-optical cable communication) equipped with three Standard Modules for environmental monitoring and seven Specialised Modules for background analysis and attenuation length measurements. All the modules are hosted in spherical 13″ high pressure resistant glass housings.\r\nIts design started at the end of 2018 and after about two years it has been successfully deployed in summer 2020 in Cascadia Basin site, connected to the underwater Ocean Networks Canada infrastructure about 40 meters away from STRAW.\r\nWe present all the steps from the design to the realization of the mooring, with a special focus on the adopted technologies and on preliminary results of data taking.'

Collaborations
, P-ONE

Keywords and Comments
'', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Luminescence of ice as a new detection channel for neutrino telescopes

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Anna Pollmann
Author and Co-Author
Anna Pollmann,

Abstract
'Natural water and ice are currently used as optical detection media in large scale neutrino telescopes, such as IceCube, KM3NeT/ANTARES and GVD. When charged particles, such as those produced by high energy neutrino interactions, pass through ice or water at relativistic speeds they induce Cherenkov light emission. This is detected by the optical modules of neutrino telescopes. However, slower moving particles, including potential exotic matter such as Magnetic Monopoles or Q-balls, cannot be detected using this channel. \r\n\r\nA new kind of signature can be detected by using light emission from luminescence in water or ice. This detection channel enables searches for exotic particles which are too slow to emit Cherenkov light and currently cannot be probed by the largest particle detectors in the world, i.e. neutrino telescopes. Luminescence light is highly dependent on the ice structure, impurities, pressure and temperature which demands a comprehensive study. \r\n\r\nLuminescence light is induced by highly ionizing particles passing through a medium and exciting the surrounding matter. To utilise this new detection channel in neutrino telescopes, laboratory measurements using water and ice as well as an in-situ measurement in Antarctic ice were performed. The experiments as well as the measurement results will be presented covering light yields, spectra and decay times. The impact on searches for new physics with neutrino telescopes will be discussed.'

Collaborations

Keywords and Comments
'particle detection; neutrino telescopes; luminescence; Q-balls; magnetic monopoles', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Data Quality Monitoring system of the Baikal-GVD experiment

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Maksim Sorokovikov
Author and Co-Author
Maksim Sorokovikov,

Abstract
'The main purpose of the Baikal-GVD Data Quality Monitoring (DQM) system is to monitor the status of the detector and collected data. The system estimates quality of the recorded signals and performs the data validation. The DQM system is integrated with the Baikal-GVD's unified software framework ("BARS") and operates in quasi-online manner. This allows us to react promptly and effectively to the changes in the telescope conditions.'

Collaborations
other (fill field below), Baikal

Keywords and Comments
", "

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Detection of Small-Scale Components in Power Law Spectra via the Applicaton of Functional Data Analysis

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 332

Presenter
Tim Ruhe
Author and Co-Author
Tim Ruhe | Wolfgang Rhode,

Abstract
'Spectra in astroparticle physics are commonly approximated by simple power laws. The steeply falling nature of these power laws, however, makes the detection of additional components rather challenging. This holds true especially, if the additional components are small compared to the established ones. Energy spectra of muon neutrinos are an interesting example of such a scenario, where the conventional and astrophysical components to the spectra have been established by the use of different analysis methods, such as likelihood fits or spectral deconvolution. The prompt component, although expected from theoretical models, has not yet been experimentally observed. This contribution presents a different approach to the analysis of power-law spectra, which is based on functional data analysis. The method itself and its implications are discussed using neutrino energy spectra as an example. Furthermore, the required resolution in future deconvolutions of energy spectra is estimated.'

Collaborations

Keywords and Comments
'power-law spectra; data analysis; prompt neutrinos; atmospheric neutrinos', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

The Calibration Units of KM3NeT : multi-purpose calibration devices

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
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Presenter
Rémy Le Breton
Author and Co-Author
Rémy Le Breton | Alin Ilioni, Michel Billault | Claude Boutonnet | Cédric Champion | Stéphane Colonges | Alexandre Creusot | Sylvain Henry | Pascale Keller | Philippe Lagier | Patrick Lamare | Jean Lesrel | Miles Lindsey Clark | Jérome Royon | Giorgio Riccobene | Dorothea Samtleben |

Abstract
'KM3NeT is a deep-sea infrastructure composed of two neutrino telescopes being deployed in the Mediterranean Sea : ARCA, near Sicily in Italy, designed for neutrino astronomy and ORCA, near Toulon in France, designed for neutrino oscillations. These two telescopes are 3D arrays of optical modules used to detect the Cherenkov radiation, which is a signature of charged particles created in the neutrino interaction and propagating faster than light in the sea water.\r\n\r\nTo achieve the best performance for the event reconstruction in the telescopes, the exact location of the optical modules, affected by the sea current, must be known at any time and the timing resolution between optical modules must reach the sub-nanosecond level. Moreover, the properties of the environment, in which the telescopes are deployed, such as temperature and salinity, are continuously monitored to allow best modelling of the acoustic signal propagation in the water.\r\n\r\nKM3NeT is going to deploy several dedicated Calibration Units hosting instruments dedicated to meet these calibration goals. The Calibration Base will host a Laser Beacon for time calibration and a long-baseline acoustic emitter and a hydrophone, which are part of the positioning system for the optical modules. Some of these Calibration Units will also be equipped with an Instrumentation Unit hosting environmental monitoring instruments. \r\n\r\nThis poster describes all the devices, features and purposes of the Calibration Units, with a special emphasis on the first such unit that will be deployed on the ORCA site in 2021.'

Collaborations
KM3NeT,

Keywords and Comments
'KM3NeT; Neutrino; Calibration; Calibration Unit', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Light concentrators for large-volume detector at the Baksan Neutrino Observatory

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Almaz Fazliakhmetov
Author and Co-Author
Almaz Fazliakhmetov,

Abstract
'At the Baksan Neutrino Observatory deployed in the Caucasus mountains, it is proposed to create, at a depth corresponding to about 4700 mwe, a large-volume neutrino detector based on a liquid scintillator with a target mass of 10 kt. The main physics goals of the detector are low-energy neutrino physics, astrophysics and geophysics.\r\nThe highest possible light yield is crucial for such detectors. To improve light yield and energy resolution in large-volume neutrino detectors, light concentrators are often mounted on photomultiplier tubes to increase the detection efficiency of optical photons from scintillation or Cherenkov light induced by charged particles. We present the results of recent R&D work aimed to develop light concentrators for the Baksan large-volume liquid scintillation neutrino detector.'

Collaborations

Keywords and Comments
'light concentrators', ''

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Webpage icrc2021.desy.de

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Analysis framework for multi-messenger astronomy with IceCube

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Kwok Lung Fan
Author and Co-Author
Kwok Lung Fan, Michael Larson | John Evans

Abstract
'Combining observational data from multiple instruments for multi-messenger astronomy can be challenging due to the complexity of the instrument response functions and likelihood calculation. We introduce a python-based unbinned-likelihood analysis package called i3mla (IceCube Maximum Likelihood Analysis) which is to be used with the public IceCube data format. i3mla is designed to be compatible with the Multi-Mission Maximum Likelihood (3ML) framework, which enables multi-messenger astronomy analyses by combining the likelihood across different instruments. By making it possible to use IceCube data in the 3ML framework, we aim to facilitate the use of neutrino data in multi-messenger astronomy. In this work we illustrate how to use the i3mla package with 3ML and present preliminary sensitivities.'

Collaborations
IceCube,

Keywords and Comments
", "

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Simulation of the Response of a Modular Scintillator Detector to Secondary Cosmic Ray flux

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 333

Presenter
Luis Otiniano
Author and Co-Author
Luis Otiniano | Rolando Calderón-Ardila | Alexander Trujillo | Alejandro Almela | Hernán Asorey | César Castromonte,

Abstract
'Muography technique is a non-invasive prospecting technique that uses the directional flux of secondary atmospheric muons as a source to scan the density variation of objects at scales of hundreds of meters. Cosmic ray detectors for muongraphy use two or more planar detectors divided into several detection pixels operating in coincidence mode, these pixels have dimensions of the order of a few centimeters. In order to achieve time and spatial resolution required by the different applications these detectors have dimension of the order of square meters.\r\nA modular detector was built based on previous developments of scintillating plastic detectors for muongraphy. The module is made up of four small crossed bars (41mm x 10mm x 82mm each one) with a wavelength shifter scintillator fiber placed in the top of each bar, similar to those used by the AMIGA project. \r\nThis array generates four detection pixels. The output signals are measured using silicon photomultipliers located at one end of each fiber (5mm away from each plastic scintillator bar), in order to maximize the collection of photons produced by charged particles passing through the array.\r\nTo characterize the response of the module to the muon flux of secondary atmospheric cosmic rays, we compare a simulation based on Geant4 and CORSIKA with actual measurements. The signal was estimated based on the single photon equivalent detected by a silicon photomultiplier.\r\nValidation of the simulation will allow us to study modular scaling of the detector in order to increase the detection area for studies related with geophysics, civil structures and nuclear materials'

Collaborations

Keywords and Comments
'Muography; simulations; plastic scintillator', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Development of calibration system for a project of a new Baksan Large Neutrino Telescope

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 32 Cherenkov Media & Detector Calibration | NU
Presenter Forum Table

Presenter
Nikita Ushakov
Author and Co-Author
Dmitry Voronin, Almaz Fazliakhmetov | Albert Gangapshev | Vladimir Gavrin | Nikita Ushakov | Tatyana Ibragimova | Vladimir Kazalov | Mahti Kochkarov | Daniel Kudrin | Valeriy Kuzminov | Bayarto Lubsandorzhiev | Arslan Lukanov | Yuri Malyshkin | Galina Novikova | Valeriy

Abstract
'We present results of the development of a calibration system for a project of a new Baksan Large Neutrino Telescope. The calibration system is based on fast blue and UV InGaN and AlGaN ultra bright and high power light emitting diodes (LEDs), a diffusing ball and fiber optics. Special fast electronic drivers for such LEDs were developed. The drivers are based on fast complementary and avalanche transistors. The diffusing ball is designed to provide uniform isotropic illumination of all photomultipliers of the detector. Thorough studies of timing and light yield parameters are done. Special emphasis is done on careful studies of compatibility of calibration system parts with liquid scintillator and ultra pure water.'

Collaborations

Keywords and Comments
'Neutrino detector; scintillation detector; calibration system; LEDs', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Evaluation of large area photomultipliers for use in a new Baksan Large Neutrino Telescope project

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Nikita Ushakov
Author and Co-Author
Nikita Ushakov, Almaz Fazliakhmetov | Albert Gangapshev | Vladimir Gavrin | Tatyana Ibragimova | Vladimir Kazalov | Mahti Kochkarov | Daniel Kudrin | Valeriy Kuzminov | Bayarto Lubsandorzhiev | Arslan Lukanov | Yuri Malyshkin | Galina Novikova | Valeriy Petkov | Alexande

Abstract
'We present results of advance studies of large area photomultipliers (PMTs) of different types from several manufacturers for use in a new Baksan Large Neutrino telescope. At first, requirements for photodetectors to be used in the telescope were formulated. Parameters of 8-inch, 10-inch and 20-inch PMTs were thoroughly studied. 8-inch PMTs under studies were ET9350 from ET Enterprises, R5912 and R5912-100 from Hamamatsu Photonics. 10-inch PMTs – R7081 and R7081-100 and R7081-100-WA from Hamamatsu Photonics. 20-inch PMTs – R12860 from Hamamatsu Photonics and MCP-PMT from NNVT. Particular emphasis was done on measurements of photocathode sensitivity, single photoelectron response, TTS, dark current counting rate and afterpulses rate.'

Collaborations

Keywords and Comments
'Neutrino detector; scintillation detector; PMTs', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

KM3NeT Core Collapse Supernovae observation program in standalone and multi-messenger modes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 334

Presenter
Vladimir Kulikovskiy
Author and Co-Author
Damien Dornic | Massimiliano Lincetto | Marta Colomer Molla | Alexis Coleiro | Vladimir Kulikovskiy,

Abstract
'The KM3NeT research infrastructure in the Mediterranean is a multi-purpose cubic-kilometer neutrino observatory consisting of two detectors optimized to study cosmic and atmospheric neutrinos between GeV to PeV energies. Additionally, KM3NeT multi-photomultiplier optical modules allow the detection of nearby MeV interaction products by selecting nanosecond coincidences within the photomultipliers of the same module. Distribution of the number of photomultipliers forming a coincidence (multiplicity) for the whole supernova emission behaves as a proxy of the average neutrino energy. An optimised coincidence selection allows the KM3NeT detectors to be sensitive to Galactic supernovae and beyond. The large KM3NeT effective volume allows a high number of detected events for a core collapse supernovae explosion and the measurement of the neutrino light curve properties, such as the light curve start time and the presence of the standing accretion shock instability oscillations. Sub-millisecond time synchronization between KM3NeT detectors allows common observation. Such a scheme can be also a viable solution to synchronize the KM3NeT telescopes with other detectors aiming to observe neutrino emission from core collapse supernovae through the SNEWS network.'

Collaborations
KM3NeT,

Keywords and Comments
'supernova; neutrinos', 'on behalf of KM3NeT collaboration'

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Evolving Antennas for Ultra-High Energy Neutrino Detection

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Julie Rolla
Author and Co-Author
Julie Rolla | For the GENETIS Collaboration,

Abstract
'Evolutionary algorithms are a type of artificial intelligence that utilize principles of evolution to efficiently determine solutions to defined problems. These algorithms are particularly powerful at finding solutions that are too complex to solve with traditional techniques and at improving solutions found with simplified methods. The GENETIS collaboration is developing genetic algorithms (GAs) to design antennas that are more sensitive to ultra-high energy neutrino-induced radio pulses than current detectors. Improving antenna sensitivity is critical because UHE neutrinos are extremely rare and require massive detector volumes with stations dispersed over hundreds of km2. The GENETIS algorithm evolves antenna designs using simulated neutrino sensitivity as a measure of fitness by integrating with XFdtd, a finite-difference time-domain modeling program, and with simulations of neutrino experiments. The best antennas will then be deployed at the RNO-G experiment in Greenland for initial testing. The GA is predicted to create antennas that improve on the designs used in the existing ARA experiment by more than a factor of 2 in neutrino sensitivities. This research could improve antenna sensitivities in future experiments and thus accelerate the discovery of UHE neutrinos. This is the first time that antennas have been designed using GAs with a fitness score based on a physics outcome, which will motivate the continued use of GA-designed instrumentation in astrophysics and beyond. This proceeding will report on advancements to the algorithm, steps taken to improve the GA performance, the latest results from our evolutions, and the manufacturing roadmap.'

Collaborations
other (fill field below), GENETIS

Keywords and Comments
'genetic algorithm; machine learning; evolutionary algorithm; antenna; neutrino', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Large area photodetectors in photon detection for large-scale neutrino physics experiments: single large area PMTs and multi small PMTs approaches.

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 33 Photodetection in Cherenkov Detectors | NU
Presenter Forum Table

Presenter
Sultim Lubsandorzhiev
Author and Co-Author
Sultim Lubsandorzhiev | Bayarto Lubsandorzhiev,

Abstract
'More than 40 years ago beginning of works on deep underwater high energy neutrino telescope projects (DUMAND and Baikal) inspired development of new photon detectors: large area photomultipliers (PMTs), multi small PMT optical modules, small PMTs equipped with wavelength shifting plates and rods and even small area solid state photon detectors for such kind application. Now days we witness rebirth of the multi small PMT approach and it started to compete quite successfully with a single large area photon detector approach. The latter have been reigning supreme for almost half century. But recent developments of astroparticle physics experiments demonstrated good competiveness of the “multi small PMTs” idea. Several projects of astroparticle physics experiments may serve as good examples, Km3NET project and coming JUNO experiment among them. We present pros and cons of both approaches.'

Collaborations

Keywords and Comments
", "

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Subcategory Experimental Methods & Instrumentation

Muography in the Andes region: applications on geophysics, industry, mining and safeguard applications in Latin America

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 335

Presenter
Hernán Asorey
Author and Co-Author
Hernán Asorey,

Abstract
'Nowadays muography is a fast-evolving and non-invasive imaging technique, and it is a direct application of basic research in astroparticle physics with important social impacts, such as its usage for the evaluation of volcanic risks. Coming from several astroparticle and high energy physics institutions in Latin American, we are building a new collaboration involving several scientists from Colombia, Perú and Argentina. In this work, we summarize the research, developments and innovative designs of new modular muographers we are carrying out in the Andes region, with special emphasis on their applications in geophysics, underground laboratories basic research, mining prospection, industry, and safeguard.'

Collaborations
other (fill field below), TBA

Keywords and Comments
'Muography; geophysics; astroparticle detectors', 'We submitted several papers on this conference in different topics of muography, so we are planning to include a talk to summarize all the involved developments. In case you think it is not necessary, please feel free to not accept this contribution. Th

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Subcategory Experimental Methods & Instrumentation

Design of four pixels (2x2) Muon Modular Wireless Detector

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 336

Presenter
Daniel Alejandro Almela
Author and Co-Author
Daniel Alejandro Almela, Juan Vega | Rolando Calderón-Ardila | Manuel Garcia Redondo | Nicolas Leal | Adrian Rielo | Adrian Sedoski Croce | Carlos Varela | Mariano Gómez Berisso | Luis Otiniano | Hernán Asorey

Abstract
'Currently, available muon detectors are bulky, heavy, and difficult to transport. Their use are limited to dedicated laboratory facilities or specific study sites. A modular wireless muon detector will facilitate transportation and installation in-situ. Furthermore, a modular detector allows adapting its geometry to optimize the study of the object of interest. These detectors would improve and facilitate measurements primarily in applications related to geophysics, civil structures, and nuclear materials.\r\nThis work presents the design of a modular wireless detector with four $41\\,mm \\times 41\\,mm$ pixels, in a $2 \\times 2$ array. Muon detection will be performed using coincidence techniques between plastic scintillator strips based on the experience of The Pierre Auger Observatory in Mendoza, Argentina. The light produced by the scintillators will be measured using silicon photomultipliers together with an electronic system providing signal conditioning and processing. The first prototypes of these detectors will be built using 3D printers and will be organized into arrays of planes to allow reconstruction of the muon trajectory.\r\nThe signals from the modules must be communicated to a centralized processing system, which will search for temporal matches and determine the direction of arrival of the particles. This system must provide flexibility to operate with a variable amount of detectors. To achieve this flexibility, the modules must be synchronized to allow a uniform identification of events. The module electronics will also be equipped with a monitoring system able to sense operational and environmental variables. Telemetry and measurement data will be pre-analysed by the detector electronics and transferred via a wireless communication system using low-cost radio modules.'

Collaborations
other (fill field below),

Keywords and Comments
'"Muon Detectors"; "Wireless Detectors"; "Muography"; "Coincidence Detectors"', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

Development muon detectors using doble-synchronized electronics detection for geophysical applications

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 337

Presenter
Rolando Calderón-Ardila
Author and Co-Author
Rolando Calderón-Ardila, Alejandro Almela | Adrian Sedoski Croce | Carlos Varela | Nicolas Leal | Mariano Gómez Berisso | Hernán Asorey

Abstract
'Muography is an imaging technique that uses the absorption of the directional flux of atmospheric muons to study geophysical objects or strategic structures. This is possible by constructing an image based on the differential absorption of the muon flux produced during the interaction of cosmic rays with the atmosphere.\r\n \r\nIn this work we present a development and implementation of a modular muon detector that aims to improve spatial resolution for each panel. Our detector uses plastic scintillators with embedded WLS fibers and multi-anode photomultipliers (64 anodes, 1 dynode). In this case the improvement in resolution and performance is achieved by the modular design and double synchronized detection at the end of each scintillator bar. Our panel prototype is made of 24 scintillators of (4.1cmx1cmx100cm) consisting of 4 arrays of 12 crossbars with a photomultiplier at each end. The modular configuration of the panels allows to change the panel geometries (in size and in shape) adapting to the studied object, allowing to obtain faster or more detailed muography images. \r\n\r\nThe detection technique is based on an analytical model used for the calibration of each photomultiplier and the collected signals at the dynode as reference. With this, we are able to find the operating point for each photomultiplier. To improve the resolution, we take advantage of the photomultiplier at each end of the bars to determine the muon passage using the previous model to account for the signal attenuation in each anode, and then determine the position of the incoming muon with sub-pixel spatial resolution. This novel strategy is optimized to increase the spatial resolution by at least a factor of two.'

Collaborations

Keywords and Comments
'Muography; Volcanoes; Muon Imaging; Cosmic-ray muons;\r\nAstroparticle Techniques; Experimental Particle Physics.', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Methods & Instrumentation

KM3NeT Acquisition Electronics: New Developments and Advances in Reliability

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 338

Presenter
Diego Real
Author and Co-Author
Diego Real | David Calvo | Vincent Van Beveren | Peter Jansweijer | Paolo Musico | Stephane Colonges | Giuliano Pellegrini,

Abstract
'The KM3NeT Collaboration is currently building a neutrino observatory at the bottom of the Mediterranean Sea. The telescopes are equipped with thousands of Digital Optical Modules hosted in glass spheres, instrumenting a volume of several cubic kilometers. The acquisition electronics is housed inside the glass sphere performing the readout of the 31 PMTs of the Digital Optical Module. In the present work is presented the latest developments in the acquisition electronics including the increase in efficiency on the Power Board, the new developments on the Central Logic Board and the different reliability methods used in KM3NeT to make the acquisition electronics more reliable.'

Collaborations
KM3NeT,

Keywords and Comments
'Acquisition electronics; electronics reliability', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

First direct evidence of the CNO fusion cycle in the Sun with Borexino

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 339

Presenter
Sindhujha Kumaran
Author and Co-Author
Sindhujha Kumaran,

Abstract
'The Borexino experiment has recently provided the first direct experimental evidence of the sub-dominant CNO-cycle in the Sun, which is assumed to be the main energy production mechanism in heavier stars. Borexino is a liquid scintillator detector located at the Laboratori Nazionali del Gran Sasso, Italy with the main goal to measure solar neutrinos. The extreme radiopurity of the scintillator and the successful thermal stabilisation of the detector have proven to be valuable assets in the quest for CNO neutrinos.\r\nThe low abundance of CNO neutrinos and the similarity of its spectral shape to that of pep solar neutrinos and the intrinsic ^{210}Bi background, make CNO neutrino detection challenging. Therefore, it is necessary to constrain these backgrounds independently. The energy and radial distribution of the events can then be exploited to perform a multivariate fit, which requires a careful evaluation of the systematic uncertainty associated with the Monte-Carlo spectral shapes used. Borexino has successfully rejected the null hypothesis of CNO-cycle neutrinos in the Sun at greater than 5.0$\\sigma$ with 99% C.L. This talk will present the overview of the strategy and methods used to achieve this result and the consequence of this result for solar and stellar physics.'

Collaborations
Borexino,

Keywords and Comments
'Borexino; CNO neutrinos; Sun; Liquid scintillator detectors; solar metallicity; solar fusion reaction;', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

An analysis of a tau-neutrino origin for the atypical ANITA-IV cosmic-ray-like events

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Remy Prechelt
Author and Co-Author
Remy Prechelt, Stephanie Wissel | Andres Romero-Wolf

Abstract
"The ANITA collaboration has recently reported on four anomalous cosmic-ray-like events observed during ANITA's fourth flight that are observationally consistent with air showers from upgoing particles emerging from the Antarctic ice. One possible interpretation of these events is that they are due to ultrahigh energy tau neutrinos interacting in the Earth, resulting in an extensive air shower initiated by the decay of the tau lepton after it leaves the ice. Unlike previous ANITA anomalous events that were observed from steeply inclined angles, the four events observed by ANITA-IV appear to originate very close to the radio horizon. We present a comprehensive study of a tau-neutrino origin for these events (from both point-source and diffuse neutrino fluxes) and discuss how these events compare against the point source limits set by other neutrino observatories."

Collaborations
ANITA,

Keywords and Comments
'ANITA; tau neutrino; anomalous events; ultrahigh energy; UHE; PUEO; tau', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Update of the supernova neutrinos monitoring with the LVD experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 340

Presenter
CARLO FRANCESCO VIGORITO
Author and Co-Author
CARLO FRANCESCO VIGORITO, GIANMARCO BRUNO | WALTER FULGIONE | ANDREA MOLINARIO

Abstract
'The Large Volume Detector (LVD) at the INFN Gran Sasso National Laboratory, Italy, is a neutrino observatory designed to study low energy neutrinos from gravitational stellar collapses. The detector, 1000 tons of liquid scintillator, is sensitive to core-collapse supernovae via neutrino burst detection with 100\\% efficiency in the Milky Way.\r\n\r\nIn this paper we discuss methods of the neutrino burst search and we present the results of the last run, lasting from 2014, January 1st to 2021, Jan 4th for a total live time of 2504 days.\r\n\r\nIn the lack of a positive observation in this dataset and including all previously published results since 1992 for a total lifetime of 9839 days, the upper limit on the rate of core collapse and failed supernova explosions out to distances of 25 kpc is 0.085 year^{-1} at 90\\% c.l. .'

Collaborations
other (fill field below), LVD Collaboration

Keywords and Comments
'Supernova; Neutrinos; Detector', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Comparison of the measured atmospheric muon rate with Monte Carlo simulations and sensitivity study for detection of prompt atmospheric muons with KM3NeT

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 341

Presenter
Piotr Kalaczyński
Author and Co-Author
Piotr Kalaczyński,

Abstract
'The KM3NeT Collaboration has successfully deployed the first detection units of the next generation undersea neutrino telescopes in the Mediterranean Sea at the two sites in Italy and in France. The data sample collected between December 2016 and January 2020 has been used to measure the atmospheric muon rate at two different depths under the sea level: 3.5 km with KM3NeT/ARCA and 2.5 km with KM3NeT/ORCA . Atmospheric muons represent an abundant signal in a neutrino telescope and can be used to test the reliability of the Monte Carlo simulation chain and to study the physics of extensive air showers caused by highly-energetic primary nuclei impinging the Earth's atmosphere. At energies above PeV the contribution from prompt muons, created right after the first interaction in the shower, is expected to become dominant, however its existence was not yet experimentally confirmed. In this contribution data collected with the first detection units of KM3NeT are compared to Monte Carlo simulations based on MUPAGE and CORSIKA codes. The main features of the simulation and reconstruction chains are discussed and presented. Additionally, sensitivities of both KM3NeT/ARCA and KM3NeT/ORCA to the prompt muon component are derived using CORSIKA code.'

Collaborations
KM3NeT,

Keywords and Comments
'CORSIKA; KM3NeT; ORCA; ARCA; DU; Detection Unit; muon; neutrino; CR; Cosmic Ray; air shower; simulation; MUPAGE; Mediterranean Sea; underwater neutrino telescope; PMT; DOM', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

The Baikal-GVD neutrino telescope as an instrument for studying Baikal water luminescence

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 36 Shower Reconstruction and Pointing | NU
Presenter Forum Table

Presenter
Rastislav Dvornicky
Author and Co-Author
Rastislav Dvornicky,

Abstract
'The next generation neutrino telescope Baikal-GVD is placed in open water of Lake Baikal. The aim of the experiment is the detection of high energy astrophysical neutrinos. In particular, the goal is the registration of the Cherenkov radiation emitted when charged particles are passing through the deep water in Lake Baikal. The detector is indeed a three-dimensional array of photo-sensors (optical modules - OMs) arranged in fully independent operational units called clusters. \r\n\r\nApart from Cherenkov radiation, also the background light is registered. The trigger system of a cluster is designed in such a way that signals from each OM in a time window of 5 micro-seconds are stored, if a trigger condition is fulfilled. In this way, we collect the data on count rates of pulses \r\ncollected by each particular OM. These are mainly associated with the luminescence of Baikal water and are registered almost continuously. \r\n\r\nWe will present time and spatial variations of the count rates data acquired by several clusters of the Baikal-GVD telescope. In addition, we will present some selected results on luminescence of water in Lake Baikal.'

Collaborations
other (fill field below), Baikal-GVD

Keywords and Comments
'', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Methods for the suppression of background cascades produced along atmospheric muon tracks

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 36 Shower Reconstruction and Pointing | NU
Presenter Forum Table

Presenter
Zuzana Bardačová
Author and Co-Author
Zuzana Bardačová | For the Baikal Collaboration,

Abstract
'The Baikal-GVD detector (Gigaton Volume Detector) is a large-scale neutrino telescope located at a depth of 1366 metres in Lake Baikal. One of its main purposes is to identify high-energy extraterrestrial neutrinos and to locate their sources on the sky. In recent (year 2020), it is a three dimensional array of 2016 optical modules (OMs), sub-arranged into 7 functionally independent units called clusters. \r\n\r\nCharged-current interactions of electron neutrino and neutral-current interactions of all three neutrino flavours create a unique light signature of a single “cascade” in the detector. However, cascade pattern can also be produced by discrete stochastic energy losses along the atmospheric muon tracks. These constitute an avoidable background in the search of astrophysical neutrinos. Therefore, different kinds of data analysis methods for the suppression of background events have been developed.\r\n\r\nThe suppression is achieved by means of the time and charge information of signals detected at the OMs. One of the method tries to find the maximum number of track hits amongst cascade hits, which are present in the muon bundle event. Other techniques rely on the distributions of hits charges and positions of hit OMs associated with cascade events. All suppression tools were developed and optimized on the Monte Carlo simulation datasets.'

Collaborations
other (fill field below), Baikal Collaboration

Keywords and Comments
'neutrinos; cascades; atmospheric muons; background cascades;', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

IceCube Search for High-Energy Neutrinos from Ultra-Luminous Infrared Galaxies

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 39 Astrophysical Neutrinos – Theoretical & Experimental Results | NU
Presenter Forum Table

Presenter
Pablo Correa
Author and Co-Author
Pablo Correa | Krijn de Vries | Nick van Eijndhoven | For the IceCube Collaboration,

Abstract
'With infrared luminosities $L_{\\mathrm{IR}} \\geq 10^{12} L_{\\odot}$, Ultra-Luminous Infrared Galaxies (ULIRGs) are the most luminous objects in the infrared sky. They are predominantly powered by starburst regions with star-formation rates $>\\sim 100~ M_{\\odot}~ \\mathrm{yr^{-1}}$. ULIRGs can also host an active galactic nucleus (AGN). Both the starburst and AGN environments contain plausible hadronic accelerators, making ULIRGs candidate neutrino sources. We present the results of an IceCube stacking analysis searching for high-energy neutrinos from a representative sample of 75 ULIRGs with $z \\leq 0.13$. While no significant excess of ULIRG neutrinos is found in 7.5 years of IceCube data, upper limits are reported on the neutrino flux from these 75 ULIRGs as well as the full ULIRG source population. In addition, constraints are provided on models predicting neutrino emission from ULIRGs.'

Collaborations
IceCube,

Keywords and Comments
'ULIRG; neutrino sources; stacking analysis', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

High-Energy Neutrinos From Core-Collapse Supernovae

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 342

Presenter
Jannis Necker
Author and Co-Author
Jannis Necker | For the IceCube Collaboration,

Abstract
"IceCube is a cubic kilometer neutrino detector array in the Antarctic ice that was designed to search for astrophysical, high-energy neutrinos. It has detected a diffuse flux of astrophysical neutrinos that appears to be of extragalactic origin. A possible contribution to this diffuse flux could stem from core-collapse supernovae. The high-energy neutrinos could either come from the interaction of the ejecta with a dense circumstellar medium or a jet, emanating from the star's core, that stalls in the star's envelope. In this poster, I will present results of a Stacking Analysis to search for this high-energy neutrino emission from core-collapse supernovae."

Collaborations
IceCube,

Keywords and Comments
'High-Energy Neutrinos; Supernovae; core-collapse; Supernovae; interacting; Supernovae; choked-jet; Neutrino Astronomy;', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Search for STaus in IceCube

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Jan-Henrik Schmidt-Dencker
Author and Co-Author
Jan-Henrik Schmidt-Dencker | Christian Haack | Stephan Meighen-Berger,

Abstract
'The tau lepton’s supersymmetric partner, the stau, appears in some models as the next-to-lightest particle. This makes it also a long-lived particle. In this scenario, its signature is a long, dim and minimally ionizing track when traveling through the IceCube detector. Independent of their primary energy, the stau tracks appear like low-energy muons in the detector. A potential signal of staus would thus be an excess over muon tracks induced by atmospheric muon neutrinos. Our analysis focuses on the region around the horizon as here the ratio between stau signal and atmospheric background is largest. We will present the sensitivity to constrain the stau mass using IceCube and demonstrate this analysis’s potential with future improvements.'

Collaborations
IceCube,

Keywords and Comments
'BSM;STau;IceCube;', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Searches for neutrinos from precursors and afterglows of Gamma-ray Bursts using the IceCube Neutrino Observatory

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 343

Presenter
Kunal Deoskar
Author and Co-Author
Kunal Deoskar | Elizabeth Friedman | Paul Coppin | For the IceCube Collaboration,

Abstract
'Gamma-ray bursts (GRBs) are among the most powerful events observed in our universe and have long been considered as possible sources of ultra-high-energy cosmic rays, which makes them promising neutrino source candidates. Previous IceCube searches for neutrino correlations with GRBs focused on the prompt (main emission) phase of the GRB and found no significant correlation between neutrino events and the observed GRBs. This motivates us to extend our search beyond the prompt phase. We perform analyses looking for evidence of neutrino emission up to 14 days before and after the prompt phase of GRBs. These analyses rely on a sample of candidate muon-neutrino events observed by IceCube from May 2011 to October 2018. The analyses are model-independent. Two of them scan different time-windows for possible neutrino emission, while a third analysis targets precursor emission based on GRB precursor observations by Fermi-GBM. We discuss the results and implications of these searches including limits on the contribution of GRBs to the diffuse neutrino flux.'

Collaborations
IceCube,

Keywords and Comments
'IceCube Neutrino Observatory; GRB; astrophysical neutrinos; astrophysical neutrino sources; muons; precursors; afterglows; prompt phase', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

A novel microstructure based model to explain the IceCube ice anisotropy

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 36 Shower Reconstruction and Pointing | NU
Presenter Forum Table

Presenter
Martin Rongen
Author and Co-Author
Martin Rongen | Dmitry Chirkin | For the IceCube Collaboration,

Abstract
'The IceCube Neutrino Observatory instruments about 1 km^3 of deep, glacial ice at the geographic South Pole using 5160 photomultipliers to detect Cherenkov light from relativistic, charged particles. Most IceCube science goals rely on precise understanding and modeling of the optical properties of the instrumented ice. A peculiar light propagation effect observed by IceCube is an anisotropic attenuation, which is aligned with the local flow of the ice. Recent efforts have shown this effect is most likely due to curved photon trajectories resulting from the asymmetric light diffusion in the birefringent polycrystalline microstructure of the ice. This new model can be optimized by adjusting the average size and shape of the ice crystals. We present the parametrization of the birefringence effect in our photon propagation simulation, the fitting procedures and results. The impact of the new ice model on the agreement between data and Monte Carlo is also discussed.'

Collaborations
IceCube,

Keywords and Comments
'calibration; ice properties', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

ANTARES - Baikal GVD Alerts Analysis

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 344

Presenter
Sergio Alves Garre
Author and Co-Author
Sergio Alves Garre,

Abstract
'ANTARES and Baikal-GVD are both Cherenkov neutrino telescopes located in\r\nthe Northern Hemisphere. As a consequence, their fields of view overlap al-\r\nlowing for a combined study of the sky. ANTARES sends alerts after a fast on-\r\nline analysis based on energy and reconstruction direction of track-like events.\r\nFrom December of 2018 up to the beginning of 2021, Baikal-GVD received 38\r\nANTARES alerts, and followed up a total of 32.\r\n\r\nNo prompt coincidence was found. However, a search into the Baikal-GVD cas-\r\ncade sample showed some events falling within an angular distance of less than\r\n5° for three of the ANTARES alerts in a time span of 48 hours. The 4.5° angular\r\nresolution of Baikal-GVD allows for the possibility of these events to be spatially correlated, which makes them of special interest.\r\n\r\nA dedicated offline analysis based on the full ANTARES data sample has been\r\nstarted to search for additional coincident tracks and cascades at a 3σ signifi-\r\ncance. With this contribution we present the final results on the offline analysis\r\nof the three ANTARES alerts: limits on the astrophysical neutrino fluency as ob-\r\ntained by this analysis are reported.'

Collaborations
Antares, Baikal-GVD

Keywords and Comments
'Astroparticle Physics: Neutrinos: ANTARES: Baikal-GVD: Cherenkov Neutrino Telescope: Mediterranean Sea: Follow-up Analysis: Neutrino Fluence:', 'Co-authors I could not find: Federico Versari, A.D Avrorin, Zh. -A. Dzhilkibaev, M.D. Shelepov and O.V. Suvorova'

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Solar Atmospheric Neutrinos searches with ANTARES neutrino telescope

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 36 Shower Reconstruction and Pointing | NU
Presenter Forum Table

Presenter
Daniel Lopez-Coto
Author and Co-Author
Daniel Lopez-Coto, Sergio Navas | Juande Zornoza | for the ANTARES collaboration

Abstract
'The interaction of cosmic-rays with the solar atmosphere can yield neutrinos as final state\r\nparticles. These neutrinos are expected to be mainly produced at the surface of the Sun and to be\r\nabsorbed in the inner part.\r\nSolar Atmospheric Neutrinos\u200b \u200b represent an irreducible source of background to solar dark\r\nmatter searches, and its detection would be important in the characterization of the\r\nbackground.\r\nThe deep-sea neutrino telescope ANTARES, located in the Mediterranean Sea, is well suited to\r\nperform this search. In this work, 11 years of ANTARES data have been analysed and the\r\nresulting sensitivities are presented.'

Collaborations
Antares, KM3NeT

Keywords and Comments
'ANTARES; Neutrino Telescopes; Dark Matter', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

First neutrino oscillation measurement in KM3NeT/ORCA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 345

Presenter
Lodewijk Nauta
Author and Co-Author
Lodewijk Nauta | For the KM3NeT collaboration, Zineb Aly | Valentin Pestel | Paul De Jong

Abstract
'KM3NeT is a Cubic Kilometer Neutrino Telescope that is currently being constructed at the bottom of the Mediterranean Sea. The KM3NeT/ORCA detector will be used for oscillation physics with atmospheric neutrinos, with as main goal establishing the neutrino mass ordering.\r\n\r\nIn 2019, 4 out of the total of 115 vertical lines carrying the light sensors of the ORCA detector had been deployed, while 6 are operational from early 2020.\r\n\r\nWith this partial detector configuration, neutrino oscillations can already be observed. Neutrino flavor oscillations depend on the energy the neutrino carries and the distance it travelled. The distance the atmospheric neutrino travelled can be probed by using the incoming angle in the detector. By measuring the number of events as function of incoming angle and energy in the detector one has a proxy for finding the oscillation parameters.\r\n\r\nDue to multiple background channels, of which atmospheric muons are the largest component, on average three in every one million triggered events comes from a neutrino interacting in the sea water. This contribution focuses on extracting the neutrino signal from the data, results from data/MC comparisons, and how to determine the oscillation parameters $\\theta_{23}$ and $\\Delta m_{31}^2$ by fitting an oscillation model and estimating the associated systematic uncertainties that have to be taken into account.'

Collaborations
KM3NeT,

Keywords and Comments
'Neutrino oscillation physics; Atmospheric neutrinos; Atmospheric muons; VLVnT; Neutrino mass ordering;', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Observation of the cosmic ray shadow of the Sun with the ANTARES neutrino telescope

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 346

Presenter
Matteo Sanguineti
Author and Co-Author
Andrey Romanov | Matteo Sanguineti,

Abstract
'The ANTARES neutrino telescope is operating in the Mediterranean Sea in its full configuration since 2008. On their journey to the Earth, cosmic rays (CRs) can be absorbed by celestial objects, like the Sun, leading to a deficit in secondary muons produced by CR interactions from the solid angle region covered by the Sun, the so-called Sun "shadow" effect. This phenomenon can be used to evaluate fundamental telescope characteristics: the detector angular resolution and pointing accuracy. This work describes the study of the Sun "shadow" effect using the ANTARES data collected between 2008 and 2017. The statistical significance of the Sun shadow observation is $3.7\\sigma$ and the estimated angular resolution value of the ANTARES telescope for downward-going muons is $0.59^{\\circ} \\pm 0.10^{\\circ}$. This result is consistent with the expectations obtained from the Monte Carlo simulations and also with the estimation from the Moon "shadow" analysis of 2007-2016 years. No evidence of systematic pointing shift is found and the resulting pointing accuracy is in agreement with the expectations.'

Collaborations
Antares,

Keywords and Comments
'Cosmic ray & astroparticle detectors; Cosmic ray propagation; Neutrino detectors', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Atmospheric neutrinos from the first KM3NeT/ORCA data and prospects for measuring the atmospheric neutrino flux

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 36 Shower Reconstruction and Pointing | NU
Presenter Forum Table

Presenter
Dimitris Stavropoulos
Author and Co-Author
Dimitris Stavropoulos | Ekaterini Tzamariudaki | Christos Markou, For the KM3NeT collaboration

Abstract
'KM3NeT is a research infrastructure aiming to study astrophysical sources as well as to perform particle physics studies, through the detection of neutrinos in the abyssal depths of the Mediterranean Sea. The KM3NeT/ORCA detector (Oscillation Research with Cosmics in the Abyss), currently under construction, is deployed at 2450m depth near Toulon, France. Its primary goal is to determine the Neutrino Mass Ordering. It consists of vertical structures (Detection Units) equipped\r\nwith spherical Digital Optical Modules, each hosting a set of photomultiplier tubes capable of detecting neutrino events from the Cherenkov radiation induced by the daughter particles.\r\nData collected by the KM3NeT/ORCA detector with 4 and with 6 Detection Units, corresponding to an operation time of 6 months and more than a year respectively, are used for this study. The performance of the KM3NeT/ORCA detector with 4 and with 6 Detection Units will be discussed. The selection of a high-purity sample of atmospheric neutrino events will be presented as well as the prospects for measuring the atmospheric neutrino flux using this sample of atmospheric neutrinos at an early stage of the detector construction.'

Collaborations
KM3NeT,

Keywords and Comments
'Atmospheric Neutrinos; Neutrinos; Cosmic Rays; Cherenkov Detector; Atmospheric Neutrino Flux; Prospects; KM3NeT; Neutrino Astronomy Background;', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

All-flavour search for a diffuse cosmic neutrino flux with ANTARES

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 347

Presenter
Luigi Antonio Fusco
Author and Co-Author
Luigi Antonio Fusco | For the ANTARES Collaboration,

Abstract
'The ANTARES neutrino telescope, located in the Mediterranean Sea, is the longest-operated under-sea neutrino detector, having collected data for more than 14 years and since 2008 in its full configuration. These data have been used to search for a diffuse flux of cosmic neutrinos, upgrading previously published results both in terms of livetime and in search method. In particular, a new event selection strategy, developed for the study of the atmospheric neutrino flux, allows a further rejection of atmospheric foregrounds, thus enabling a considerable reduction of previous systematic uncertainties connected with the background estimation . The results of this new analysis are reported in this contribution.'

Collaborations
Antares,

Keywords and Comments
'', 'on behalf of the ANTARES Collaboration'

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Search for Magnetic Monopoles with ten years of ANTARES data

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Jihad Boumaaza
Author and Co-Author
Jihad Boumaaza, Jürgen Brunner | Yahya TAYALATI | Abdelilah MOUSSA

Abstract
'The present study is an updated search for magnetic monopoles using data taken with the ANTARES neutrino telescope over a period of 10 years (January 2008 to December 2017). In accordance with some grand unification theories, magnetic monopoles could have been created during the phase of symmetry breaking in the early Universe, and accelerated by galactic magnetic fields. As a consequence of their high energy, they could cross the Earth and emit a significant signal in a Cherenkov-based telescope like ANTARES, for appropriate mass and velocity ranges. This analysis uses a run-by-run simulation strategy, as well as a new simulation of magnetic monopoles taking into account the Kasama, Yang and Goldhaber cross section. The results obtained for relativistic magnetic monopoles with velocity $v \geq 0.57c$ will be presented.'

Collaborations
Antares, KM3NeT

Keywords and Comments
'Magnetic Monopole; Neutrinos Telescope; Antares', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Every Flare, Everywhere: An All-Sky Untriggered Search for Astrophysical Neutrino Transients Using IceCube Data

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 348

Presenter
Francesco Lucarelli
Author and Co-Author
William Luszczak | Francesco Lucarelli,

Abstract
'Recent results from IceCube regarding TXS 0506+056 suggest the presence of neutrino flares that are not temporally coincident with a significant corresponding gamma ray flare. Such flares are particularly difficult to identify, as their presence must be inferred from the temporal distribution of neutrino data alone. Here we present the results of using a novel method to search for all such flares across the entire neutrino sky in 10 years of IceCube data, using both gaussian and box-shaped flare hypotheses. Unlike for past searches, that looked for only the most significant neutrino flare in the data at a given direction, here we implement an algorithm to combine information from multiple flares associated with a single source candidate. This represents the most detailed description of the neutrino sky to date, providing the location and intensity of all neutrino cluster candidates in both space and time. These results can be used to further constrain potential populations of transient neutrino sources, serving as a complement to existing time-integrated and time-dependent methods. We additionally present the results of applying this method to a catalog of gamma-ray emitters which has previously been found to contain an excess of neutrinos at the level of 3.3 sigma. Notably, this catalog contains both TXS 0506+056 and NGC 1068, both sources which have also shown elevated emission under previous time-integrated studies.'

Collaborations
IceCube,

Keywords and Comments
'Neutrinos; AGN; Statistical Methods; IceCube; Multi-messenger', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

A Combined Analysis of IceCube's Muon Track and Cascade Neutrino Data

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 349

Presenter
Erik Ganster
Author and Co-Author
Erik Ganster | Richard Naab | Zelong Zhang | For the IceCube Collaboration,

Abstract
"The IceCube Neutrino Observatory first observed a diffuse flux of high energy astrophysical neutrinos in 2013. Since then, this observation has been confirmed in multiple detection channels such as high energy starting events, cascades, and through-going muon tracks. Combining these event selections into a global fit of IceCube's neutrino data could strongly improve the understanding of the astrophysical neutrino flux properties: challenging the simple unbroken power-law flux model as well as the astrophysical neutrino flux composition. One key component of such a combined analysis is the consistent modelling of systematic uncertainties of different event selections. This can be achieved using the novel SnowStorm Monte Carlo method which allows constraints to be placed on multiple systematic parameters from a single simulation set. We will report on the status of a new combined analysis of through-going muon tracks and cascades, which is currently being prepared. It is based on a consistent all flavor neutrino signal and background simulation using, for the first time, the SnowStorm method to analyze IceCube's high-energy neutrino data."

Collaborations
IceCube,

Keywords and Comments
", "

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Searches for and Characterization of Astrophysical Neutrinos using Starting Track Events in IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 350

Presenter
Manuel Silva
Author and Co-Author
Manuel Silva | Sarah Mancina, Albrecht Karle

Abstract
'The IceCube Neutrino Observatory is a cubic kilometer-sized detector designed to detect neutrinos of astrophysical origin. However, muons created by cosmic rays interacting in the atmosphere pose a significant background for these astrophysical neutrinos particularly in the southern equatorial sky. Correctly identifying neutrino events that start in the detector allows us to reduce the atmospheric muon component while retaining a high rate of starting neutrino events. The method presented today also rejects atmospheric neutrinos if they are accompanied by muons from the same cosmic ray shower, lowering the 50% purity threshold for astrophysical-to-atmospheric neutrinos from 100 TeV to ~10 TeV at declinations less than -25°. This allows us to measure the diffuse astrophysical neutrino spectrum to ~10 TeV with excellent precision. In addition, we discuss searches for galactic plane point sources and diffuse galactic plane neutrino emission in the Southern sky and our plans to release high astrophysical-purity real-time alerts to the multi-messenger community using starting track events.'

Collaborations
IceCube,

Keywords and Comments
'icecube; low background; starting track; galactic plane; diffuse neutrino;', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Searching for neutrino transients below 1 TeV with IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 351

Presenter
Michael Larson
Author and Co-Author
Michael Larson | Justin Vandenbrouck | Alex Pizzuto,

Abstract
"Recent observations of GeV gamma-rays from novae have led to a paradigm shift in the understanding of these objects. While it is now believed that shocks contribute significantly to the energy budget of novae, it is still unknown if the emission is hadronic or leptonic in origin. Neutrinos could hold the key to definitively differentiating between these two scenarios, though the energies of such particles would be much lower than are typically targeted with neutrino telescopes. IceCube's densely instrumented DeepCore sub-array provides the ability to reduce the threshold for observation from 1 TeV down to approximately 10 GeV. We will discuss recent measurements in this low energy regime, details of a new sub-TeV selection, and prospects for future searches for transient neutrino emission."

Collaborations
IceCube,

Keywords and Comments
'Sub-TeV; Neutrino Astronomy', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Measuring neutrino cross-section with IceCube at intermediate energies (~100 GeV to a few TeV)

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Sarah Nowicki
Author and Co-Author
Sarah Nowicki | For the IceCube Collaboration,

Abstract
'Whether studying neutrinos for their own sake or as a messenger particle, neutrino cross-sections are critically important for numerous analyses. On the low energy side, measurements from accelerator experiments reach up to a few 100s of GeV. On the high energy side, neutrino-earth absorption measurements extend down to a few TeV. The intermediate energy range has yet to be measured experimentally. This work is made possible by the linear relationship between the event rate and cross-section, and will utilize IceCube muon neutrino data collected between 2010 and 2018. An advanced energy reconstruction, tailored to the unique properties of the energy range and using the full description of photon propagation in ice, is applied to an event sample of neutrino-induced through-going muons to perform a forward folding analysis.'

Collaborations
IceCube,

Keywords and Comments
'cross-section; neutrinos', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

A time-independent search for neutrinos from galaxy clusters with IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 352

Presenter
Mehr Nisa
Author and Co-Author
Mehr Nisa, Andrew Ludwig | Srinivasan Raghunathan | Marcos Santander

Abstract
'Clusters of galaxies — with their turbulent magnetic fields and abundant matter content — are a promising class of potential neutrino sources. Cosmic rays accelerated within the large-scale shocks, Active Galactic Nuclei (AGN), or both can be confined in galaxy clusters over cosmological timescales and produce a steady flux of neutrinos in secondary interactions. The IceCube Neutrino Observatory has detected a diffuse flux of high-energy astrophysical neutrinos. After ten years of operations, however, the origin of this flux remains largely unconstrained. In this work, we perform a stacked search for neutrinos, using a population of over one thousand galaxy clusters detected by the Planck Satellite via the Sunyaev-Zeldovich (SZ) effect up to a redshift $z = 1$. We present the first results on the contribution of galaxy clusters to the diffuse neutrino flux and discuss the implications for various models of cosmic-ray acceleration in large-scale structures.'

Collaborations
IceCube,

Keywords and Comments
'Particle acceleration; Clusters; AGN.', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Atmospheric neutrinos with the first detection units of KM3NeT-ARCA

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 36 Shower Reconstruction and Pointing | NU
Presenter Forum Table

Presenter
Anna Sinopoulou
Author and Co-Author
Anna Sinopoulou | Rosa Coniglione | Ekaterini Tzamariudaki,

Abstract
'The KM3NeT Collaboration is constructing two deep-sea Cherenkov detectors in the Mediterranean Sea, aiming at neutrino oscillation measurements with the ORCA array, while the ARCA array is aimed at neutrino astronomy in the TeV range. In March 2021, a major step will be taken in the construction of ARCA, bringing the total number of detection lines from one to six. If successful, ARCA will be similar to ANTARES in volume. \r\nIn this contribution, we will present the very first data from the new KM3NeT-ARCA configuration. The commissioning and calibration efforts will be presented. The performance will be demonstrated using atmospheric muons and the first atmospheric neutrinos will be shown. The results will be put in context of the ongoing production plans.'

Collaborations
KM3NeT,

Keywords and Comments
'Atmospheric neutrinos; KM3NeT-ARCA; underwater neutrino telescope; atmospheric muons; neutrino astronomy', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Searching for High Energy Neutrinos from Magnetars with IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 353

Presenter
Ava Ghadimi
Author and Co-Author
Ava Ghadimi, Marcos Santander | On behalf of the IceCube Collaboration

Abstract
"Magnetars are neutron stars with very strong magnetic fields on the order of 10^{13} to 10^{15} G. Young magnetars with oppositely-oriented magnetic fields and spin moments may emit high-energy (HE) neutrinos from their polar caps as they may be able to accelerate cosmic rays to above the photomeson threshold (Zhang, et. al 2003). Giant flares of soft gamma-ray repeaters (a subclass of magnetars) may also produce HE neutrinos and therefore a HE neutrino flux from this class is potentially detectable (Ioka, et.al 2005). Here we present plans to search for neutrino emission from magnetars listed in the McGill Online Magnetar Catalog using 10 years of well-reconstructed IceCube muon-neutrino events looking for significant clustering around magnetars' direction. IceCube is a cubic kilometer neutrino observatory at the South Pole and has been fully operational for the past ten years."

Collaborations
IceCube,

Keywords and Comments
'magnetars; neutrinos; point source; icecube', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Searching for time-dependent high-energy neutrino emission from X-ray binaries with IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 354

Presenter
Qinrui Liu
Author and Co-Author
Qinrui Liu, Ali Kheirandish

Abstract
'X-ray binaries are long-standing candidates for the source of Galactic cosmic rays and neutrinos. The compact object in a binary system can be the site for cosmic-ray acceleration, while high-energy neutrinos can be produced by the interactions of cosmic rays in the jet of the compact object, the stellar wind, or the atmosphere of the companion star. We report a time-dependent study of high-energy neutrinos from X-ray binaries with IceCube using 7.5 years of muon neutrino data and X-ray observations. In the absence of significant correlation, we report upper limits on the neutrino fluxes from these sources and provide a comparison with theoretical predictions.'

Collaborations
IceCube,

Keywords and Comments
'astrophysical neutrinos; Galactic neutrino source; X-ray binary; IceCube', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Characterization of the PeV astrophysical neutrino energy spectrum using down-going tracks

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 355

Presenter
Yang Lyu
Author and Co-Author
Yang Lyu,

Abstract
'The IceCube Neutrino Observatory has observed a diffuse flux of astrophysical neutrinos with energies from TeV to a few PeV. Recent IceCube analyses are not sensitive to PeV neutrinos because their fluxes are attenuated by the Earth and the Extremely High Energy (EHE) result targets cosmogenic neutrinos only above 10 PeV. In this work, we present a new event selection that fills the gap between 1 PeV and 10 PeV. This sample is obtained by selecting high-energy down-going through-going tracks from 8 years of data. To achieve a high signal-to-background ratio, the atmospheric muon backgrounds are reduced by using the stochasticity information of the events and the IceTop surface array as a veto. To characterize the astrophysical neutrino flux and test the existence of a cut-off in the neutrino energy spectrum at a few PeV, a global fit will be performed by combining this sample with results from the 7-year High Energy Starting Events (HESE) analysis.'

Collaborations
IceCube,

Keywords and Comments
'Astrophysical neutrino; downgoing tracks; diffuse; IceTop veto', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

A New Search for Neutrino Point Sources with IceCube

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 39 Astrophysical Neutrinos – Theoretical & Experimental Results | NU
Presenter Forum Table

Presenter
Hans Niederhausen
Author and Co-Author
Hans Niederhausen | Theo Glauch | Chiara Bellenghi | Tomas Kontrimas | Christian Haack | Martin Wolf | Rene Reimann | for the IceCube Collaboration,

Abstract
"The IceCube Neutrino Observatory, deployed beneath the South Pole, is the largest neutrino telescope in the World. While eight years have passed since IceCube discovered a diffuse flux of high-energy astrophysical neutrinos, the sources of the vast majority of these neutrinos remain unknown. Here, we present a new search for neutrino point sources that improves the accuracy of the statistical analysis, especially in the low energy regime. We replaced the usual Gaussian approximations of IceCube's point spread function with precise numerical representations, obtained from simulations, and combined them with new machine learning-based estimates of event energies and angular errors. Depending on source properties, the new analysis provides improved source localization, flux characterization and thereby discovery potential (by up to 30%) over previous works. The analysis will be applied to IceCube data that has been recorded with the full 86-string detector configuration from 2011 to 2020 and includes improved detector calibration"

Collaborations
IceCube,

Keywords and Comments
'IceCube; Neutrino Point Sources', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

The diffuse supernova neutrino background in Super-Kamiokande

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 356

Presenter
Sonia El Hedri
Author and Co-Author
Sonia El Hedri,

Abstract
'Neutrinos have played a key role in astrophysics, from the\r\ncharacterization of nuclear fusion processes in the Sun to the\r\nobservation of supernova SN1987A and multiple extragalactic events. The\r\nSuper-Kamiokande experiment has played a major part in past in these\r\nastrophysical studies by investigating low energy O(10)~MeV neutrinos\r\nand currently exhibits the best sensitivity to the diffuse neutrino\r\nbackground from distant supernovae. Here, I present an overview of the\r\nsearch for the diffuse supernova background in Super-Kamiokande, and\r\ndiscuss how the current strategies will evolve after the SuperK-Gd upgrade.'

Collaborations
other (fill field below), Super-Kamiokande

Keywords and Comments
'Neutrinos; Supernovae; Super-Kamiokande', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Search for upward-going showers with the Fluorescence Detector of the Pierre Auger Observatory

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Massimo Mastrodicasa
Author and Co-Author
Massimo Mastrodicasa | For the Pierre Auger Collaboration,

Abstract
'We present the results of a search for upward-going showers using the Fluorescence Detector (FD) of the Pierre Auger Observatory. Upward-going air showers are a possible interpretation of the recent events reported by the ANITA Collaboration in the energy range above 10^{17} eV. Given its operation time and wide field of view, the FD is sufficiently sensitive to upward-going events and can be used to support or constrain this interpretation. If confirmed, it would require either new phenomena or significant modifications to the standard model of particle physics.\r\nTo perform this search, a set of quality selection criteria was defined by using 10% of the available FD data from 14 years of operation. This subset was mainly used to clean the data to remove laser events, used to monitor the atmosphere, which were not properly labelled. The background for this search consists of cosmic-ray events with specific geometric configurations which can be reconstructed erroneously as upward-going events in a monocular reconstruction. To distinguish candidates from these false positives, calculate exposure and obtain the expected background, dedicated simulations for signal (upward-going events) and background (downward-going events) have been performed. The detector exposure is large enough to strongly constrain the interpretation of ANITA anomalous events. Results of the analysis after unblinding the data set are presented.'

Collaborations
Auger,

Keywords and Comments
'', 'The talk could also fit in MM | Multi-Messenger track'

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

A Time-Variability Test for Candidate Neutrino Sources

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Pranav Dave
Author and Co-Author
Pranav Dave,

Abstract
'Recent studies with IceCube have shown signs of a time-integrated flux of astrophysical neutrinos from point-like sources such as TXS 0506+56 and NGC 1068. Time-variability of this neutrino emission from TXS 0506+56 has been studied extensively by assuming a temporal profile of the possible flare(s) or searching for temporal neutrino correlation with other electromagnetic counterparts. However, experimental evidence of the temporal profile of an astrophysical neutrino signal, besides the TXS 0506+56 source, remains lacking. In this study, we present a new KS-test based method for investigating time-variability. This new method complements the existing time-dependent search methods with a test for arbitrary time-variability, independent of an assumed temporal profile or electromagnetic counterpart. Additionally, this method provides a diagnostic tool for characterizing point-like source candidates in IceCube by distinguishing variable from steady neutrino emission and we show results of applying this method to a small catalog of candidate blazars.'

Collaborations
IceCube,

Keywords and Comments
'IceCube; astrophysical neutrinos; neutrino sources', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Search for high-energy neutrino emission from hard X-ray AGN

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 39 Astrophysical Neutrinos – Theoretical & Experimental Results | NU
Presenter Forum Table

Presenter
Sreetama Goswami
Author and Co-Author
Sreetama Goswami | Marcos Santander | George C. Privon | On behalf of the IceCube Collaboration,

Abstract
'The IceCube Neutrino Observatory has detected high-energy astrophysical neutrinos in the TeV-PeV range. These neutrinos have an isotropic distribution on the sky, and therefore likely originate from extragalactic sources. Active Galactic Nuclei (AGN) form a class of astronomical objects which are promising neutrino source candidates given their high electromagnetic luminosity and potential ability to accelerate cosmic rays up to energies larger than 10^{16} eV. Interactions of these cosmic rays within the AGN environment are expected to produce both neutrinos and pionic gamma rays. Some hadronic models of AGN emission suggest that such gamma rays can in turn interact with the dense photon fields of AGN and cascade down to hard X-rays and MeV gamma rays. We present an update on the IceCube stacking analysis searching for high-energy neutrinos from hard X-ray sources sampled from the *Swift*-BAT AGN Spectroscopic Survey (BASS).'

Collaborations
IceCube,

Keywords and Comments
'AGN; high-energy neutrinos; hard X-ray sources.', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Search for Astrophysical Neutrino Transients with IceCube DeepCore

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 39 Astrophysical Neutrinos – Theoretical & Experimental Results | NU
Presenter Forum Table

Presenter
Chujie Chen
Author and Co-Author
Chujie Chen,

Abstract
"DeepCore, as a densely instrumented sub-detector of IceCube, extends IceCube's energy reach down to about 10 GeV, enabling the search for astrophysical transient sources, e.g., choked gamma-ray bursts. While many other past and on-going studies focus on triggered time-dependent analysis, we aim to utilize a newly developed event selection and dataset for an untriggered all-sky time-dependent search for transients. In this work, all-flavor neutrinos are used, where neutrino types are determined based on the topology of the events. We extend the previous DeepCore transient half-sky search to an all-sky search and focus only on short timescale sources (with a duration of 10^2 ~ 10^5 seconds). All-sky sensitivities to transients in an energy range from 10 GeV to 300 GeV will be presented in this poster. We show that DeepCore can be reliably used for all-sky searches for short-lived astrophysical sources."

Collaborations
IceCube,

Keywords and Comments
", "

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

The Baikal-GVD neutrino telescope: search for high-energy cascades

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 36 Shower Reconstruction and Pointing | NU
Presenter Forum Table

Presenter
Zhan-Arys Dzhilkibaev
Author and Co-Author
Zhan-Arys Dzhilkibaev,

Abstract
'Baikal-GVD is a next generation, kilometer-scale neutrino telescope currently under construction in Lake Baikal. GVD is formed by multi-megaton subarrays (clusters) and is designed for the detection of astrophysical neutrino fluxes at energies from a few TeV up to 100 PeV. The design of Baikal-GVD allows one to search for astrophysical neutrinos with flux values measured by IceCube already at early phases of the array construction. We present here preliminary results of the search for high-energy neutrinos via the cascade mode with the Baikal-GVD neutrino telescope.'

Collaborations
other (fill field below), Baikal-GVD

Keywords and Comments
'neutrino astronomy; neutrino telescopes', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

A tau scenario application to a search for upward-going showers with the Fluorescence Detector of the Pierre Auger Observatory

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Ioana Alexandra Caracas
Author and Co-Author
Ioana Alexandra Caracas | For the Pierre Auger Collaboration,

Abstract
'The Pierre Auger Observatory has a large exposure to search for upward propagating shower-like events, and we have used 14 years of its Fluorescence Detector (FD) data to perform a generic search for such events. Recent observations of two coherent radio pulses with the ANITA detector are consistent with steeply upward-going cosmic-ray showers with energies of few tenths of an EeV and remain unexplained. We have performed a general search for up-going air-showers of any type and here it is recast in terms of a general tau lepton model. For maximal flexibility, only the propagation, decay and interactions of tau leptons are treated in this analysis, meaning that the results are independent of the tau production scenario. This treatment allows for a straightforward application of these results to the wide range of neutrino models which currently aim to describe the "anomalous" ANITA events. The goal is accomplished by generating tau leptons within the Earth and its atmosphere with an intensity dependent on the media density. The zenith angle, location and calorimetric energy of any resulting tau-induced air showers are then used to calculate the exposure.\r\n\r\n\r\nAbove 0.2\\,EeV, preliminary results indicate the FD has an exposure which exceeds the estimates of ANITA\'s exposure\r\nto up-going tau primaries with elevation angles greater than $20^\\circ$ from the horizon. Results for different neutrino-agnostic models of tau leptons interacting in the sensitive volume will be presented. Full exposure and sensitivity information for a range of zenith angles is provided, facilitating the flexible application of these results for the community.'

Collaborations
Auger,

Keywords and Comments
'', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Posteriori analysis on IceCube double pulse tau neutrino candidates

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 36 Shower Reconstruction and Pointing | NU
Presenter Forum Table

Presenter
Wei Tian
Author and Co-Author
Wei Tian, Maximilian Meier | Logan Wille

Abstract
'Astrophysical tau neutrinos can cause double pulse waveform signals in IceCube photon sensors. A previous 8-year analysis has found three tau neutrino candidates and the most promising one which is located very near to the dust layer in the detector. We will present a posteriori analysis on this event using a new ice model treatment with continuously varying parameters to do targeted volume re-simulation for tau neutrino and other background neutrino ensembles, which aims to explore the impact of different ice models on the expected signal and background statistics.'

Collaborations
IceCube,

Keywords and Comments
'', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

A Template-based UHE Neutrinos Search with the Askaryan Radio Array (ARA)

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Myoungchul Kim
Author and Co-Author
Myoungchul Kim, Shigeru Yoshida | Aya Ishihara | For the ARA Collaboration

Abstract
"The Askaryan Radio Array (ARA) is a gigaton size neutrino radio telescope located at the near geographic South Pole. ARA has five independent stations designed to detect Askaryan emission coming from the interaction between ultra-high energy neutrinos (> 10 PeV) and Antarctic ice. Each station corresponds of 16 antenna clusters deployed in a matrix shape under ~200 m deep in the ice. The simulated neutrino template, including the detector response model, was implemented as a new search technique for reducing background noise and increasing the vertex reconstruction resolution. The template is designed to scan through the data by the matched filter method, inspired by LIGO, looking for a low SNR neutrino signature and ultimately aiming to lower the detector's energy threshold. I will present the estimated sensitivity improvements to ARA analyses through the application of the template technique with results from simulation and data."

Collaborations
other (fill field below), ARA

Keywords and Comments
'Template: Matched filter; ARA; Askaryan Radio Array; UHE Neutrinos; Neutrinos; Astrophysics; South Pole; Askaryan; Antenna; Radio; Sensitivity; Analysis', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

The NuMoon Experiment: Lunar Detection of Cosmic Rays and Neutrinos with LOFAR

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table

Presenter
Godwin Komla Krampah
Author and Co-Author
Godwin Komla Krampah, For the LOFAR CR-KSP

Abstract
'The low flux of ultra-high-energy cosmic rays (UHECRs) makes it challenging to understand their origin and nature. A very large effective aperture is provided by the lunar Askaryan technique. Particle cascades in a dielectric medium produce radio emission through the Askaryan effect. Ground based radio telescopes are used to search for nanosecond radio pulses that are produced when cosmic rays or neutrinos interact with the Moon's surface. The LOw Frequency ARray (LOFAR) is currently the largest radio array operating at frequencies between $110 - 190$~MHz; the optimum frequency range for lunar signal search and $30 - 80$~MHz for radio detection of air showers. One minute of observation has been carried out with six LOFAR stations beam-formed towards the Moon. In this contribution, we present some preliminary results of the analysis of the data and a complete description of the analysis steps.'

Collaborations
LOFAR,

Keywords and Comments
", "

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

An atmospheric neutrino flux calculation constrained by measurements of cosmic muon fluxes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 357

Presenter
Juan-Pablo Yanez
Author and Co-Author
Juan-Pablo Yanez | Anatoli Fedynitch,

Abstract
'Atmospheric neutrinos, produced by cosmic ray interactions, are a unique probe to study neutrino oscillations and exotic phenomena beyond the standard model, as well as the main background to measurements of astrophysical neutrinos. Due to the higher precision of next generation detectors, flux uncertainties are increasingly impacting such studies, in particular driven by the lack of measurements from hadronic particle production in the very forward region. In this work we introduce constraints provided by inclusive muon flux measurements into the calculations of lepton fluxes provided by the MCEq code to obtain a new atmospheric neutrino flux prediction. We also explore the potential that new muon flux data could have on further reducing the uncertainties in atmospheric neutrino fluxes.'

Collaborations

Keywords and Comments
'atmospheric neutrinos; neutrino astronomy; hadronic physics', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Searches for Neutrino Sources with IceCube Cascade Events

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 358

Presenter
Stephen Sclafani
Author and Co-Author
Stephen Sclafani | Mirco Hünnefeld,

Abstract
'IceCube has discovered a flux of astrophysical neutrinos, and more recently has used muon-neutrino datasets to present evidence for one source; a flaring blazar known as TXS 0506+056. However, the sources responsible for the majority of the astrophysical neutrino flux remain elusive. Opening up new channels for detection can improve sensitivity and increase the chance of a discovery. In this work we present a new neutrino dataset relying heavily on Deep-Neural-Networks (DNN) to select cascade events produced from neutral-current interactions of all flavors and charged-current interactions with flavors other than muon-neutrino. The speed of DNN based selections allows the event selection to be performed in near-realtime with a single GPU. Cascade events have reduced angular resolution when compared to muon-neutrino events, however the resulting dataset has a lower energy threshold in the southern sky and a lower background rate. These benefits lead to an improved sensitivity to sources in the southern sky when compared to muon-neutrino datasets. This improvement is particularly promising for identifying transient neutrino sources in the southern sky and neutrino production from the galactic plane.'

Collaborations
IceCube,

Keywords and Comments
", "

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Capabilities of the ARIANNA Neutrino Pointing Resolution, with Implications for Future Ultra-high Energy Neutrino Astronomy

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Steven Barwick
Author and Co-Author
Steven Barwick | For the ARIANNA Collaboration,

Abstract
'We describe a radio-frequency polarization measurement by the ARIANNA surface station using a residual hole from the South Pole Ice Core (SPICEcore) Project. Radio pulses were emitted from a transmitter located down to 1.7 km below the snow surface. After deconvolving the raw signals for the detector response and attenuation from propagation through the ice, the signal pulses show no significant distortion and agree with a reference measurement of the emitter made in an anechoic chamber. The direction to transmitted radio pulse was measured with an angular resolution of 0.37 degree [statistical error]. For polarization, the statistical error of the polarization vector is depth dependent and below 1 degree. In addition, a slow systematic error as a function of depth is 2.7 degrees. Neither the direction or polarization measurement show a significant offset as a function of depth relative to expectation.\r\n\r\nWe also report the on the results of a simulation study of the ARIANNA neutrino direction and energy resolution. The software tool NuRadioMC was used to reconstruct the polarization and viewing angle to determine the neutrino direction. Multiple models of Askaryan radiation and detector sites along with a range of neutrino energies were tested. The neutrino space angle resolution was determined to be below 3 degrees, which is comparable to the systematic polarization uncertainty. Therefore it is expected that the polarization resolution, which is the dominant contribution to the neutrino space angle resolution, will be improved in future studies by determining and eliminating systematic effects. Finally, the fractional neutrino energy resolution is reported at 0.25, which is below the inelasticity limit.'

Collaborations
other (fill field below), ARIANNA

Keywords and Comments
'Askaryan; UHE neutrinos; ice radio detection; polarization; angular resolution', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Search for nuclearites with the KM3NeT detector

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Alice Paun
Author and Co-Author
Alice Paun | for the KM3NeT Collaboration, Gabriela Pavalas | Vlad Popa

Abstract
'Strange quark matter (SQM) is a hypothetical type of matter composed of almost equal quantities of up, down and strange quarks. Massive SQM particles are called nuclearites. Nuclearites with masses greater than 10^{13} GeV and velocities of about 250 km/s (typical galactic velocities) could reach the Earth and interact with atoms and molecules of sea water within the sensitive volume of the deep-sea neutrino telescopes. The SQM particles can be detected with the KM3NeT telescope (whose first lines are already installed in the Mediterranean Sea and taking data) through the visible blackbody radiation generated along their path inside or near the instrumented area. In this work the results of a study using Monte Carlo simulations of down-going nuclearites are discussed. Preliminary sensitivities of the KM3NeT experiment for a flux of nuclearites are also presented.'

Collaborations
KM3NeT,

Keywords and Comments
'strange quark matter; nuclearites; neutrino telescopes; KM3NeT; Monte Carlo simulations', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Implementing a Low-Threshold Analysis with the Askaryan Radio Array (ARA)

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Kaeli Hughes
Author and Co-Author
Kaeli Hughes | For the ARA Collaboration,

Abstract
'The Askaryan Radio Array (ARA) is a ground-based radio detector at the South Pole designed to capture Askaryan emission from ultra-high energy neutrinos interacting within the Antarctic ice. The newest ARA station has been equipped with a phased array trigger, in which radio signals in multiple antennas are summed in predetermined directions prior to the trigger. In this way, impulsive signals add coherently, while noise likely does not, allowing the trigger threshold to be lower than a traditional ARA station. In this talk, I will discuss our ability to analyze these low-threshold events, using data from the 2019 season to illustrate new analysis techniques that yield high efficiency for low-SNR signals. I will also discuss how these analysis techniques could be applied to next-generation radio detectors.'

Collaborations
other (fill field below), ARA

Keywords and Comments
'neutrino; radio; low threshold; Askaryan; Antarctica; analysis; Askaryan Radio Array; ARA; phased array;', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

The Diffuse Supernova Neutrino Background in Super-Kamiokande

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 359

Presenter
Alberto Giampaolo
Author and Co-Author
Alberto Giampaolo,

Abstract
'Detecting the Diffuse Supernova Neutrino Background at Super-Kamiokande requires designing state-of-the-art background removal technique to reject radioactivity induced by cosmic muon spallation, and identify atmospheric neutrino interactions. Identifying the neutron produced by the interaction of DSNB antineutrinos would allow to remove most of these backgrounds, but is particularly challenging in pure water. With the advent of the SK-Gd era, the efficiency of the neutron tagging procedure will increase dramatically, and the SK experiment will make significant gains in its sensitivity to the DSNB. I will present the role of neutron tagging and the challenges it provides, as well as how this technique could evolve to take full advantage of the SK-Gd capabilities.'

Collaborations
other (fill field below), Super-Kamiokande

Keywords and Comments
'', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Search for exotic neutrino interactions by XMASS-I detector

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
hiroshi ogawa
Author and Co-Author
hiroshi ogawa | For the XMASS collaboration,

Abstract
'XMASS is multi-purpose experiment using liquid xenon and is located at the Kamioka Observatory in Japan. The detector consists of a liquid xenon with a single-phase of 832 kg active volume and has a low energy threshold, low backgrounds and large target mass. In XMASS, it is possible to verify the topics of low energy neutrino physics which would give hints on models beyond SM. Now we have searched for exotic neutrino-electron interactions that could be produced by a neutrino millicharge, by a neutrino magnetic moment, or by dark photons using solar neutrinos in XMASS. We analyzed the data between November 2013 and March 2016 for 711days dataset. No significant signals have been observed with predicting the backgrounds in detector. We obtained an upper limit of neutrino millicharge of $5.4\\times10^{-11}$e for all flavors of neutrino. We also set individual flavors to be $7.3 \\times 10^{-12} e$ for $\\nu_e$, $1.1 \\times 10^{-11} e$ for $\\nu_{\\mu}$, and $1.1 \\times 10^{-11} e$ for $\\nu_{\\tau}$. The limits for $\\nu_{\\mu}$ and $\\nu_{\\tau}$ are the best direct experimental limits. We also obtain an upper limit for the neutrino magnetic moment of 1.8$\\times$10$^{-10}\\mu_{B}$. In addition, we obtain upper limits for the coupling constant of dark photons in the $U(1)_{B-L}$ model of 1.3$\\times$10^{-6} if the dark photon mass is 1$\\times 10^{-3}$ MeV$/c^{2}$, and 8.8$\\times$10^{-5} if it is 10 MeV$/c^{2}$. In particular, we almost exclude the possibility to understand the muon $g-2$ anomaly by dark photons.'

Collaborations
other (fill field below), XMASS

Keywords and Comments
'neutrino; millicharge; magnetic moment; dark photon; low background; liquid xenon.', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Polarization Reconstruction of Cosmic Rays with the ARIANNA Neutrino Radio Detector

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Leshan Zhao
Author and Co-Author
Leshan Zhao | For the ARIANNA Collaboration,

Abstract
'The ARIANNA detector is designed to detect neutrinos of energies above $10^{16} eV$. Due to the similarity in generated radio signals, cosmic rays are often used as test beams for neutrino detectors. Some ARIANNA detector stations are equipped with antennas capable of detecting air showers. The radio emission properties of air showers are well understood, and the polarization of the radio signal can be predicted from arrival direction with high precision. For this reason, cosmic rays can be used as a proxy to assess the reconstruction capabilities of the ARIANNA neutrino detector. We report on dedicated efforts of reconstructing the polarization of cosmic-ray radio pulses. A total of 245 cosmic rays are identified from over 90,000 triggered events collected between Dec 1, 2018 and Mar 15, 2019. A cut was put on these events requiring them to have a signal-to-noise (SNR) ratio of at least 5 in all upward-facing channels. Polarization of these cosmic rays were reconstructed with a resolution of 4 degrees (68% containment), which agrees with the expected value we obtained from simulation.'

Collaborations
other (fill field below), ARIANNA

Keywords and Comments
'Askaryan; cosmic ray; calibration source; UHE neutrino detector; polarization; radio; indirect; measurement', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

A neural network based UHE neutrino reconstruction method for the Askaryan Radio Array (ARA)

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Yue Pan
Author and Co-Author
Yue Pan | For the ARA Collaboration,

Abstract
'The Askaryan Radio Array (ARA) is an ultra-high energy (UHE) neutrino (E_nu > 10^17 eV) detector at South Pole. ARA aims to utilize radio signals detected from UHE neutrino interactions in the glacial ice to infer properties about the interaction vertex as well as the incident neutrino. To retrieve these properties from experiment data, the first step is to extract timing, amplitude and frequency information from waveforms of different antennas buried in the deep ice. These features can then be utilized in a neural network to reconstruct the neutrino interaction vertex position, incoming neutrino direction and shower energy. So far, vertex can be reconstructed through interferometry while neutrino reconstruction is still under investigation. Here I will present a solution based on multi-task deep neural networks which can perform reconstruction of both vertex and incoming neutrinos with a reasonable precision. After training, this solution is capable of rapid reconstructions (e.g. 0.1ms/event compared to 10000ms/event in a conventional routine) useful for trigger and filter decisions, and can be easily generalized to different station configurations for both design and analysis purposes.'

Collaborations
other (fill field below), ARA

Keywords and Comments
'', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Measuring the Neutrino Cross Section Using 8 years of Upgoing Muon Neutrinos

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Sally Robertson
Author and Co-Author
Sally Robertson,

Abstract
'The IceCube neutrino observatory detects neutrinos at energies orders of magnitude higher than those accessible to current neutrino accelerators. Above 40 TeV, neutrinos traveling through the Earth will be absorbed as they interact via charge current interactions with nuclei, creating a deficit of Earth-crossing neutrinos detected at IceCube. In this analysis we use the Earth as a target to measure the neutrino cross section for muon neutrinos passing through IceCube. The previous published results of this analysis showed the cross section to be consistent with Standard Model predictions for 1 year of IceCube data. In this analysis we extend the studies to 8 years of data, increasing the statistics by an order of magnitude and improving the treatment of systematic uncertainties. We present the updated cross section measurement studies in three decade-wide bins, and compare to previous IceCube cross section results.'

Collaborations
IceCube,

Keywords and Comments
", "

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Seasonal Variations of the Unfolded Atmospheric Neutrino Spectrum with IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 360

Presenter
Karolin Hymon
Author and Co-Author
Karolin Hymon, Tim Ruhe | For the IceCube Collaboration

Abstract
"The IceCube Neutrino Observatory is a detector array at the South Pole with the central aim of studying astrophysical neutrinos. However, the majority of the detected neutrinos originates from cosmic ray interactions in the atmosphere. The rate of these atmospheric neutrinos shows a seasonal variation indicating that the rate changes with the temperature in the stratosphere. These seasonal changes of the atmospheric neutrino energy spectrum will be investigated using the Dortmund Spectrum Estimation Algorithm (DSEA). Based on results obtained from 10% of IceCube's atmospheric muon neutrino data, taken between 2011 and 2018, the differences of the measured fluxes during the Austral summer and winter will be discussed."

Collaborations
IceCube,

Keywords and Comments
'atmospheric neutrinos; unfolding; Dortmund Spectrum Estimation Algorithm; IceCube; seasonal variations; spectrum reconstruction', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Optical analysis of the Pacific Ocean Neutrino Experiment (P-ONE) site using data from the first pathfinder mooring

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 36 Shower Reconstruction and Pointing | NU
Presenter Forum Table

Presenter
Christian Fruck
Author and Co-Author
Christian Fruck | Andreas Gärtner | Immacolata Carmen Rea | For the P-ONE Collaboration,

Abstract
'The Pacific Ocean Neutrino Experiment (P-ONE) collaboration, currently forming around Ocean Networks Canada (ONC), including Canadian as well as German universities, pursues the goal of constructing a new large-scale neutrino telescope at the 2600 m deep Cascadia Basin, off the Canadian coast. While the instrumented volume needs to be at least on the order of km^3 for the physics goals of P-ONE to be met, the density of photo sensors needs to be kept as low as possible in order to optimize construction costs. This naturally puts very high demands on the optical properties of the water at the site, which should ideally exhibit minimal extinction and scattering in order to optimize the light yield and timing needed for the reconstruction of neutrino-induced Cherenkov light flashes. Another important aspect is the light background from natural sources, such as bioluminescence and K40 radioactive decay.\r\nIn order to evaluate the proposed site for P-ONE, two pathfinder missions have already been deployed successfully, one in 2018 and the other in 2020. In this presentation we will show the results from the first mission that was primarily aimed at evaluating the optical properties of the site in terms of absorption, scattering and backgrounds.'

Collaborations
other (fill field below), P-ONE

Keywords and Comments
'neutrino telescopes; site characterization; optical properties', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Searches for point-like sources of cosmic neutrinos with 13 years of ANTARES data

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 39 Astrophysical Neutrinos – Theoretical & Experimental Results | NU
Presenter Forum Table

Presenter
Giulia Illuminati
Author and Co-Author
Giulia Illuminati | for the ANTARES Collaboration,

Abstract
'The main goal of the ANTARES neutrino telescope is the identification of neutrinos from astrophysical sources. Thanks to its location in the Northern hemisphere, ANTARES can rely on an advantageous view of the Southern Sky, in particular for neutrino energies below 100 TeV. This feature, combined with a very good angular resolution for high-quality selected events, makes the telescope an excellent tool to test for the presence of point-like sources, especially of Galactic origin. In ANTARES, track-like events (mainly resulting from from $\\nu_{\\mu}$ charged current -- CC -- interactions) are reconstructed with a median angular resolution of $0.4^{\\circ}$ while for shower-like events (mainly coming from $\\nu_{e}$ CC and all-flavour neutral current -- NC -- interactions) a median angular resolution of $3^{\\circ}$ is achieved. The ANTARES Collaboration published the result of the search for cosmic point-like neutrino sources using track-like and shower-like events collected during nine years of data taking [Phys. Rev. D96 (2017) 082001]. In this contribution, the update to this analysis using a total of 13 years of data recorded between early 2007 and early 2020 (3845 days of livetime) is presented. Moreover, the results of the dedicated searches for neutrino candidates from the tidal disruption events AT2019dsg and AT2019fdr, recently indicated as the most likely counterparts of two high-energy IceCube neutrinos, IC191001A and IC200530A, are reported.'

Collaborations
Antares,

Keywords and Comments
'ANTARES; neutrino; point-like sources', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

KM3NeT/ARCA sensitivity to transient neutrino sources

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 361

Presenter
Juan Palacios González
Author and Co-Author
Juan Palacios González, Marta Colomer Molla | Agustín Sánchez Losa | Francisco Salesa Greus | Damien Dornic | Sebastien Le Stum | on behalf of the KM3NeT collaboration

Abstract
'The KM3NeT collaboration is constructing a km3 volume neutrino telescope in the Mediterranean sea, called ARCA (Astroparticle Research with Cosmics in the Abyss), that will achieve an unprecedented sensitivity to high-energy cosmic neutrinos. This telescope will be able to reconstruct the arrival direction of the neutrinos with a precision of ~0.1 degrees. The configuration of ARCA makes it sensitive to neutrinos in a wide energy range, from sub-TeV up to tens of PeV. Moreover, this detector has a large field of view and a very high duty cycle, allowing for full-sky (and all-flavours) searches. All these features make ARCA an excellent instrument to study transient neutrino sources.\r\n\r\nAtmospheric muons and neutrinos, produced by primary cosmic rays, constitute the main background for ARCA. This background can be several orders of magnitude higher than the expected cosmic neutrino flux. In this work, we introduce an event selection which reduces the background up to a negligible level inside the region of interest and within the search time window. In particular, we apply this method to estimate the ARCA sensitivity to some example targets such as interesting gravitational wave events (e.g. GW170817) and TeV gamma-ray bursts (e.g. GRB 190114C). The ARCA performance to detect a given neutrino flux, including the discovery flux, sensitivity and effective area, are provided for this particular selection.'

Collaborations
KM3NeT,

Keywords and Comments
'neutrino; ARCA; sensitivity; transient sources', ''

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Webpage icrc2021.desy.de

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Low-energy astrophysics with KamLAND

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Nanami Kawada
Author and Co-Author
Nanami Kawada, Shuhei Obara | Koji Ishidoshiro | For the KamLAND Collaboration

Abstract
'We present two results of a search for MeV-scale neutrino and anti-neutrino events correlated with gravitational wave events/candidates and large solar flares with KamLAND.\r\n\r\nThe KamLAND detector is a large-volume neutrino detector using liquid scintillator, which is located at 1 km underground under the top of Mt. Ikenoyama in Kamioka, Japan.\r\nKamLAND has multiple reaction channels to detect neutrinos. Electron antineutrino can be detected via inverse-beta decay with 1.8 MeV neutrino energy threshold. All flavors of neutrinos can be detected via neutrino-electron scattering without neutrino energy threshold.\r\nKamLAND has continued the neutrino observation since 2002 March.\r\n\r\nWe use the data set of 60 gravitational waves provided by the LIGO/Virgo collaboration during their second and third observing runs and search for coincident electron antineutrino events in KamLAND.\r\nWe find no significant coincident signals within a $\\pm$500 s timing window from each gravitational wave and present 90% C.L. upper limits on the electron antineutrino fluence between 10^{8}--10^{13} cm^{-2} for neutrino energies of 1.8--111 MeV.\r\n\r\nFor a solar-flare neutrino search at KamLAND, we determine the timing window using the solar X-ray data set provided by the *GOES* satellite series from 2002 to 2019 and search for the excess of coincident event rate on the all-flavor neutrinos.\r\nWe find no significant event rate excess in the flare time windows and get 90% C.L. upper limits on the fluence of neutrinos of all flavors (electron anti-neutrinos) between 10^{10}--10^{13} cm^{-2} (10^{8}--10^{13} cm^{-2}) for neutrino energies in the energy range of 0.4--35 MeV.'

Collaborations
other (fill field below), the KamLAND collaboration

Keywords and Comments
'neutrino; low-energy; astrophysics; gravitational wave; solar flare', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Search for an association between neutrinos and radio-selected blazars with ANTARES

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 39 Astrophysical Neutrinos – Theoretical & Experimental Results | NU
Presenter Forum Table

Presenter
Julien Aublin
Author and Co-Author
Julien Aublin | Alexander Plavin,

Abstract
'Recently, evidence for an association between high energy neutrinos\r\ndetected by IceCube and radio-selected blazars has been found by\r\nPlavin et al. (2020, 2021). This result was achieved using an all sky\r\ncomplete sample of 3411 blazars selected on their parsec-scale flux\r\ndensity at 8 GHz higher than 150 mJy.\r\nWe perform an analysis using the same sample of radio-selected blazars\r\nand search for a positional correlation with the astrophysical\r\nneutrino candidates selected for point source searches from the data\r\ncollected by the ANTARES detector between January 29, 2007 and\r\nFebruary 28, 2020.\r\nFirst results of this search are presented and discussed.'

Collaborations
Antares,

Keywords and Comments
'Neutrinos; Blazars; Catalogs', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Latest results on neutrino non-standard interactions with ANTARES and KM3NeT/ORCA Phase 1

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 362

Presenter
Jerzy Manczak
Author and Co-Author
Jerzy Manczak, Nafis Rezwan Khan Chowdhury | Sergio Navas

Abstract
'Neutrino Non Standard Interactions (NSI) are one of the sub-dominant effects which can affect neutrinos propagating through matter via observable changes in their oscillation patters predicted by the standard oscillation parameters. These interactions should modify neutrino flavour ratio observed in neutrino telescopes measuring atmospheric neutrino flux. \r\nThe ANTARES neutrino telescope has already proven its sensitivity for NSI with 10 years of data taking. KM3NeT, the ANTARES successor, is a next-generation neutrino telescope currently under construction in the Mediterranea Sea. ORCA is a dense array that constitutes the low-energy branch of KM3NeT with the main aim of resolving the neutrino mass hierarchy. By now, the KM3NeT/ORCA Phase 1 has already been deployed, which makes 6 out of the planned 115 detection lines operational. Even with this limited capability, neutrino oscillations can already be measured and studied. \r\nIn this contribution, a summary of the most recent results on NSI from the ANTARES detector, which has produced best worldwide limits in some interesting regions of the parameter space, will be shown. These results will also be compared to projections from different configuration stages of the KM3NeT/ORCA detector. For the first time, the combined NSI measurements from 4 months of data taking with 4 detection units and 1 year with 6 DUs of KM3NeT/ORCA will be presented.'

Collaborations
KM3NeT, Antares

Keywords and Comments
'neutrino telescope; non standard interactions; neutrino oscillations', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Sensitivity of the KM3NeT/ORCA detector to the neutrino mass ordering and beyond

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Mathieu Perrin-Terrin
Author and Co-Author
Mathieu Perrin-Terrin | For the KM3NeT collaboration,

Abstract
'The KM3NeT collaboration is currently building a new generation of large-volume water-Cherenkov neutrino telescopes in the Mediterranean sea. Two detectors, ARCA and ORCA, are under construction. They feature different neutrino energy thresholds: TeV range for ARCA and GeV range for ORCA. The main research goal of ORCA is the measurement of the neutrino mass ordering and atmospheric neutrino oscillation parameters, while the detector is also sensitive to a wide variety of other physics topics, including non-standard interactions, sterile neutrinos and Earth tomography, as well as low-energy neutrino astronomy. \r\nThis contribution will present an overview of the updated ORCA sensitivity projection to its main science objectives, including - but not limited to - the measurement of the neutrino mass ordering and oscillation parameters Future perspectives for ORCA to serve as far detector for a long baseline neutrino experiment with a neutrino beam from the U70 accelerator complex at Protvino in Russia will also be discussed.'

Collaborations
KM3NeT,

Keywords and Comments
'Neutrino Mass Ordering; Neutrino Oscillation; P2O; KM3NeT', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Development of the Double Cascade Reconstruction Techniques in the Baikal-GVD Neutrino Telescope

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 36 Shower Reconstruction and Pointing | NU
Presenter Forum Table

Presenter
Eliška Eckerová
Author and Co-Author
Eliška Eckerová | For the Baikal-GVD Collaboration,

Abstract
'Baikal-GVD is a cubic-kilometer scale neutrino telescope installed in Lake Baikal. The main goal of this telescope is the neutrino detection via detecting the Cherenkov radiation of the secondary charged particles originating in the interactions of neutrinos. The basic detection unit of this telescope is a photo-multiplier tube enclosed in a pressure resistant glass sphere – optical module. The optical modules are arranged in independently working units called clusters.\r\n\r\nOne of the methods for astrophysical neutrino detection is an observation of high energy tau neutrinos (E ≳ 100 TeV), which create double cascade signature in charged current interaction.\r\n\r\nIn this contribution, three independent techniques for search and reconstruction of double cascades will be introduced. The first technique is based on study of pulse shapes, the second method is based on identification of two distinct cascades created in a cluster, and the third one combines single cascade reconstruction technique with multi-cluster events studies. The very first steps in the development of these techniques will be presented.'

Collaborations
other (fill field below), Baikal-GVD

Keywords and Comments
'double cascades; tau neutrino; double pulses; reconstruction techniques', ''

Branch	NU | Neutrinos & Muons
Subcategory	Experimental Results

Expectations for the high-energy neutrino detection from starburst galaxies with KM3NeT/ARCA

Time	21 July 2021 | 12:00 - 13:30 | Berlin Time
Session	Discussion: 26 Galactic Sources & Winds | MM
Presenter Forum Table	363

Presenter
Walid Idrissi Ibnsalih
Author and Co-Author
Walid Idrissi Ibnsalih, Pasquale Migliozzi | Antonio Marinelli | Gennaro Miele | Antonio Ambrosone | Ofelia Pisanti | Ankur Sharma

Abstract
'Starburst galaxies (SBGs) and more generally starforming galaxies represent a class of galaxies with a high star formation rate (10-100 Mo/year). Despite their low luminosity, they can be considered as guaranteed “factories” of high energy neutrinos, being “reservoirs” of accelerated cosmic rays and hosting a high density target gas in their central region. In this contribution, the possibility of observing their neutrino signals is explored with the KM3NeT/ARCA telescope, which is in construction in the Mediterranean sea. The differential sensitivity and discovery potential for different SBG scenarios are reported for both shower and track event analyses in the 100 GeV – 100 PeV energy range.'

Collaborations
KM3NeT,

Keywords and Comments
'Starburst galaxies; neutrino telescope; diffuse signal', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

IceCube Search for Earth-traversing ultra-high energy Neutrinos

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Ibrahim Safa
Author and Co-Author
Ibrahim Safa | Carlos Arguelles | for the IceCube collaboration,

Abstract
'The search for ultra-high energy neutrinos is more than half a century old. While the hunt for these neutrinos has led to major leaps in neutrino physics, including the detection of astrophysical neutrinos, neutrinos at the EeV energy scale remain undetected. Proposed strategies for the future have mostly been focused on direct detection of the first neutrino interaction, or the decay shower of the resulting charged particle. Here we present an analysis that uses, for the first time, an indirect detection strategy for EeV neutrinos. We focus on tau neutrinos that have traversed Earth, and show that they reach the IceCube detector, unabsorbed, at energies greater than 100 TeV for most trajectories. This opens up the search for ultra-high energy neutrinos to the entire sky. We use ten years of IceCube data to perform an analysis that looks for secondary neutrinos in the northern sky, and highlight the promise such a strategy can have in the next generation of experiments when combined with direct detection techniques.'

Collaborations
IceCube,

Keywords and Comments
'EeV; neutrinos; GZK; UHE; ultra-high energy', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

KM3NeT performance on oscillation and absorption tomography of the Earth

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 365

Presenter
Lukas Maderer
Author and Co-Author
Lukas Maderer, Veronique van Elewyck | Joao Coelho | Edouard Kaminski

Abstract
'The KM3NeT neutrino telescope, currently under construction, consists of two detectors in the Mediterranean Sea, ORCA and ARCA, both using arrays of optical modules to detect the emitted Cherenkov light from charged particles created in neutrino interactions. Although originally designed for neutrino oscillation and astrophysical research, this experiment also bears unprecedented possibilities for other fields of physics. Here we present its performance for neutrino tomography, i.e. the study of the Earth’s internal structure and composition.\r\nOwing to the different energy ranges covered by its two detectors ORCA and ARCA, KM3NeT will be the first experiment to perform both oscillation and absorption neutrino tomography. Resonance effects in the oscillations of GeV neutrinos traversing the Earth will allow KM3NeT/ORCA to measure the electron density along their trajectory, leading to potential constraints of the proton-to-nucleon (Z/A) ratio in the traversed matter. Absorption tomography aims at the detection of neutrinos in the TeV-PeV range with KM3NeT/ARCA. At PeV energies, the Earth is opaque for neutrinos which leads to a reduction of the upgoing neutrino flux at the detector side from which conclusions can be drawn about the density of the inner layers of the Earth.\r\nWe show here first sensitivity studies of the potential of KM3NeT to address open questions of geophysics concerning the chemical composition and matter distribution in the Earth’s core and mantle through neutrino tomography.'

Collaborations
KM3NeT,

Keywords and Comments
'Atmospheric neutrinos; Absorption tomography; Oscillation tomography;', ''

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

TAROGE-M: Radio Observatory on Antarctic High Mountain for Detecting Near-Horizon Ultra-High Energy Air Showers

Time 13 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 08 Radio Observations of Cosmic Rays | CRI-NU
Presenter Forum Table

Presenter
Shih-Hao Wang
Author and Co-Author
Shih-Hao Wang | For the TAROGE and the ARIANNA Collaborations,

Abstract
'The TAROGE-M observatory is an autonomous antenna array on the top of Mt.~Melbourne ($\\sim2700$ m altitude) in Antarctica, designed to detect radio pulses from ultra-high energy (over 10^{17} eV) air showers coming from near-horizon directions. The targeted sources include cosmic rays, Earth-skimming tau neutrinos, and most of all, the anomalous near-horizon upward-going events of yet unknown origin discovered by ANITA experiments. The detection concept follows that of ANITA: monitoring large area of ice from high-altitude and taking advantage of strong geomagnetic field and quiet radio background in Antarctica, whereas having significantly greater livetime and scalability. \r\n\r\nThe TAROGE-M station, upgraded from its prototype built in 2019, was deployed in January 2020, and consists of 6 log-periodic dipole antennas pointing horizontally with bandwidth of 180-450 MHz. The station is then calibrated with drone-borne transmitter, with which the event reconstruction obtained $\\sim0.3^\\circ$ angular resolution. The station was then smoothly operating in the following month, with the live time of $\\sim30$ days, before interrupted by a power problem, and its online filtering has identified several candidate cosmic-ray events and sent out via satellite communication. In this paper, the instrumentation of the station for polar and high-altitude environment, its radio-locating performance, the preliminary result on cosmic-ray detection, and the future extension plan are presented.'

Collaborations
other (fill field below), TAROGE, ARIANNA

Keywords and Comments
'ultra-high energy cosmic ray; ultra-high energy cosmic neutrinos; extensive air shower; radio detection; ANITA anomalous event; Antarctica', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Recent Progress in Solar Atmospheric Neutrino Searches with IceCube

Time 16 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 36 Shower Reconstruction and Pointing | NU
Presenter Forum Table

Presenter
Joshua Villarreal
Author and Co-Author
Joshua Villarreal | Gerrit Roellinghoff | Jeffrey Lazar,

Abstract
'Cosmic-rays interacting with nucleons in the solar atmosphere produce a cascade of particles that give rise to a flux of high-energy neutrinos and gamma-rays. Fermi has observed this gamma-ray flux; however, the associated neutrino flux has escaped observation. In this contribution, we put forward two strategies to detect these neutrinos, which, if seen, would push forward our understanding of the solar atmosphere and provide a new testing ground of neutrino properties. First, we will extend the previous analysis, which used high-energy through-going muon events collected in the years of maximum solar activity and yielded only flux upper limits, to include data taken during the solar minimum from 2018 to 2020. Extending the analysis to the solar minimum is important as the gamma-ray data collected during past solar cycles indicates a possible enhancement in the high-energy neutrino flux. Second, we will incorporate sub-TeV events and include contributions from all neutrino flavors. These will improve our analysis sensitivity since the solar atmospheric spectrum is soft and, due to neutrino oscillations, contains significant contributions of all neutrino flavors. As we will present in this contribution, these complementary strategies yield a significant improvement in sensitivity, making substantial progress towards observing this flux.'

Collaborations
IceCube,

Keywords and Comments
", "

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Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Latest Results from the Daya Bay Experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 366

Presenter
Tadeas Dohnal
Author and Co-Author
Tadeas Dohnal | For the Daya Bay Collaboration,

Abstract
'The Daya Bay Reactor Neutrino Experiment, located in southeast China, was designed to measure short baseline oscillation of electron antineutrinos originating from six 2.9 GW_{th} nuclear reactors. Since 2011, it has collected an unprecedented sample of millions of reactor antineutrino candidates, the largest sample in the world up to date, which led to the discovery of the non-zero $\\theta_{13}$ mixing angle just in 2012. In this talk, we present an overview of the latest results from Daya Bay including the measurement of oscillation parameters driving the reactor antineutrino disappearance at short baseline, with the most precise measurement of the $\\theta_{13}$ mixing angle in the world, search for light sterile neutrino mixing and search for electron antineutrinos associated with gravitational wave events among others.'

Collaborations
other (fill field below), Daya Bay

Keywords and Comments
'', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Tuning parametric models of the atmospheric muon flux in MUPAGE to data from the KM3NeT detector

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 367

Presenter
Brían Ó Fearraigh
Author and Co-Author
Brían Ó Fearraigh,

Abstract
'The muons produced by cosmic ray interactions in the upper atmosphere constitute the main background for underwater neutrino detectors such as KM3NeT (the Cubic Kilometre Neutrino Telescope), which is currently being deployed in the Mediterranean Sea at two distinct locations. Situated at different depths, the KM3NeT/ARCA and KM3NeT/ORCA detectors experience a different flux of muons, and thus are uniquely positioned to study their evolution and propagation from cosmic ray showers. It is imperative to the main physics goals of the experiment that the atmospheric muon background is modelled correctly, which aids in benchmarking and understanding the detector response to the constant flux of these particles. \r\n\r\nIn this study, the data from the KM3NeT/ORCA detector is used and compared with the Monte Carlo prediction from the MUPAGE (MUons from PArametric formulas: a fast GEnerator for neutrino telescopes) software package, which generates the energy spectrum, lateral distribution, and muon multiplicity of muon bundles according to a specific parametrisation. This parametrisation consists of many free parameters which can be tuned such that simulated physical observables in the detector agree with those measured in data. In this way, improvements to the data-Monte Carlo agreement are achieved by quantitatively comparing the level of agreement between simulated and measured observables in the KM3NeT detector.'

Collaborations
KM3NeT,

Keywords and Comments
'atmospheric muon background; KM3NeT; ORCA; ARCA; DU; Detection Unit; muon; neutrino; CR; Cosmic Ray; air shower; simulation; MUPAGE; Mediterranean Sea; underwater neutrino telescope; PMT; DOM', ''

Branch NU | Neutrinos & Muons

Subcategory Experimental Results

Observations of track-like neutrino events with Baikal-GVD

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 368

Presenter
Dmitry Zaborov
Author and Co-Author
Dmitry Zaborov | for the Baikal-GVD Collaboration,

Abstract
'Baikal Gigaton Volume Detector (Baikal-GVD) is a km^3-scale neutrino detector currently under construction in Lake Baikal, Russia. The detector currently consists of 2016 optical modules arranged on 56 vertical strings. Further extension of the array is planned for March 2021. The data from the partially complete array have been analyzed using a χ^2-based track reconstruction algorithm. After suppression of the downward-going atmospheric muon background, a flux of upward-going neutrino events is observed, dominated by the atmospheric neutrinos. The reconstructed energy spectrum is compared with the expectations for the atmospheric neutrino and diffuse astrophysical neutrino fluxes.'

Collaborations
other (fill field below), Baikal-GVD

Keywords and Comments
'atmospheric neutrino; diffuse astrophysical neutrino flux; atmospheric muons; neutrino telescope; Baikal-GVD', ''

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Branch NU | Neutrinos & Muons

Subcategory Future projects

The Future of High-Energy Astrophysical Neutrino Flavor Measurements

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Ningqiang Song
Author and Co-Author
Ningqiang Song, Shirley Li | Carlos Arguelles | Mauricio Bustamante | Aaron Vincent

Abstract
'The next generation of neutrino telescopes, including Baikal-GVD, KM3NeT, P-ONE, TAMBO, and IceCube-Gen2, will be able to determine the flavor of high-energy astrophysical neutrinos with 10% uncertainties. With the aid of future neutrino oscillation experiments --- in particular JUNO, DUNE, and Hyper-Kamiokande --- the regions of flavor composition at Earth that are allowed by neutrino oscillations will shrink by a factor of ten between 2020 and 2040. We critically examine the ability of future experiments and show how these improvements will help us pin down the source of high-energy astrophysical neutrinos and a sub-dominant neutrino production mechanism with and without unitarity assumed. As an illustration of beyond-the-Standard-Model physics, we also show that the future neutrino measurements will constrain the decay rate of heavy neutrinos to be below $2\\times 10^{-5}~$$m$/eV/s assuming they decay into invisible particles.'

Collaborations

Keywords and Comments
'high energy astrophysical neutrinos; neutrino telescopes; neutrino flavor composition', 'arXiv:2012.12893'

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Branch NU | Neutrinos & Muons

Subcategory Future projects

Trinity: an imaging air Cherenkov telescope to search for Ultra-High-Energy neutrinos.

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Anthony Brown
Author and Co-Author
Anthony Brown, Nepomuk Otte | Igancio Taboada | Michele Doro | Mose Mariotti | Dave Keida | R. Wayne Springer | Eliza Gazda | Oscar Romero Matamala | Mahdi Bagheri | Lauren Stewart

Abstract
'Earth-skimming neutrinos are those which travel through the Earth's crust at a shallow angle. For Ultra-High-Energy (E$_\\nu$ > 1 PeV; UHE) earth-skimming tau neutrinos, there is a high-probability that the tau particle created by a neutrino-Earth interaction will emerge from the ground before it decays. When this happens, the decaying tau particle initiates an air shower of relativistic sub-atomic particles which emit Cherenkov radiation. To observe this Cherenkov radiation, we propose the Trinity experiment. \r\n\r\nTrinity will consist of a network of dedicated imaging air Cherenkov telescopes that will observe the horizon searching for these tau-induced air showers. Using a novel optics design, individual Trinity telescopes will have a 60 degrees wide field of view, a spherical primary mirror, a curved camera focal plane housing 3300 SiPM pixels and will be sensitive to neutrinos in the 1 PeV to 10^4 PeV energy range. The expected sensitivity fills the gaps between that of IceCube and that expected from radio UHE detectors such as GRAND. Trinity will provide critical measurements to study flavor physics and neutrino cross-sections at energies that are out of reach for accelerators. In this contribution, we present the present design of Trinity and discuss its performance.'

Collaborations
other (fill field below), Trinity

Keywords and Comments
'tau neutrino; UHE; Cherenkov Telescope; earth-skimming; instrumentation', ''

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Branch NU | Neutrinos & Muons

Subcategory Future projects

Statistical uncertainty derivation in probabilistic classification with DSEA+

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 37 Reconstruction & Analysis Techniques | NU
Presenter Forum Table

Presenter
Leonora Kardum
Author and Co-Author
Leonora Kardum,

Abstract
"The Dortmund Spectrum Estimation Algorithm (DSEA+) is a novel approach to unfolding by translating deconvolution tasks into multinomial classification problems, which enables the use of readily available tools. The algorithm is employable with several prebuilt classification models, making it advantageous to other methods due to its generality, simplicity, and broadness. DSEA+, primarily developed for the purpose of reconstructing energy spectra in the field of Cherenkov astronomy, can be therefore applied to other areas of research. The estimation of statistical uncertainties within DSEA mandates a special treatment of the algorithm's iterative nature. Here, we present a full derivation of statistical uncertainties in DSEA+ with probabilistic classification applied to spectral reconstruction."

Collaborations

Keywords and Comments
", "

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Branch NU | Neutrinos & Muons

Subcategory Future projects

The Giant Radio Array for Neutrino Detection (GRAND) project

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Kumiko Kotera
Author and Co-Author
Kumiko Kotera | For the GRAND Collaboration,

Abstract
'The GRAND project aims to detect ultra-high-energy neutrinos, cosmic rays and gamma rays, with an array of 200,000 radio antennas over 200,000 km2, split into ~20 sub-arrays of ~10,000 km2 deployed worldwide. The strategy of GRAND is to detect air showers above 10^17 eV that are induced by the interaction of ultra-high-energy particles in the atmosphere or in the Earth crust, through its associated coherent radio-emission in the 50-200 MHz range. In its final configuration, GRAND plans to reach a neutrino-sensitivity of ~10^{-10} GeV cm^-2 s^-1 sr^-1 above 5x10^{17} eV combined with a sub-degree angular resolution. GRANDProto300, the 300-antenna pathfinder array, is planned to start data taking in 2021. It aims at demonstrating autonomous radio detection of inclined air-showers, and study cosmic rays around the transition between Galactic and extra-Galactic sources. We present preliminary designs and simulation results, plans for the ongoing, staged approach to construction, and the rich research program made possible by the proposed sensitivity and angular resolution.'

Collaborations
other (fill field below), GRAND

Keywords and Comments
", "

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Branch NU | Neutrinos & Muons

Subcategory Future projects

Sensitivity of a radio array embedded in a deep Gen2-like optical array.

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Abby Bishop
Author and Co-Author
Abby Bishop | Ben Hokanson-Fasig | Lu Lu | Albrecht Karle,

Abstract
'Constraining the high energy neutrino flux has been a challenge for decades. IceCube has discovered an astrophysical flux up to 10 PeV and is now planning a large extension with IceCube-Gen2, including an optical array and a large radio array at shallow depth. Neutrino searches for energies >100PeV are best done with such shallow radio detectors like Askaryan Radio Array (ARA) or similar (buried as deep as 200 meters below the surface) as the radio signal has km-length attenuation lengths and the sensors are cheaper to deploy. This poster explores the potential of opportunistically burying radio antennas within the planned IceCube-Gen2 detector volume (between 1400 meters and 2600 meters below the surface) on the Gen 2 strings to bridge the sensitive energy gap between IceCube optical and shallow neutrino searches. A hybrid detection of events in optical and radio could substantially improve the uncertainty of neutrino cascade direction as radio signals do not scatter in ice. We show the first results of simulating neutrinos from an astrophysical and a cosmogenic flux interacting with 5880 ARA-style vertically polarized radio antennas distributed evenly across 98 strings in the Gen2 sunflower geometry using the PyREx radio simulation package. Standalone radio and hybrid event rates will be presented.'

Collaborations
IceCube-Gen2,

Keywords and Comments
'Askaryan; radio; PeV Cascades', ''

Branch NU | Neutrinos & Muons

Subcategory Future projects

Sensitivity studies for the IceCube-Gen2 radio array

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Steffen Hallmann
Author and Co-Author
Steffen Hallmann | Brian Clark | Christian Glaser | Daniel Smith | for the IceCube-Gen2 Collaboration,

Abstract
'The IceCube Neutrino Observatory at the South Pole has measured the diffuse astrophysical neutrino flux up to ~PeV energies and is starting to identify first point source candidates. \r\nThe next generation facility, IceCube-Gen2, aims at extending the accessible energy range to EeV in order to measure the continuation of the measured astrophysical spectrum, to identify neutrino sources, and to search for a cosmogenic neutrino flux. As part of IceCube-Gen2, a radio array is foreseen that is sensitive to detect Askaryan emission of neutrinos beyond ~5 PeV. Surface and deep antenna stations have different benefits in terms of effective area, resolution, and the capability to reject backgrounds from cosmic-ray air showers and may be combined to reach best sensitivity. The optimal detector configuration is still to be identified.\r\n\r\nThis contribution presents the full-array simulation efforts for a combination of deep and surface antennas, and compares different design options with respect to their sensitivity to fulfill the science goals of IceCube-Gen2.'

Collaborations
IceCube-Gen2,

Keywords and Comments
'sensitivity studies;GZK;neutrino;pointsource;diffuse', ''

Branch NU | Neutrinos & Muons

Subcategory Future projects

Optimization of the optical array geometry for IceCube-Gen2

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 369

Presenter
Anastasiia Omeliukh
Author and Co-Author
Anastasiia Omeliukh | for the IceCube-Gen2 Collaboration,

Abstract
'IceCube-Gen2 is a planned extension of the IceCube Neutrino Observatory at the South Pole designed to study the high-energy neutrino sky from TeV to EeV energies with a five times better point source sensitivity than the current IceCube detector. This is achieved by deploying 120 new strings with attached optical sensors in a pattern around IceCube that features considerably larger distances between individual strings than the ~125m for the existing detector. Here, we present the results of an optimization study searching for the best point source sensitivity while varying the IceCube-Gen2 string spacing between 150m and 350m.'

Collaborations
IceCube-Gen2,

Keywords and Comments
'IceCube-Gen2; point source sensitivity; detector geometry; optimization.', ''

Branch NU | Neutrinos & Muons

Subcategory Future projects

PLEnuM: A global and distributed monitoring system of high-energy astrophysical neutrinos

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 370

Presenter
Lisa Schumacher
Author and Co-Author
Matthias Huber | Lisa Schumacher | Matteo Agostini | Mauricio Bustamante | Foteini Oikonomou | Elisa Resconi,

Abstract
'High-energy astrophysical neutrinos, discovered by IceCube, are now regularly observed, albeit at a low rate due to their low flux. As a result, open questions about high-energy neutrino astrophysics and particle physics remain limited by statistics at best, or unanswered at worst. Fortunately, this situation will improve soon: in the next few years, a host of new neutrino telescopes, currently under planning and construction, will come online. It is natural to combine their collected observing power: we propose the Planetary Neutrino Monitoring System (PLEnuM), a concept for a global repository of high-energy neutrino observations, in order to finally give firm answers to open questions. PLEnuM will reach up to four times the exposure available today by combining the exposures of current and future neutrino telescopes distributed around the world $-$ IceCube, IceCube-Gen2, Baikal-GVD, KM3NeT, and P-ONE. Depending on the declination and spectral index, PLEnuM will improve the sensitivity to astrophysical neutrinos by up to two orders of magnitude. We present first estimates on the capability of PLEnuM to discover Galactic and extragalactic sources of astrophysical neutrinos and to characterize the diffuse flux of high-energy neutrinos in unprecedented detail.'

Collaborations

Keywords and Comments
'high-energy neutrinos; neutrino astronomy; PLEnuM; astrophysical neutrinos; galactic neutrinos;', ''

Branch NU | Neutrinos & Muons

Subcategory Future projects

Simulation and sensitivities for a phased IceCube-Gen2 deployment

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Brian Clark
Author and Co-Author
Brian Clark | Rob Halliday | for the IceCube-Gen2 Collaboration,

Abstract
'The IceCube neutrino observatory opened the window on high-energy neutrino astronomy by confirming the existence of PeV astrophysical neutrinos and identifying the first compelling astrophysical neutrino source in the blazar TXS0506+056. Planning is underway to build an enlarged instrument, IceCube-Gen2, which will extend measurements to higher energies, increase the rate of observed cosmic neutrinos and provide prospects for detecting fainter sources. IceCube-Gen2 is planned to have an enlarged in-ice optical array, a radio array at shallower depths for detecting ultra-high (>100 PeV) neutrinos, and a surface component studying cosmic rays. In this contribution, we will discuss the simulation of the in-ice optical component of the baseline design of the IceCube-Gen2 detector, which foresees the deployment of an additional ~120 new detection strings to the existing 86 in IceCube over ~7 Antarctic summer seasons. Motivated by the phased construction plan for IceCube-Gen2, we discuss how the reconstruction capabilities and sensitivities of the instrument are expected to progress throughout its deployment.'

Collaborations
IceCube-Gen2,

Keywords and Comments
'neutrino; sensitivity studies', ''

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Branch NU | Neutrinos & Muons

Subcategory Future projects

Diffuse Supernova Neutrino Background Detection at JUNO

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Jie Cheng
Author and Co-Author
Jie Cheng,

Abstract
'As an underground multi-purpose neutrino detector with 20 kton liquid scintillator, Jiangmen Underground Neutrino Observatory (JUNO) is competitive with and complementary to the water-Cherenkov detectors on the search for the diffuse supernova neutrino background (DSNB). Typical supernova models predict 2-4 events per year within the optimal observation window in the JUNO detector. The dominant background is from the neutral-current (NC) interaction of atmospheric neutrinos with ^{12}C nuclei, which surpasses the DSNB by more than one order of magnitude. We evaluated the systematic uncertainty of NC background from the spread of a variety of data-driven models and further developed a method to determine NC background within 10% with in situ measurements. Besides, the NC-like backgrounds can be effectively suppressed by the intrinsic pulse-shape discrimination (PSD) capabilities of liquid scintillators. In this talk, I will present in detail the improvements on NC background uncertainty evaluation, PSD discriminator development, and finally, the potential of DSNB sensitivity in JUNO.'

Collaborations
other (fill field below), JUNO

Keywords and Comments
", "

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Branch NU | Neutrinos & Muons

Subcategory Future projects

A new Baksan Large Neutrino Telescope: the project's status

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Nikita Ushakov
Author and Co-Author
Nikita Ushakov, Dmitry Voronin | Galina Novikova | Vladimir Kazalov | Andrei Sidorenkov | Evgeniy Veretenkin | Daniel Kudrin | Mahti Kochkarov | Yuri Malyshkin | Valeriy Petkov | Valeriy Kuzminov | Albert Gangapshev | Alexander Shikhin | Evgeniy Yanovich | Arslan Lukanov

Abstract
'A large-volume liquid scintillator neutrino detector is proposed to develop at the Baksan Neutrino Observatory of Institute for Nuclear Research of the Russian Academy of Sciences in the North Caucasus. The detector will be located at the depth of 4700 m.w.e. (meter of water equivalent). A target mass of the detector will be 10 kt. This multipurpose detector is being developed to study primarily natural neutrino and antineutrino fluxes namely fluxes of solar neutrinos, geoneutrinos and neutrinos from other astrophysical sources. \r\nThe project is aimed to have a record energy resolution which along with its location at the large depth and relatively far distance from operating nuclear reactors will allow reaching a record sensitivity to the natural neutrino and antineutrino fluxes. We report in the paper the present status of the project and describe some selective results of the project first stage - the detector prototype with 0.5 t liquid scintillator. Results of R&D for the project second stage with 5 t liquid scintillator are presented too.\r\nLast but not least, the project, if implemented, would be a successor of the Borexino experiment and other European projects like LENA.'

Collaborations

Keywords and Comments
'Neutrino detector; scintillation detector; geoneutrino', ''

Branch NU | Neutrinos & Muons

Subcategory Future projects

Potential for 3+1 and Lorentz violation measurements with DUNE

Time 20 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 57 New Physics | CRD-CRI-DM-GAD-GAI-NU-MM-SH
Presenter Forum Table

Presenter
Austin Schneider
Author and Co-Author
Austin Schneider | Barbara Skrzypek | Carlos Arguelles | Janet Conrad,

Abstract
'This talk presents phenomenology related to the observation of high energy atmospheric neutrinos in the Deep Underground Neutrino Experiment (DUNE). DUNE is a next-generation long-baseline neutrino oscillation experiment designed to perform precision measurements of the neutrino parameters and study neutrino interactions. This program includes the construction of four 17 kT Far Detector (FD) liquid argon (LAr) time projections chambers (TPC). The large instrumented mass of the FD and unprecedented detail of LAr TPCs provide a unique opportunity to explore atmospheric neutrinos in a largely untouched energy regime. Between 50 GeV and 1 TeV, the DUNE FD will measure the spectrum and arrival distribution of atmospheric muon-neutrinos interacting in nearby bedrock and within the detector. Other neutrino experiments have limited energy resolution in this regime, presenting a unique opportunity for DUNE. This energy regime is relevant for constraining beyond Standard Model (BSM) scenarios like 3+1 sterile neutrino models and Lorentz violating effects. We present the potential for new contributions from DUNE with atmospheric neutrino measurements and sensitivity to these BSM scenarios.'

Collaborations
other (fill field below),

Keywords and Comments
'Sterile neutrinos; 3+1; Lorentz violation; DUNE; Deep Underground Neutrino Experiment; Atmospheric neutrinos; Neutrinos', ''

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Branch NU | Neutrinos & Muons

Subcategory Future projects

Science case and detector concept for ARIANNA high energy neutrino telescope at Moore's Bay, Antarctica

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Steven Barwick
Author and Co-Author
Steven Barwick | For the ARIANNA Collaboration,

Abstract
"The proposed ARIANNA neutrino detector, located at sea-level on the Ross Ice Shelf, Antarctica, consists of 200 autonomous and independent detector stations separated by 1 kilometer in a uniform triangular mesh. The primary science mission of ARIANNA is to search for sources of neutrinos with energies greater than 100 PeV, complementing the reach of IceCube. An ARIANNA observation of a neutrino source would provide strong insight into the enigmatic sources of cosmic rays. ARIANNA observes the radio emission from high energy neutrino interactions in the Antarctic ice. Among radio based concepts under current investigation, ARIANNA would uniquely survey the vast majority of the southern sky at any instant in time, and an important region of the northern sky, by virtue of its location on the surface of the Ross Ice Shelf in Antarctica. The broad sky coverage is specific to the Moore's Bay site, and makes the ARIANNA surface-based technology ideally suited to contribute to the multi-messenger thrust by the US National Science Foundation, Windows on the Universe – Multi-Messenger Astrophysics, providing capabilities to observe sources that vary strongly over time. The ARIANNA architecture is designed to measure the angular direction to 3 degrees and shower energy to 25% for every neutrino candidate. These high quality neutrino events are expected to play important role in the pursuit of multi-messenger observations of astrophysical sources. The surface-based architecture serves to inform future projects of much larger scale, such as the IceCube-Gen2 project."

Collaborations
other (fill field below), ARIANNA

Keywords and Comments
"neutrino; high-energy; Askaryan; radio; Antarctica; ice; Moore's Bay; Ross Ice Shelf; point sources; diffuse flux", "

Branch NU | Neutrinos & Muons

Subcategory Future projects

Overview of Cherenkov Telescope onboard EUSO-SPB2 for the Detection of Ultra-High Energy Neutrinos

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Mahdi Bagheri
Author and Co-Author
Mahdi Bagheri, Jane Nachtman | John Krizmanic | Patrick Reardon | for the JEM-EUSO Collaboration | Eliza Gazda | Michael Miller | Evgeny Kuznetsov | Ivan Fontane | Nepomuk Otte | Eleanor Judd | Mark Christl | Lawrence Wiencke | Yaser Onel | Oscar Romero Matamala

Abstract
'Astrophysical Ultra-High Energy (UHE) neutrinos probe the accelerators of Ultra-High Energy Cosmic Rays (UHECR), the composition of UHECR, and neutrino physics at the highest energies. UHE-tau neutrinos (E > 10 PeV) skimming the Earth produce tau leptons which can emerge from the ground, decay, and initiate an upward-going particle shower in the atmosphere. By measuring the Cherenkov emission from these extensive air showers, the particle shower energy and incident neutrino direction can be reconstructed. By using a Cherenkov telescope in the Extreme Universe Space Observatory Super Pressure Balloon 2 (EUSO-SPB2) instrument, we will classify known and unknown sources of backgrounds for future space-based neutrino detectors. Furthermore, we will search for UHE-tau neutrinos below the limb and observe air showers from cosmic rays above the limb. EUSO-SPB2 is an approved NASA ultra-long-duration balloon mission that is planned to fly in 2023 and is a precursor of the Probe of Extreme Multi-Messenger Astrophysics (POEMMA), a candidate for an Astrophysics probe-class mission. The 0.785 m^2 Cherenkov telescope is equipped with a 512-pixel SiPM camera covering a 12.8° x 6.4° (Horizontal x Vertical) field of view. The camera signals are digitized with a 100 MS/s readout system. In this presentation, we discuss the status of the telescope development, the camera integration, and simulation studies of the camera response.'

Collaborations

Keywords and Comments
'Tau Neutrino; Cherenkov Telescope; Instrumentation', ''

Branch NU | Neutrinos & Muons

Subcategory Future projects

Status and prospects of the Hyper-Kamiokande project

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Yoshitaka Itow
Author and Co-Author
Yoshitaka Itow,

Abstract
'The Hyper-Kamiokande project is a 260-kton Water Cherenkov together with an upgraded high-intensity neutrino beam from J-PARC. The inner detector with the 190-kton fiducial volume is viewed by 20-inch PMTs and multi-PMT modules providing state-of-art of Cherenkov ring reconstruction with a few MeV energy thresholds. Thanks to the further improvements of systematic errors with near detector complex, precision neutrino oscillation study will be performed with the 8-times larger fiducial mass and with 20-times higher intensity of neutrino beam. Significant improvement is also foreseen in the studies in nucleon decay and low energy neutrino astronomy such as solar or supernova neutrinos. \r\n In 2020, construction of the far detector has been started at the Tochibora mine, Kamioka. The initial rock excavation and detail geological survey are on-going as well as logistics preparation around the construction area. The first mass production of newly developed 20-inch PMTs has been also started. The organization of the project is now transited to the official Hyper-Kamiokande collaboration to pursue construction works in coming years. \r\nHere we will present the newest update of project status and milestones of construction and physics prospect toward the operation foreseen in 2027.'

Collaborations
Hyper-K,

Keywords and Comments
'Neutrino; water Cherenkov; underground detector', ''

Branch NU | Neutrinos & Muons

Subcategory Future projects

Prospects for neutrino astrophysics with Hyper-Kamiokande

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Takatomi Yano
Author and Co-Author
Takatomi Yano,

Abstract
'Hyper-Kamiokande is a multi-purpose next generation neutrino experiment.\r\nThe detector is a two-layered cylindrical shape ultra-pure water tank, with its height of 64 m and diameter of 71 m.\r\nThe inner detector will be surrounded by 40,000 twenty-inch photosensors to detect water Cherenkov radiation due to the charged particles and provide our fiducial volume of 187 kt.\r\nThis detection technique is established by Kamiokande and Super-Kamiokande. As the successor of these experiments, Hyper-K will be located deep underground, 650 m below Mt. Tochibora at Kamioka in Japan to reduce cosmic-ray backgrounds.\r\nBesides our physics program with accelerator neutrino, atmospheric neutrino and proton decay, neutrino astrophysics is an important research topic for Hyper-K.\r\nWith its fruitful physics research programs, Hyper-K will play a critical role in the next neutrino physics frontier.\r\nIt will also provide important information via astrophysical neutrino measurements, i.e., solar neutrino, supernova burst neutrinos and supernova relic neutrino.\r\nHere, we will discuss the physics potential of Hyper-K neutrino astrophysics.'

Collaborations
Hyper-K,

Keywords and Comments
'', ''

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Branch NU | Neutrinos & Muons

Subcategory Future projects

JUNO Physics Prospects

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
João Pedro Athayde Marcondes de André
Author and Co-Author
João Pedro Athayde Marcondes de André | for the JUNO Collaboration,

Abstract
"JUNO will be a multi-purpose underground neutrino observatory being constructed in the south of China. The JUNO detector, with a 20 kton liquid scintillator target instrumented with about 18k 20" PMT and about 26k 3" PMT, will be strategically located 53 km from the Taishan and Yangjiang Nuclear Power Plants. Using reactor antineutrinos, JUNO will be able to measure several neutrino oscillation parameters with sub-percent precision as well as to determine the neutrino mass ordering to ~3 sigma over 6 years of operation. Furthermore, JUNO will have a broad physics program, ranging from studying neutrinos from other sources, such as solar and supernova neutrinos, to searching for BSM physics such as proton decay. This talk will give an overview on the JUNO's broad physics potential."

Collaborations
other (fill field below), juno

Keywords and Comments
'Neutrino Mass Ordering; JUNO; neutrino oscillation; solar neutrino; supernova neutrino', ''

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Branch NU | Neutrinos & Muons

Subcategory Future projects

The Radar Echo Telescope for Neutrinos (RET-N)

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Krijn de Vries
Author and Co-Author
Krijn de Vries | steven prohira, for the Radar Echo Telescope collaboration

Abstract
'We present the Radar Echo Telescope for Neutrinos (RET-N). RET-N focuses on the detection of the cosmic neutrino flux at >PeV energies by means of the radar detection technique. This method aims to bridge the energy gap between the diffuse neutrino flux detected by IceCube up to a few PeV and the sought for cosmogenic neutrinos at EeV energies by the in-ice Askaryan detectors, as well as the air-shower radio detectors. The radar echo method is based on the detection the ionization trail in the wake of a high-energy neutrino-induced particle cascade in ice. This technique, recently validated in a beam test (T576 at SLAC) is also the basis for the RET-N pathfinder experiment, RET-CR, which is currently under development. Based on the T-576 results, we show that the radar echo method leads to very promising sensitivities to detect cosmic neutrinos in the PeV-EeV region and above. We present the RET-N project and its proposed timeline, as well as the results of our sensitivity studies.'

Collaborations
, Radar Echo Telescope Collaboration

Keywords and Comments
'Neutrino ; Radar detection ; >PeV flux', ''

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Subcategory Future projects

Neutrino mass ordering determination through combined analysis with JUNO and KM3NeT/ORCA

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
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Presenter
João Pedro Athayde Marcondes de André
Author and Co-Author
João Pedro Athayde Marcondes de André, Nhan Chau | Marcos Dracos | Antoine Kouchner | Veronique van Elewyck | Leonidas Kalousis | on behalf of the KM3neT Collaboration

Abstract
'The determination of neutrino mass ordering (NMO) is one of the prime goals of several neutrino experiments. KM3NeT/ORCA and JUNO are two next-generation neutrino oscillation experiments both aiming at addressing this question. ORCA can determine the NMO by probing Earth matter effects on the oscillation of atmospheric neutrinos in the GeV energy range. JUNO, on the other hand, is sensitive to the NMO by investigating the interference effects of fast oscillations in the reactor electron antineutrino spectrum at medium baseline. This poster presents the potential of determining the NMO through a combined analysis of JUNO and ORCA data. When measuring the $\\Delta m^2_{31}$ with a wrong ordering assumption, the best-fit values are different between the two experiments. This tension, together with good constraints on the $\\Delta m^2_{31}$ measurement by both experiments, enhances the combined NMO sensitivity beyond the simple sum of their sensitivities. The analysis shows that 5$\\sigma$ significance is reachable in less than 2 years of data taking with both experiements for true normal neutrino mass ordering assuming current global best-fit values of the oscillation parameters, while 6 years will be needed for any other parameter set.'

Collaborations
KM3NeT, juno

Keywords and Comments
'Neutrino mass ordering;JUNO; KM3NeT;ORCA;combined analysis', ''

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Branch NU | Neutrinos & Muons

Subcategory Future projects

Pacific Ocean Neutrino Experiment (P-ONE): prototype line development

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Christian Spannfellner
Author and Co-Author
Christian Spannfellner | Matthias Danninger | For the P-ONE Collaboration,

Abstract
'The Pacific Ocean Neutrino Experiment (P-ONE) is a new initiative to construct one of the world's largest neutrino detectors in the deep Pacific Ocean off the coast of British Columbia, Canada. Located in the Cascadia Basin region, P-ONE builds on a number of key strengths within the Canadian oceanographic community. The Cascadia Basin monitoring site is part of the NEPTUNE observatory of Ocean Networks Canada (ONC), which provides power and data connections to various deep ocean sites, accessible to experiments. In cooperation with ONC, the collaboration successfully deployed two pathfinder experiments, the STRAW projects, in 2018 and 2020, respectively. These pathfinder mooring lines aim to measure the optical and ambient background characteristics of the Cascadia Basin in a depth of 2660m. The P-ONE prototype line is the successor of these mooring lines and the next step towards the P-ONE neutrino observatory. The main objective of the prototype line lies in the construction, deployment, and operation of a complete P-ONE mooring line as prove of concept of the individual components. This line will comprise P-ONE digital optical modules to measure the emerging Cherenkov radiation by neutrino-induced processes and P-ONE calibration devices to provide in-situ calibration of the detector. The prototype line will be complemented by external geometry calibration units to verify the envisioned calibration principles. We will present the concepts of this P-ONE prototype line, the optical sensors, and the calibration modules.'

Collaborations
other (fill field below), P-ONE

Keywords and Comments
'Neutrino astronomy; Pacific Ocean Neutrino Experiment (P-ONE); photodetection;', ''

Branch NU | Neutrinos & Muons

Subcategory Future projects

Interpreting the high-energy neutrino sky through an angular power spectrum analysis

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 372

Presenter
Ariane Dekker
Author and Co-Author
Ariane Dekker, Marco Chianese | Shin'ichiro Ando

Abstract
'The origin of high-energy neutrinos, observed in the last 10 years by IceCube, is unknown. We gain more insight by studying the expected angular distribution of potential source populations, considering that IceCube observes a neutrino sky consistent with an isotropic distribution.\r\nWe simulate neutrino skymaps by applying statistical distributions for the fluxes of extra-galactic sources and investigate the sensitivities of current (IceCube) and future (IceCube-Gen2 and KM3NeT) experiments. I will show that the angular power spectrum is a powerful probe to assess the angular characteristics of neutrino data and demonstrate that we can constrain rare and bright source classes with current IceCube data.\r\nAnother potential source is the decay or annihilation of dark matter, suggested by the observed excess in the High-Energy-Starting-Event (HESE) data set of IceCube. These neutrinos are expected to correlate with the galactic centre, allowing us to distinguish between dark matter and astrophysical origin. We apply the angular power spectrum analysis to the HESE data, and set model-independent limits on dark matter properties. This method relies only on the angular distribution of neutrino events and is therefore stable against astrophysical uncertainties.\r\nMoreover we perform a sensitivity forecast for IceCube-Gen2 and KM3NeT exposure for different decaying and annihilating channels. KM3NeT is especially sensitive to low dark matter masses due to its visibility towards the galactic centre. We therefore extend to masses above 100 GeV, and find that even at lower energies, the angular power spectrum analysis offers a robust way to interpret the neutrino sky.'

Collaborations

Keywords and Comments
'Neutrino Telescopes; Angular power spectrum; High-energy neutrinos', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

Unified thermal model for photohadronic neutrino production in astrophysical sources

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 373

Presenter
Damiano F. G. Fiorillo
Author and Co-Author
Damiano F. G. Fiorillo, Stefano Morisi | Arjen Van Vliet | Walter Winter

Abstract
'Astrophysical neutrino fluxes are often modeled as power laws of the energy. This is reasonable in the case of hadronic sources, but it does not capture the behavior in photohadronic sources, where the spectrum depends on the properties of the target photons on which protons collide. This limits the possibility of a unified treatment of different sources. In order to overcome this difficulty, we model the target photons by a blackbody spectrum. This model is sufficiently flexible to reproduce neutrino fluxes from known photohadronic sources; we apply it to study the sensitivity of Dense Neutrino Arrays, Neutrino Telescopes and Neutrino Radio Arrays to photohadronic sources. We also classify the flavor composition of the neutrino spectrum in terms of the parameter space. We discuss the interplay with the experiments, studying the changes in the track-to-shower ratio induced by different flavor compositions, both within and outside the region of the Glashow resonance.'

Collaborations

Keywords and Comments
'Photohadronic sources; astrophysical neutrino production', ''

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Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

Reaching the EeV frontier in neutrino-nucleon cross sections in upcoming neutrino telescopes

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Victor Valera
Author and Co-Author
Victor Valera, Mauricio Bustamante

Abstract
'Measuring neutrino interactions with matter is arduous but rewarding. To date, experiments have measured the neutrino-nucleon cross section in the MeV-PeV range, using terrestrial and astrophysical neutrinos. We endeavor to push that measurement to the EeV scale, in order to test competing expectations of the deep structure of nucleons and possibly reveal new neutrino interactions. Cosmogenic neutrinos, long-sought but still undiscovered, provide the only feasible way forward. However, because their flux is low, they have evaded detection so far. Fortunately, upcoming in-ice radio-detection neutrino telescopes, like RNO-G and the radio component of IceCube-Gen2, have a real chance of discovering them in the next 10-20 years. In preparation, we perform the first detailed study of their sensitivity to the deep-inelastic-scattering neutrino-nucleon cross section at EeV energies, extracted from the attenuation of the cosmogenic neutrino flux as it traverses the Earth across different directions. We use up-to-date predictions and tools at every step: in the flux of cosmogenic neutrinos---predicted using recent ultra-high-energy cosmic-ray measurements---in their propagation inside the Earth---computed using leading and sub-leading neutrino interactions---and in their detection in radio-based neutrino telescopes---based on advanced simulated detector responses.'

Collaborations

Keywords and Comments
'cosmogenic neutrinos; neutrino cross section; ultra-high energy; IceCube-Gen2; neutrino telescopes; new physics', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

EAS Optical Cherenkov signatures of tau neutrinos for space and suborbital detectors

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Mary Hall Reno
Author and Co-Author
Mary Hall Reno | Tonia Venters | John Krizmanic | for the JEM-EUSO and POEMMA Collaborations,

Abstract
'Multi-messenger observations of transient astrophysical sources have the potential to characterize the highest energy accelerators and the most extreme energy environments in the Universe. Detection of neutrinos, in particular tau neutrinos generated by neutrino oscillations in transit from their sources to Earth, is possible for neutrino energies above 10 PeV using optical Cherenkov detectors imaging upward-moving extensive air showers (EAS). These EAS are produced from Earth-interacting tau neutrinos leading to tau leptons that subsequently decay in the atmosphere. We compare neutrino detection sensitivities for generic short- and long-burst transient neutrino sources to sensitivities to a diffuse neutrino flux for the second generation Extreme Universe Space Observatory on a Super-Pressure Balloon (EUSO-SPB2) balloon-borne mission and the proposed space-based Probe of Extreme Multi-Messenger Astrophysics (POEMMA) mission.'

Collaborations
other (fill field below), JEM-EUSO and POEMMA Collaborations

Keywords and Comments
'ultra-high energy neutrinos; tau neutrinos; transient neutrino source detection', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

Seasonal variation of atmospheric muons

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 374

Presenter
Thomas Gaisser
Author and Co-Author
Thomas Gaisser, Stef Verpoest

Abstract
'Competition between decay and re-interaction of charged pions and kaons depends on the temperature/density profile of the upper atmosphere. The amplitude and phase of the variations depend on the minimum muon energy required to reach the detector and on muon multiplicity in the detector. Here we compare different methods for characterizing the muon production profile and the corresponding effective temperature, with application to measurements of single and multiple muons by MINOS and NOvA in mind. A muon production profile based on a parameterization of simulations of muons as a function of primary energy is compared with approximate analytic solutions of the cascade equation integrated over primary energy. One goal is to determine the extent to which the geometrical effect of muon production at higher altitude when the temperature is higher can explain the anti-correlation with effective temperature observed for multiple muon events. Another is to compare different methods in the literature for defining effective temperature.'

Collaborations

Keywords and Comments
'muons; multiplicity; variation; underground', ''

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Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

Monte Carlo simulations of neutrino and charged lepton propagation in the Earth with nuPyProp

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Sameer Patel
Author and Co-Author
Sameer Patel | Mary Hall Reno | For the nuSpaceSim collaboration,

Abstract
'An accurate modeling of neutrino flux attenuation and the distribution of leptons they produce in transit through the Earth is an essential component to determine neutrino flux sensitivities of underground, sub-orbital and space-based detectors. Through neutrino oscillations over cosmic distances, astrophysical neutrino sources are expected to produce nearly equal fluxes of electron, muon and tau neutrinos. Of particular interest are tau neutrinos that interact in the Earth at modest slant depths to produce $\\tau$-leptons. Some $\\tau$-leptons emerge from the Earth and decay in the atmosphere to produce extensive air showers. Future balloon-borne and satellite-based optical Cherenkov neutrino telescopes will be sensitive to upward air showers from tau neutrino induced $\\tau$-lepton decays. We present nuPyProp, a python code that is part of the nuSpaceSim package. NuPyProp generates look-up tables for exit probabilities and energy distributions for $\\nu_\\tau\\to \\tau$ and $\\nu_\\mu\\to \\mu$ propagation in the Earth. This flexible code runs with either stochastic or continuous electromagnetic energy losses for the lepton transit through the Earth. Current neutrino cross section models and energy loss models are included along with templates for user input of other models. NuPyProp results are compared with other recent simulation packages for neutrino and charged lepton propagation. Sources of modeling uncertainties are described and quantified.'

Collaborations
other (fill field below), nuSpaceSim

Keywords and Comments
'neutrino telescopes; Monte Carlo simulations', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

Arrival time distribution of muons from extensive air showers

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 375

Presenter
Allan Machado Payeras
Author and Co-Author
Allan Machado Payeras | Anderson Campos Fauth | For the Pierre Auger Collaboration,

Abstract
'The upgraded surface detectors of the Pierre Auger Observatory will provide data that enables the separation of signals due to the muonic component of extensive air showers. Such information permits the application of new event reconstruction methods, that will contribute to composition studies of high-energy cosmic rays and the understanding of their origin. Considering the idea of using the muonic signals from the upgraded surface detectors, we studied the characterisation of muon distributions in extensive air showers using CORSIKA simulations of showers initiated by protons and calcium nuclei with energy of $10^{19}\\ \\mathrm{eV}$ and QGSJet-04 as the model of hadronic interaction for high-energies. We analysed the time distribution of muons arriving at the observation level for different radial distances to the shower core. The results were compared with analytical expressions, and agreement was found. The understating of such distributions is crucial for the development of reconstruction methods that can be applied to data from the upgraded Auger Observatory.'

Collaborations
Auger,

Keywords and Comments
'extensive air shower; muons; Corsika simulation; simulation; arrival-time distribution', ''

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Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

nuSpaceSim: A Comprehensive Simulation for the Modeling of Optical and Radio Signals from Extensive Air Showers Induced by Cosmic Neutrinos for Space-based Experiments

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
John Krizmanic
Author and Co-Author
John Krizmanic | Yosui Akaike | Luis Anchordoqui | Douglas Bergman | Ike Buckland | Austin Cummings | Johannes Eser | Claire Guépin | Simon Mackovjak | Angela V. Olinto | Tom Paul | Sameer Patel | Alex Reustle | Andres Romero-Wolf | Mary Hall Reno | Fred,

Abstract
'nuSpaceSim is a comprehensive end-to-end simulation package to model the optical and radio signals from extensive air showers (EAS) induced by cosmic neutrino interactions. The development has initially focused on modeling the upward-moving EASs sourced from tau neutrino interactions within the Earth that employs a new modeling package, nuPyProp. nuSpaceSim is designed to model all aspects of the processes that lead to the neutrino-induced EAS signals, including the modeling of the neutrino interactions inside the Earth, propagating the leptons into the atmosphere, modeling the tau-lepton decays, forming composite EAS, generating the air optical Cherenkov and radio signals, modeling their propagation through the atmosphere, including using a MERRA-2 database driven application to generate cloud maps, and modeling detector responses. nuSpaceSim uses a vectorized Python implementation of a sampled library approach to efficiently simulate neutrino-induced and background signals at a specific orbit or balloon altitude. A detector response module, based on user-inputted response parameters, subsequently is used to record the events and determine acceptance. The framework will allow for the calculation of the sky coverage and the pointing requirements needed for target-of-opportunity (ToO) follow-up observations of transients, as well as the assessment of the effects of dark-sky airglow and UHECR backgrounds. nuSpaceSim will provide an efficient and practical cosmic neutrino EAS signal generation modeling package to aid in the development of future sub-orbital and space-based experiments. In this paper, the nuSpaceSim framework, physics modeling, and the cosmic neutrino measurement capabilities of example experimental configurations will be presented.'

Collaborations
other (fill field below), nuSpaceSim

Keywords and Comments

'nuSpaceSim; nuPyProp; neutrino; space-based; Cherenkov; simulation; modeling; tau lepton; upward moving; extensive air shower; Earth skimming', 'This work is supported by NASA grant 80NSSC19K0626 and 17-APRA17-0066.'

Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

Application of parabolic equation methods to in-ice radiowave propagation for ultra high energy neutrino detection experiments

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Cade Sbrocco
Author and Co-Author
Cade Sbrocco | Steven Prohira, for the Radar Echo Telescope collaboration

Abstract
'Many ultra high energy neutrino detection experiments seek radiowave signals from neutrino interactions deep within polar ice, and an understanding of in-ice radiowave propagation is therefore of critical importance. The parabolic equation (PE) method for modeling the propagation of radio waves is a suitable intermediate between ray tracing and finite-difference time domain (FDTD) methods in terms of accuracy and computation time. The RET collaboration has developed the first modification of the PE method for use in modeling in-ice radiowave propagation for ultra high energy cosmic ray and neutrino detection experiments. In this presentation we will detail the motivation for the development of this technique, the process by which it was modified for in-ice use, and showcase the accuracy of its results by comparing to FDTD and ray tracing.'

Collaborations
other (fill field below), Radar Echo Telescope

Keywords and Comments
'parabolic equations; neutrinos; ultra-high energy; simulations; ice; radar;', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

A shell like kilometer spaced array around Icecube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 376

Presenter
Daniele Fargion
Author and Co-Author
Daniele Fargion,

Abstract
'Icecube neutrino detector traces energetic TeVs-PeVs neutrino signals by their cascades or by their tracks inside its kilometer icy cube volume. Cascades are mostly for electron or tau or neutral current, tracks for muons. Cascades show mostly poor directionality. Tracks are sharp in directionality. TeVs-PeVs muon tracks are either born inside, HESE, or outside Icecube. These more abundant trough-going upward muons have their interactions outside the Icecube mainly in dense rock around. Such kilometer long tracks offer much precise ideal neutrino astronomy. Moreover highest tens TeV or PeVs neutrinos are opaque to the Earth, arriving mainly upward and horizontally crossing short Earth cord. Therefore we considerfor this upgrade Icecube detector, a widest kilometers spaced concentric array rings around Icecube each ring a kilometer far from the other. To discover upward-horizontal kilometer muon tracks we neglect (and save) the denser Icecube array structures needed to detect cascades. Therefore we save the hundred meter distances from each vertical array, as volumetric dense present Icecube detectors. In a more simple configuration we suggest the widest building of a shell like spiral array, centered on Icecube, spaced nearly one kilometer each ring from next ring leading to largest array net able to trace most upward horizontal muon tracks neutrino Astronomy. Such wider (km) empty array volumes for the same array number, may at best amplify, almost quadratically, the observed mass volume, in comparision to a more dense cubic (hundred meter) dense full volumes. In a first approximation one may obtain in place of a cubic 10 kilometer Icecube a shell like spiral volume about 100 kilometer mass-volume detector.'

Collaborations

Keywords and Comments
'Icecube; Tracks; Muons; neutrino;cascades', ''

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Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

Neutrino signals by Upward Tau airshowering at Earth horizons and by Muon airshowering at Moon shadows

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Daniele Fargion
Author and Co-Author
Daniele Fargion,

Abstract
'Neutrinos are invisible, but their interactions with matter and their leptons signature leave an observable trace. Because the huge atmospheric neutrino noise, produced by cosmic ray rain, there is much hope for reveal highest energy neutrino as an astronomy, above TeVs energy. Neutrino and antineutrino are three. Electron traces radiate a lot therefore are short (meters) trace inside solid matter. Muons radiate much less, therefore are more penetrating (km at TeVs) but escape from matter and decay at far distances, larger than Earth size. Tau are hardly made by cosmic rays. They arise by astrophysical neutrinos democratically mixed in stellar and cosmic oscillating flights. Tau are also very penetrating but very unstable. They decay soon at PeV (49 meter) and their decay in air is amplified in widest area and richest secondaries airshowers. Therefore they are proposed since two decades and searched by recent experiments from mountains, valleys or space: tau airshowers from Earth horizons. Muons at TeVs or above may decay only from the Moon flight to Earth. Their secondary electron trace may airshower on Earth atmosphere as gamma ones. Because magnetic fields, bending vanishes above 6 TeV; the track is contained inside the moon shadows. Therefore rarest gamma-like airshower in LHAASO or in future widest kilometer size gamma array as GRAND may reveal these trough going muons escaping Moon and decaying as electron on terrestrial air. More energetic and fragmented decay may occur from PeVs tau, mostly hadronic pions, escaping and decaying from Moon toward Earth. Novel neutrino astronomy, free of atmospheric noise, may be revealed into widest gamma array recording the Moon shadows.'

Collaborations

Keywords and Comments
'Moon; Neutrino;Muons; Tau; Airshowers', ''

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Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

A Numerical Approach to Angular Distributions in Hadronic Cascades

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 377

Presenter
Tetiana Kozynets
Author and Co-Author
Tetiana Kozynets | Anatoli Fedynitch | D. Jason Koskinen,

Abstract
'Hadronic interactions of highly energetic projectiles in matter induce rich cascades of daughter particles, an example being atmospheric neutrinos produced in cosmic ray air showers. Fully analytical modelling of such cascades, due to the amount and the complexity of the coupled processes involved, is infeasible, while Monte Carlo simulations remain computationally expensive. These complications are mitigated in the numerical Matrix Cascade Equation (MCEq) code, which reaches Monte Carlo-like precision at extremely low computational costs. Previously, the MCEq framework has included longitudinal-only development of the hadronic cascades.\r\n\r\nTo accurately model secondaries at MeV-GeV energies in particle cascades, we extends the one-dimensional cascade equation solver to 2D by including angular development. The distributions are computed via the Fourier spectral method and compared to those produced with the Monte Carlo cascade codes. The potential applications of this study include fast numerical calculations of particle fluxes in air showers and atmospheric lepton flux calculations, which will benefit simulation chains of the cosmic ray and neutrino experiments.'

Collaborations

Keywords and Comments
'atmospheric air showers; cosmic rays; hadronic cascades; low energy; atmospheric neutrinos; atmospheric muons; cascade equations; MCEq; neutrino flux', ''

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Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

Upgrade of Honda atmospheric neutrino flux calculation with implementing recent hadron interaction measurements

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 378

Presenter
Kazufumi Sato
Author and Co-Author
Kazufumi Sato | Hiroaki Menjo | Yoshitaka Itow | Morihiro Honda,

Abstract
'Atmospheirc neutrino flux calculation by M. Honda (Honda flux [1]) has used as a flux prediction in many experiments including the oscillation analysis in Super-Kamiokande, and has greatly contributed in the neutrino physics. In this talk, we will present an upgrade of the neutrino flux calculation with accelerator-data-driven modifications.\r\nThe dominant uncertainty of the Honda flux arises from insufficient understanding of the hadron interactions inside air showers. Such uncertainty has been evaluated by using atmospheric muon observation data at the ground. This introduces relatively large uncertainties in the momentum regions below 1 GeV and above O(10) GeV, the former is due to energy deposition of muons before reaching the ground and the latter is due to the kaon contribution to the neutrino production.\r\nSeveral precise measurements for hadron production using accelerator beams have been recently performed or planned, like NA61, HARP, and BNL-E910. These data will compensate the muon observation by providing information for different phase space and kaon production. We incorporate these accelerator-data-driven modifications into the flux calculation. This allows the systematic uncertainty of atmospheric neutrino oscillation analysis to be evaluated based on the accelerator measurements. \r\n[1] M. Honda, et. al., Phys. Rev. D 92, 023004 (2015)'

Collaborations

Keywords and Comments
'atmospheric neutrino; neutrino flux; simulation;', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Methods

Vertex and energy reconstruction of UHE particles using in-ice radar for the RET experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 379

Presenter
Uzair Abdul Latif
Author and Co-Author
Uzair Abdul Latif | Vesna Lukic | Dieder Van den Broeck | Dylan Frikken | Enrique Huesca Santiago, for the Radar Echo Telescope collaboration

Abstract
'The Radar Echo Telescope (RET) experiment plans to use the radar technique to detect Ultra-High Energy (UHE) cosmic rays and neutrinos in the polar ice sheets. When a UHE particle collides with an ice molecule, it produces a shower of relativistic particles, which leaves behind a trail of plasma in the ice. Radiowaves can be reflected off this plasma and be detected by receiving antennas. Vertex and energy reconstruction of the primary UHE particle is dependent upon an understanding of the radar signal properties. We will be discussing various methods to simulate the radar signal and calculate our vertex and energy reconstruction resolution.'

Collaborations
other (fill field below), Radar Echo Telescope

Keywords and Comments
'Radar;Ice;Vertex;Cosmic Rays;Neutrinos;Ultra High Energy;', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

High-Energy Neutrino Production in Clusters of Galaxies

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 39 Astrophysical Neutrinos – Theoretical & Experimental Results | NU
Presenter Forum Table

Presenter
Saqib Hussain
Author and Co-Author
Saqib Hussain, Elisabete de Gouveia Dal Pino | Rafael Alves Batista

Abstract
'In this work, we compute the contribution from clusters of galaxies to the diffuse neutrino background. Clusters of galaxies can potentially produce cosmic rays (CRs) up to very-high energies via large-scale shocks and turbulent acceleration. Due to their unique magnetic-field configuration, CRs with energy $\\sim 10^{17}$ eV or smaller can be trapped within these structures over cosmological time scales, and generate secondary particles, including neutrinos and gamma rays, through interactions with the background gas and photons. We employ three-dimensional cosmological magnetohydrodynamical simulations of structure formation to model the turbulent intergalactic medium. We use the distribution of clusters within this cosmological volume to extract the properties of this population. We propagate CRs in this environment using multi-dimensional Monte Carlo simulations across different redshifts (from $z = 5$ to $z =0$), considering all relevant photohadronic, photonuclear, and hadronuclear interactions. We also include the cosmological evolution of the CR sources. We find that for CRs injected with a spectral index 1.5 - 2.7 and cutoff energy $E_{max} = 10^{16}$ – 10^{17} eV, clusters contribute to a substantial fraction to the diffuse flux observed by the IceCube Neutrino Observatory, and most of the contribution comes from clusters with $M > 10^{14}$ solar mass and redshifts $z < 0.3$.'

Collaborations

Keywords and Comments
'galaxies: clusters: intracluster medium; neutrinos; magnetic fields', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Sub-GeV atmospheric neutrinos, CP violation

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 380

Presenter
Ara Ioannisian
Author and Co-Author
Ara Ioannisian,

Abstract
'Sub-GeV atmospheric neutrino oscillations are a promising source of information on the leptonic CP phase δ. In that energy range the oscillations are very fast, far beyond the resolution of modern neutrino detectors. However, the necessary averaging over those fast oscillations does not wash out the CP violation effects. The propagation/oscillation of 3 neutrinos is reduced to 2 neutrino propagation/oscillation inside the Earth. The analytic results are very accurate and physically transparent for interpretation/understanding.'

Collaborations

Keywords and Comments
'neutrino; atmospheric neutrino; CP violation', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Very high energy neutrinos from Gamma Ray Bursts in dense clusters

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 39 Astrophysical Neutrinos – Theoretical & Experimental Results | NU
Presenter Forum Table

Presenter
Andrzej Śmiałkowski
Author and Co-Author
Wlodek Bednarek | Andrzej Śmiałkowski,

Abstract
'The progenitors of gamma-ray bursts (GRBs) are massive stars still immersed in dense stellar clusters. \r\nWe consider a scenario in which protons accelerated within the jet of GRB can escape to dense regions. \r\nProtons interact efficiently with the matter of the cluster and produce high energy neutrinos. We calculate the spectra of relativistic protons within the cluster and spectra of neutrinos from their interactions with the matter. \r\nNeutrinos produced by the whole population of the GRBs should contribute to the extragalactic neutrino background. \r\nWe calculate extragalactic neutrino background from GRBs and compare it with the observations of the IceCube.'

Collaborations

Keywords and Comments
'Gamma-ray burst; radiation mechanism - non thermal gamma rays and neutrinos', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Neutrinos from galactic sources

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 39 Astrophysical Neutrinos – Theoretical & Experimental Results | NU
Presenter Forum Table

Presenter
Viviana Niro
Author and Co-Author
Viviana Niro,

Abstract
'The HAWC telescopes has recently revealed new spectra for gamma-ray sources in the Galactic plane. In this talk I will review the possibility of detecting these sources at KM3 detectors. I will consider, with particular emphasis, the 2HWC J1825-134 source. Amongst the HAWC sources, it is indeed the most luminous in the multi-TeV domain and therefore is one of the first that should be searched for with a neutrino telescope in the northern hemisphere. I will show the prospects to detect this source at the KM3NeT detector and comment on the possibilities for others neutrino telescopes. \r\nI will consider, moreover, the gamma-ray sources eHWC J1907+063, eHWC J2019+368 and 2HWC J1857+027. For these sources, I will show the prediction for neutrinos at the IceCube detector, presenting the calculation of the statistical significance, considering 10 and 20 years of running time, and I will comment on the current results reported by the collaboration.'

Collaborations

Keywords and Comments
'High-energy neutrinos; Neutrino astronomy; High-energy cosmic-ray physics and astrophysics', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

HE Neutrinos beyond Standard Model: steriles and secret interactions

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Ninetta Saviano
Author and Co-Author
Ninetta Saviano,

Abstract
'Ultra High Energy cosmogenic neutrinos may represent a unique opportunity\r\nto unveil possible new physics interactions in the neutrino sector. At\r\nthis regard, we have investigated the effects on high and ultrahigh energy\r\nactive neutrino fluxes due to active-sterile secret interactions mediated\r\nby a new pseudoscalar particle. These interactions become relevant at\r\nvery different energy scales depending on the masses of the scalar\r\nmediator and of sterile neutrino. As a consequence, we have found\r\ninteresting phenomenological implications on two benchmark fluxes we\r\nconsider, namely an astrophysical power law flux, in the range below 100\r\nPeV, and a cosmogenic flux, in the Ultrahigh energy range.'

Collaborations

Keywords and Comments
'', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Broadband RF Phased Array Design for UHE neutrino detection

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 34 Radio Detection of Neutrinos | NU
Presenter Forum Table

Presenter
Jordan Hanson
Author and Co-Author
Jordan Hanson,

Abstract
'Phased array radio-frequency (RF) systems have a wide variety of applications in engineering and physics research. Phased array designs are proposed as a trigger system for Askaryan-class in-situ ultra-high energy (UHE) neutrino detectors. Located in Antarctica, these detectors will record RF pulses generated by UHE neutrinos via the Askaryan effect. Modelling the response of phased arrays is straightforward in an environment with uniform index of refraction. However, some detector designs call for phased array deployment at depths where the index of refraction is changing. One solution for computing the response of phased arrays in such an environment is computational electromagnetics with the finite difference time-domain method (FDTD). Using the open-source MIT Electrogmagnetic Equation Propagation (MEEP) package, a set of phased array designs are presented and compared to theoretical expectations. Precise matches between MEEP simulation and radiation pattern predictions at different frequencies and beam angles are demonstrated. Given that the computations match the theory, the effect of embedding a phased array within a medium of varying index of refraction is then studied. Understanding the effect of varying index on phased arrays is critical for proposed UHE neutrino observatories which rely on phased arrays embedded in natural ice. Future work will develop phased array concepts with parallel MEEP for speed and complexity enhancements that account for the 3D shape of proposed dipole antennas proposed as the physical RF elements for in-situ detectors.'

Collaborations
IceCube-Gen2, ARIANNA

Keywords and Comments
'FDTD methods; MEEP; phased array antennas; antenna theory; Askaryan effect; UHE neutrinos', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Neutrinos from charm: forward production at the LHC and in the atmosphere

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 381

Presenter
Yu Seon Jeong
Author and Co-Author
Weidong Bai | Milind Diwan | Maria Vittoria Garzelli | Yu Seon Jeong | Fnu Karan Kumar | Mary Hall Reno,

Abstract
'Theoretical predictions of the prompt atmospheric neutrino flux have large uncertainties associated with charm hadron production, by far the dominant source of prompt neutrinos in the atmosphere. The flux of cosmic rays, with its steeply falling energy spectrum, weights the forward production of charm in the evaluation of the atmospheric neutrino flux at high energies. The current LHCb experiment at CERN constraints charm production in kinematic regions relevant to the prompt atmospheric neutrino flux. The proposed Forward Physics Facility has additional capabilities to detect neutrino fluxes from forward charm production at the LHC. We discuss the implications of the current and planned experiments on the development of theoretical predictions of the high energy atmospheric neutrino flux.'

Collaborations

Keywords and Comments
'Prompt atmospheric neutrinos; forward charm production', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

High-Energy Neutrinos from Non-Relativistic Shock-Powered Transients

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 39 Astrophysical Neutrinos – Theoretical & Experimental Results | NU
Presenter Forum Table

Presenter
Ke Fang
Author and Co-Author
Ke Fang,

Abstract
'Shock interaction has been argued to play a role in powering a range of optical transients, including supernovae, classical novae, stellar mergers, tidal disruption events, and fast blue optical transients. These same shocks can accelerate relativistic ions, generating high-energy neutrino and gamma-ray emission via hadronic pion production. We introduce a model for connecting the radiated optical fluence of non-relativistic transients to their maximal neutrino and gamma-ray fluence. We apply this technique to a wide range of extra-galactic transient classes in order to place limits on their contributions to the cosmological high-energy neutrino backgrounds. Based on a simple model for diffusive shock acceleration at radiative shocks, calibrated to novae, we demonstrate that several of the most luminous transients can accelerate protons up to 10^{16} eV, sufficient to contribute to the IceCube astrophysical background. Furthermore, we show that several of the considered sources−particularly hydrogen-poor supernovae−may serve as “gamma-ray- hidden” neutrino sources due to the high gamma-ray opacity of their ejecta, evading constraints imposed by the non-blazar Fermi-LAT background.'

Collaborations

Keywords and Comments
", "

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Cosmic Ray Elemental Spectra and Atmospheric Neutrino Fluxes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 382

Presenter
Rachel Scrandis
Author and Co-Author
Rachel Scrandis | Deven Bowman | Eun-Suk Seo,

Abstract
'Atmospheric neutrinos are produced when cosmic rays interact with Earth’s atmosphere. The relationship between the cosmic ray spectrum and the neutrino spectrum is especially important around the cosmic ray all-particle knee. These energies correspond to the regime in which astrophysical neutrinos begin to dominate the neutrino flux, so accurate modeling of the cosmic-ray spectrum around the knee can be used to help separate background from signal. Currently, direct measurements of elemental spectra reach their upper energy limit just below the all-particle knee, requiring extrapolation in order to probe the transitional neutrino source energy regime. In this work, the cosmic ray knee is modeled as a transition between acceleration sources, each with a rigidity dependent acceleration limit. Cosmic-ray particles reach the limit at Z * E$_{max}$ where Z is the particle charge and E$_{max}$ is the proton’s limit. Utilizing the Matrix Cascade Equations code, the cosmic-ray elemental spectra were used to calculate resulting atmospheric neutrino fluxes. Various parameterizations to model cosmic rays are explored, and the effects of the resulting elemental spectra on the neutrino fluxes are investigated. The neutrino results are also compared to experimental data.'

Collaborations

Keywords and Comments
'atmospheric neutrinos; cosmic ray all-particle; MCEq; cosmic rays; neutrinos; elemental spectra;', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Uncertainties of the energy loss by inelastic interactions of muons with nuclei

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 383

Presenter
Alexander Sandrock
Author and Co-Author
Alexander Sandrock | Edgar Bugaev | Rostislav Kokoulin | Anatoly Petrukhin,

Abstract
'High-energy muons loose their energy by ionization, pair production, bremsstrahlung and inelastic interaction with nuclei. The process with the largest uncertainty is the inelastic interaction with nuclei. Since the energy loss is dominated by soft interactions with small momentum transfer, parton distribution functions are not applicable and phenomenological parametrizations have to be used. The parametrizations of the proton structure functions that are commonly used in muon transport simulation tools such as PROPOSAL, MUM, MUSIC or Geant4 were determined on the basis of the data available about 20 years ago. In this contribution, we refit several commonly used parametrizations to the data on deep inelastic scattering available today, including the precise combined data from the HERA experiments H1 and ZEUS, which have become available a few years ago. We compare the goodness of fit and calculate the uncertainty of the average energy loss from the uncertainties and correlations of the fit parameters.'

Collaborations

Keywords and Comments
", "

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

New interactions of ultra-high-energy neutrinos: end-to-end forecasts for upcoming neutrino telescopes

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Mauricio Bustamante
Author and Co-Author
Mauricio Bustamante | Kjartan Másson | Victor Valera,

Abstract
'Do new neutrino interactions manifest at ultra-high energies? Fortunately, the upcoming next generation of neutrino telescopes have a real chance of answering this question by discovering the long-awaited cosmogenic neutrinos, with EeV energies, produced in the interaction of ultra-high-energy cosmic rays with cosmological photon backgrounds. At these energies, a new, massive mediator may enhance the ordinarily feeble neutrino-neutrino interactions: cosmogenic neutrinos would undergo new, "secret" interactions on the background of low-energy relic neutrinos. Their energy spectrum would develop characteristic dips centered around the energies where the interaction is resonant. Currently, constraints disfavor mediators with masses up to the MeV scale; cosmogenic neutrinos may push searches to GeV-scale mediators. We perform a realistic and detailed end-to-end forecast of the sensitivity of upcoming radio-based neutrino telescopes RNO-G and IceCube-Gen2 to secret neutrino interactions. At every stage of the analysis, we use state-of-the-art ingredients: in the prediction of the cosmogenic neutrino flux---derived from fits to recent ultra-high-energy cosmic-ray data and sophisticated cosmic-ray interaction models---in the propagation of cosmogenic neutrinos through the Earth---based on the latest calculations of neutrino-matter interactions---and in the forecast of detected event rates---based on the latest detector simulations. We explore representative possibilities of flavor-changing and flavor-preserving secret interactions within a general theoretical framework. Our analysis provides a replicable template for forecasting the realistic sensitivity of next-generation neutrino telescopes to new neutrino physics at ultra-high energies.'

Collaborations

Keywords and Comments
'secret neutrino interaction; icecube-gen2; new physics; ultra-high-energy; radio; rno-g; self-interaction; neutrino; cosmogenic; relic; interaction; bsm', ''

ICRC 2021

Conference Office icrc2021@desy.de
Webpage icrc2021.desy.de

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Neutrino predictions from choked GRBs and comparison with the observed cosmic neutrino flux

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 39 Astrophysical Neutrinos – Theoretical & Experimental Results | NU
Presenter Forum Table

Presenter
Irene Di Palma
Author and Co-Author
Silvia Celli | Angela Zegarelli | Irene Di Palma | Antonio Capone | Michela Fasano | Dafne Guetta,

Abstract
'The lack of spatial anisotropies in the sky map distribution of observed cosmic neutrinos hints towards the extra-galactic nature of their major sources. However, strong constraints are imposed by the Fermi-LAT data on the isotropic gamma-ray background regardless of the neutrino production mechanism, suggesting that the observed neutrinos might possibly originate in sources that remain hidden to gamma-ray observations. We discuss the possibility that neutrinos may come from choked jets, namely those resulting from a supernova explosion such that the collimated material fail to break out of the stellar envelope. Here we estimate the neutrino flux and spectrum expected from choked Gamma-Ray Bursts (GRB), by performing detailed calculations of pγ interactions and accounting for all the neutrino production channels and scattering angles. We provide predictions of expected event rates for operating neutrino telescopes, as ANTARES and IceCube, as well as for under construction telescopes, as KM3NeT. We also compute the contribution of the choked GRB population to the diffuse astrophysical neutrino flux, thus providing constraints on the local rate of this source population as to reproduce the observed neutrino flux.'

Collaborations

Keywords and Comments
'Neutrinos - gamma ray busts', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

IceCube constraints on Violation of Equivalence Principle

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Damiano Francesco Giuseppe Fiorillo
Author and Co-Author
Damiano Francesco Giuseppe Fiorillo, Gianpiero Mangano | Stefano Morisi | Ofelia Pisanti

Abstract
'Among the information provided by high energy neutrinos, a promising possibility is to analyze the effects of a Violation of Equivalence Principle (VEP) on neutrino oscillations. We analyze the IceCube data on atmospheric neutrino fluxes under the assumption of a VEP and obtain updated constraints on the parameter space with the benchmark choice that neutrinos with different masses couple with different strengths to the gravitational field. In this case we find that the VEP parameters times the local gravitational potential at Earth can be constrained at the level of 10^{-27}. We show that the constraints from atmospheric neutrinos strongly depend on the assumption that the neutrino eigenstates interacting diagonally with the gravitational field coincide with the mass eigenstates, which is not a priori justified: this is particularly clear in the case that the basis of diagonal gravitational interaction coincide with the flavor basis, which cannot be constrained by the observation of atmospheric neutrinos. Finally, we quantitatively study the effect of a VEP on the flavor composition of the astrophysical neutrinos, stressing again the interplay with the basis in which the VEP is diagonal: we find that for some choices of such basis the flavor ratio measured by IceCube can significantly change.'

Collaborations

Keywords and Comments
'IceCube; Violation of Equivalence Principle; Beyond Standard Model physics', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Scalar Non Standard Interactions at long baseline experiments

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Abinash Medhi
Author and Co-Author
Abinash Medhi | Debajyoti Dutta | Moon Moon Devi,

Abstract
'The discovery of neutrino oscillation confirms neutrinos have mass and the Standard Model(SM) of particle physics is not complete. It needs an extension in order to accommodate the masses and mixing of neutrinos, which essentially leads to beyond SM(BSM) physics. The unknown couplings involving neutrinos, so-called the Non-Standard Interactions(NSIs)[1] may appear as a 'new physics' in different neutrino experiments. Neutrino NSI can have a sizable impact on neutrino oscillation and can impact the measurements of different mixing parameters in various neutrino experiments. The recent work on scalar NSI[2] has shown a great potential to probe it further. Unlike vector NSI, scalar NSI appears as a correction to the neutrino mass matrix rather than acting as a matter potential. This may lead to a significantly different phenomenological consequence in different neutrino experiments. Moreover, as scalar NSI affects the mass matrix, it also gives a possibility of probing it to different neutrino mass models. \r\n\tIn this work, we explored the effect of scalar NSI in different long-baseline experiments (DUNE, T2HK, etc). We point out that scalar NSI can considerably affect the neutrino oscillation in Long baseline(LBL) experiments and can complicate the measurement of the CP phase. Also as it appears as a correction to the neutrino mass matrix its effect is energy independent, unlike the vector NSI. We also studied the sensitivity of different LBL experiments towards finding the effects of scalar NSI. Also, we put up the possibility of probing it further to various neutrino mass models.\r\n\r\nReferences:\r\n\r\n[1] O.G.Miranda and H.Nunokawa, New Journal of Physics, 2015, 17, 095002.\r\n\r\n[2] S.F. Ge and S.J. Parke, Phys. Rev. Lett., 2019, 122, 211801.'

Collaborations

Keywords and Comments
'Neutrino Physics; Non Standard Interactions', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

A Modern High-Precision Calculation of Deep Underground Cosmic Ray Muons

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 384

Presenter
William Woodley
Author and Co-Author
William Woodley, Marie-Cécile Piro | Anatoli Fedynitch

Abstract
"We present a new efficient calculation to propagate cosmic ray muons from the surface of the Earth to deep underground laboratories, allowing us to look at the physics and performance of various models of high-energy cosmic rays. The evolution of cosmic rays in the Earth's atmosphere is computed with MCEq (Matrix Cascade Equation), taking into account different combinations of primary and hadronic interaction models in order to calculate the muon flux at the surface. The latter serves as an input for the Monte Carlo code PROPOSAL (Propagator with Optimal Precision and Optimised Speed for All Leptons) to propagate the muons through the rock. A forward prediction for underground muon spectra at different slant depths, including the muon survival probabilities and underground energy spectra, is calculated with very high precision. The reliability of this state-of-the-art calculation was achieved by comparing the results obtained for the vertical muon intensity and total muon flux with the measured data at various underground sites with both flat overburdens and mountains. The implications of the results as well as the seasonal variation of the muon flux will also be discussed."

Collaborations

Keywords and Comments
'Cosmic ray muons; Deep underground laboratories; Underground muon spectra; Seasonal variation of the muon flux', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Hadronic uncertainties of inclusive atmospheric lepton fluxes from fixed-target accelerators

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 385

Presenter
Anatoli Fedynitch
Author and Co-Author
Anatoli Fedynitch | Matthias Huber,

Abstract
'Theoretical atmospheric neutrino flux estimates serve as a crucial input for the determination of the neutrino mass hieararchy, the unitarity of the PMNS matrix and the atmospheric mixing angle $\\theta_{23}$ in underground neutrino detectors, such as the Super-Kamiokande, IceCube DeepCore and KM3Net ORCA. With the expected reduction of detector-induced systematic uncertainties by the IceCube Upgrade, and the substantial gain in effective volume of the upcoming Hyper-Kamiokande and KM3NeT ORCA detectors, the theoretical uncertainty of the non-oscillated neutrino flux and flavor composition will ultimately impact the achievable precision of future measurements. In this work, we tackle the uncertainty associated with modeling of hadronic interactions, which has the largest effect on the calculation. We develop an empirical, data-driven model (DDM), derived from high-precision accelerator data from the recent CERN North Area (NA) fixed-target experiments, and a few simple model-dependent arguments. The model is well constrained in the intermediate energy range above a few GeV up to a hundred GeV and achieves good agreement with atmospheric muon data without explicitly using it. We compare our result to reference calculations of the atmospheric neutrino flux.'

Collaborations

Keywords and Comments
'Atmospheric muons; atmospheric neutrinos; inclusive leptons; muons; neutrinos; hadronic interactions; uncertainties; hadronic uncertainties; fixed-target; NA61; IceCube; DeepCore; ORCA; Hyper-K; MCEq',

"Originally, this talk should have been given by Matthias but since he's heading off to industry in April, he will not attend this ICRC. I originally planned to give a talk on a different topic (cosmic rays and life), but since this work has been a long p

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Feasibility of detecting B8 solar neutrinos at JUNO

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Jie Zhao
Author and Co-Author
Jie Zhao | for the JUNO Collaboration,

Abstract
'In this talk we describe in detail the feasibility of detecting ^{8}B solar neutrino at JUNO with three reaction channels (neutrino-electron elastic scattering, neutrino-^{13}C charged current, and neutral current interactions). A reduced 2 MeV threshold on the recoil electron energy is achievable with optimized background reduction strategies. The advantage of JUNO for charge and neutral current channel detection is a large amount of ^{13}C (~0.2 kt). With ten years of data taking, about 60,000 ES signals and 600 NC/CC signal are expected. This leads to a simultaneous measurement of sin$^2\\theta_{12}$ and $\\Delta m^2_{21}$ using reactor antineutrinos and solar neutrinos in the JUNO detector.'

Collaborations
other (fill field below), JUNO

Keywords and Comments
'neutrino oscillation; solar neutrino; JUNO', ''

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Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

An analytical derivation of the survival probability of muon penetrating through matters

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 386

Presenter
Takao Nakatsuka
Author and Co-Author
Atsushi Iyono | Takao Nakatsuka | Kazuhide Okei | Saya Yamamoto | Shuhei Tsuji | Hiroki Matsumoto,

Abstract
'The survival probabilities of muon after penetrating through matters are evaluated analytically by solving the diffusion equation, taking account of positron-electron pair production, bremsstrahlung and photonuclear interactions, together with ionization loss. Accuracies of the results are discussed by comparing them with those derived by a Monte Carlo method. Qualitative properties of the probability for muon are also investigated by comparing the results with those for electron taking account only of bremsstrahlung.'

Collaborations

Keywords and Comments
'muon; cascade shower', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Prospects for neutrino-flavor physics with in-ice radio detectors

Time 20 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 38 The Future of Neutrino Telescopes | NU
Presenter Forum Table

Presenter
Christian Glaser
Author and Co-Author
Christian Glaser | Daniel Garcia-Fernandez | Anna Nelles,

Abstract
'The detection of the radio emission following a neutrino interaction in ice is a promising technique to obtain significant sensitivities to neutrinos with energies above 10 PeV. The detectable radio emission stems from particle showers in the ice. So far, detector simulations have considered only the radio emission from the primary interaction of the neutrino. We present how the simulation code NuRadioMC was extended to cover secondary interactions from muons and taus. Muons and taus, created by an interaction of the corresponding neutrino, can create several additional detectable showers during their propagation through the ice, which adds up to 25% to the effective volume of neutrino detectors. It provides a signature for the neutrino flavor and improves event reconstruction if multiple of these showers are detected. We simulated the signatures of secondary interactions for the RNO-G detector in Greenland and the proposed radio detector of IceCube-Gen2. We also find that the background of atmospheric muons from cosmic rays is non-negligible for in-ice arrays and that an air shower veto should be considered helpful for radio detectors.'

Collaborations

Keywords and Comments
'UHE neutrino;radio;Askaryan;NuRadioMC;flavor id;muon background;', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

A novel multimessenger study of Starburst galaxies: implications for neutrino astronomy

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 387

Presenter
Antonio Marinelli
Author and Co-Author
Antonio Marinelli, Antonio Ambrosone | Marco Chianese | Damiano Francesco Giuseppe Fiorillo | Gennaro Miele | Ofelia Pisanti

Abstract
'Starburst galaxies (SBGs) and more in general starforming galaxies represent a class of galaxies with a high star formation rate (up to 100 Mo/year). Despite their low luminosity, they can be considered as guaranteed “factories” of high energy neutrinos, being “reservoirs” of accelerated cosmic rays and hosting a high density target gas in the central region. The estimation of their point-like and diffuse contributions to the neutrino astrophysical flux measured by IceCube can be crucial to describe the diffuse neutrino spectral features as well as the peculiar point-like excess like NGC1068. To this aim we use the latest gamma-ray catalog of this class of objects to perform a multimessenger study and describe their gamma-ray emission through a calorimetric scenario.\r\nFor the diffuse analysis we perform a blending of the measured spectral indexes and obtain a multi-component description of extragalactic background light (EGB), high energy starting events (HESE) and high-energy cascade IceCube data. Remarkably, we find that, differently from recent prototype scenarios, the spectral index blending allows starburst galaxies to account for up to 40% of the HESE events at 95.4% CL and favors a maximal energy of the accelerated cosmic rays at tens of PeV.\r\nFor the point-like analysis we apply the calorimetric approach to the known SBGs within 100 Mpc, considering, where possible, a source-by-source description of the star formation rate. These results are then compared with what IceCube and ANTARES have seen at TeV energies as well as with what can be expected from the incoming KM3NeT.'

Collaborations

Keywords and Comments
'radiation mechanisms: non-thermal; galaxies: starburst ; gamma-rays: diffuse background; gamma-rays: point like; neutrino expectations', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Unraveling the nature of GRBs progenitors though neutrinos

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 39 Astrophysical Neutrinos – Theoretical & Experimental Results | NU
Presenter Forum Table

Presenter
Gibran Morales
Author and Co-Author
Gibran Morales, Nissim Fraija

Abstract
'GRBs are the most energetic electromagnetic events in the Universe. Those whose typical duration is longer than a few seconds are known as long GRBs and shorter than a few seconds are short GRBs. It is widely accepted that these events are associated with the collapse of a very massive star and the neutron star (NS) binary merger, respectively. A fast-spinning, strongly magnetized NS could be expected before a black hole (BH) in both scenarios. We allude to the thermal neutrinos' particular properties propagating inside the fireball for differentiating both scenarios in this work. We first derive the neutrino effective potential associated with each medium in a strong and weak magnetic field. We calculate the three-flavor oscillation probabilities, and finally, we get the expected neutrino rate in both scenarios. Given these observables' evolution, we can determine whether the progenitor could be associated with a strongly magnetized NS or a BH.'

Collaborations

Keywords and Comments
'Gamma-ray bursts: progenitors; Neutrinos: Propagation; Oscillations in matter', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

The Prospects to observe UHE neutrinos from astrophysical sources with Trinity

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 35 Upgoing Tau Neutrinos: Present and Future | NU
Presenter Forum Table

Presenter
Andrew Wang
Author and Co-Author
Andrew Wang | Otte Nepomuk | Michele Doro,

Abstract
'The ultrahigh-energy (UHE; > 10^6 GeV) neutrinos band is one of the last unopened windows to the universe. Although UHE neutrinos are not yet detected, we know they must exist. UHE neutrinos are either produced in interactions of ultrahigh-energy cosmic rays with the cosmic microwave background (cosmic neutrinos) or inside or close by cosmic-ray accelerators. This presentation discusses the expected rate of neutrino detections with Trinity based on predicted neutrino fluxes from astrophysical sources. Trinity is a proposed system of air-shower imaging telescopes optimized to observe ultrahigh-energy neutrinos in the range from 10^6 GeV to 10^9 GeV.'

Collaborations
Trinity,

Keywords and Comments
'ultrahigh-energy neutrinos; neutrino detection; trinity; neutrino telescope; air-shower imaging; cosmic neutrinos', ''

Branch NU | Neutrinos & Muons

Subcategory Theoretical Results

Rigorous predictions for prompt neutrino fluxes in view of VLVnT upgrades

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 31 Fundamental Physics with Neutrinos | NU
Presenter Forum Table

Presenter
Maria Vittoria Garzelli
Author and Co-Author
Maria Vittoria Garzelli | Sven-Olaf Moch | Guenter Sigl,

Abstract
'The existence of a flux of prompt atmospheric neutrinos from the decay of heavy hadrons resulting from the interaction of cosmic rays with the atmospheric nuclei is predicted by theory. Very Large Volume Neutrino Telescopes, like Icecube, KM3NeT and Baikal-GVD, should be sensitive to this neutrino component, that represents a background for the neutrinos from far astrophysical sources. However, no clear experimental evidence of prompt neutrino fluxes has been found, at least so far. In particular, the prompt neutrino component well fits to zero even in the most recent analysis of High Energy Starting Events by the IceCube collaboration, published last autumn. On the other hand, the analysis of through-going muon tracks, more sensitive to prompt neutrinos than the previous one, has established an upper limit on prompt neutrino fluxes.\r\nOur collaboration has been active in providing accurate predictions for prompt neutrino fluxes in the last few years, on the basis of rigorous QCD calculations, and in assessing many of the uncertainties related to these predictions. We discuss our most recent results and their uncertainties, which we believe constitute the most accurate and comprehensive prediction of prompt neutrino fluxes available at present, and show how they challenge the present experimental limits. We are confident that, increasing the experimental capabilities and statistical sample, as possible through e.g. the IceCube-Gen2 upgrade, will help in sharing further light on the prompt neutrino issues.'

Collaborations
other (fill field below), PROSA

Keywords and Comments
'atmospheric neutrinos; prompt neutrino fluxes; QCD; Very Large Volume Neutrino Telescopes;', ''

Branch O & E | Outreach and Education

Subcategory Future projects

Global Cosmic-Ray studies educational platform

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 30 Schools and tools | O&E
Presenter Forum Table

Presenter
Barbora Bruant Gulejova
Author and Co-Author
Barbora Bruant Gulejova,

Abstract
"The International Particle Physics Group (IPPOG) is a global network active in informal education and outreach in particle physics and related research, including cosmic-ray and astro-particle physics. Since many years, IPPOG has been actively supporting the International Cosmic Day organized by DESY and the International Muon Week organized by Quarknet. In 2015 IPPOG started work on establishing a universal portal through which successful cosmic-ray study programmes can reach out to teachers and students around the world. This common web platform is being developed by IPPOG in the frame of its new IPPOG web pages. It will contain all information for schools interested in taking part in cosmic-ray experiments and analysing real data in classroom; also instructions about how to build, borrow, or purchase cosmic-ray detectors. The platform will also facilitate collaboration and exchanges between the experiments' project managers and advertising of related events."

Collaborations
other (fill field below), International Particle Physics Outreach Group

Keywords and Comments
'global Cosmic Rays studies; cosmic rays data; outreach; education; IPPOG; particle physics; online education; platform; federation of experiments', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Transformation of the Physics and Astronomy courses

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 574

Presenter
Dmitriy Beznosko
Author and Co-Author
Dmitriy Beznosko | Tatiana Krivosheev | Alexander Iakovlev,

Abstract
'The science education in universities has several deferring moments for the general student population outside of the Physics/Astronomy fields or STEM in general. A large contribution to that comes from the high cost of the textbooks that is typical for the introductory physics and astronomy courses. Another is the lack of supporting class materials, such as audio-video materials and support tools for activities. This poster will cover the class transformation activities under the ALG grant to adopt the free textbooks from OpenStax for the intro Physics 1-2 and Astronomy 1-2 sequences, and to create the supporting materials such as presentations, tests, audio-video materials and in-browser run online tools for the class activities as applicable to the courses listed above. Adaptations to online or hybrid teaching style will be also noted, and students' survey results will be included as well.'

Collaborations

Keywords and Comments
'science education; class transformation; free textbook; class materials', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Armagh Observatory and Planetarium's Outreach Programme for the Cherenkov Telescope Array

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 29 Outreach online | O&E
Presenter Forum Table

Presenter
Michael Burton
Author and Co-Author
Michael Burton, Heather Alexander | Kerem Cubuk

Abstract
'We describe an outreach programme being undertaken at the Armagh Observatory and Planetarium (AOP) for the Cherenkov Telescope Array (CTA).   Founded in 1790 and with a rich astronomical heritage, AOP today combines the research and education arms of our organisation to bring a research-informed outreach programme to the public, most often through our planetarium-related activities. \r\n\r\nWe have developed and written, in-house, a short (10 minute) Full Dome planetarium show ("Exploring the High-Energy Universe") that describes the science of gamma-ray astronomy and introduces the CTA as the as the first ground-based gamma-ray observatory open to scientific communities. This dome show will be made freely and publicly available through the Digistar cloud to other planetaria.   It may be rendered into other formats for other planetarium projector systems. We will explain how we undertook this project and consider how it might be extended to provide outreach material for other science facilities. \r\n\r\nIn parallel, we are engaged in developing a series of short videos to introduce the scientists and the science of the UK CTA consortium, again designed for public audiences. These videos can be accessed through our social media channels. Delivery of such outreach programme in byte-sized pieces is an essential element in attracting and engaging audiences. We explain how we have developed the skill set to do this in our Education Team at AOP whilst our facility has been closed for the past year, a result of the Covid-pandemic.'

Collaborations
CTA,

Keywords and Comments
'CTA; gamma-ray; planetarium; outreach; education', 'Note: the planetarium show being discussed here could actually be shown during the ICRC using screen sharing. This would display a flat screen projection of the dome show. While obviously not providing the same experience as for a viewer seated in a pl

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Collaboration between high schools in Japan and Argentina for cosmic-ray research using Cosmic Watches

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 30 Schools and tools | O&E
Presenter Forum Table

Presenter
Takeshi Nakamori
Author and Co-Author
Takeshi Nakamori, Mika Takanashi | Ryuta Saito | Kyoka Ozaki | Rikako Kono | Kazuo S. Tanaka | Ana Beatriz Prieto | Marianela Pepe | Juan Wehinger | Lucio Martinez | Chizuru Nose | Haruhi Enomoto | Ryosuke Kita | Kyoka Maruta

Abstract
'Cosmic rays are ubiquitous and readily available, making them a good teaching tool for particle and astrophysics for young students. ‘Tan-Q’ is an inclusive outreach and educational project, providing students in Japanese junior-high or high schools for research opportunities to join in cosmic-ray and particle physics (PI: K. S. Tanaka). In the Tan-Q framework, the students in each school conduct their own research with helps from mentors who are mainly undergraduate students. Researchers are also extensively involved through regular Zoom meetings and continuous communication on Slack. Some cases are inter-school and some are international. We use Python on Google Colaboratory for data analysis. Students start with the given template analysis codes, and modify and adapt the codes for each research themes supported by the mentors. \r\n\r\nIn this paper we present one of the Tan-Q activity that is a joint research between high schools in Japan and Argentina to observe cosmic-ray muons using Cosmic Watches. Cosmic Watch, originally developed by the MIT group, consists of a plastic scintillator with a SiPM and Arduino is used for data acquisition. Our primary goal is to investigate the muon flux differences due to the differences in circumstances like altitudes and geomagnetic field strengths. Those involved learn not only particle physics but also the statistical data analysis methods.'

Collaborations

Keywords and Comments
'school projects; Cosmic Watch; international', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Outreach and educational activities within the EEE cosmic ray network

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 575

Presenter
Chiara Pinto
Author and Co-Author
Chiara Pinto,

Abstract
'The Extreme Energy Events (EEE) network consists in a sparse array of telescopes based on Multigap Resistive Plate Chambers, installed in high school buildings all over the Italian territory and at CERN. Besides the many research activities concerned with extensive air shower detection, long distance correlation studies and additional physics results obtained during the last decade, the EEE project is extensively employed for educational and outreach activities, exploiting a unique opportunity to promote a fruitful and close collaboration between students, high school teachers and researchers. The involvement is at all levels, from the construction of the chambers during short stages at CERN over the past 15 years, with the participation of several hundred high school students and teachers, to the installation, monitoring and data taking with the telescopes by high school teams, to master classes, physics lectures, data analysis sessions and joint discussions on the results and their interpretation. Recent developments of the EEE network led to the installation and use of additional detectors in the Arctic region and on board of sailing ships, to measure the cosmic ray flux over large latitude intervals. Periodical remote and in presence (pre-Covid era) meetings allowed in these years a large participation (several thousand people) from the high school community to the EEE activities. National and local outreach initiatives in cosmic ray physics are also carried out around Italy by the EEE network, as a contribution to the dissemination of science among young people.'

Collaborations
other (fill field below), EEE Collaboration

Keywords and Comments
'', 'The selected contribution type is talk, but I would also be willing to contribute with a poster.'

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Almost Two Decades of Teaching Astronomy and Astrophysics, and Providing Educational Resources, to Chicago Public School Students and Teachers

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 576

Presenter
Vikram Dwarkadas
Author and Co-Author
Vikram Dwarkadas,

Abstract
'Over two decades, I have been actively involved in teaching astronomy and astrophysics to Chicago Public School (CPS) students and their teachers. This work was mainly in collaboration with Don York and the CUIP group. Don is now retired, but I am carrying on doing E/PO. Valuable resources that we have created for schools include the Multiwavelength Astronomy Website, with modules for infrared, optical, ultraviolet, X-Ray and Gamma-Ray Astronomy. The content of each lesson is derived from interviews with scientists, archived oral histories, and/or memoirs. Lessons were evaluated by a science educator and at least one subject matter expert before being produced for the web. They are supplemented by NASA media; archival material from the University of Chicago Library and other archives; and participant contributed photographs, light curves, and spectra. Summer programs provided training to CPS teachers to use the resource in their classroom. I have given several talks to CPS teachers, mainly on X-ray astronomy. Currently I am leading the CHARM (Chicago Area Research Mentoring) initiative. I am working with a class of 17 diverse 11th grade honors students at the UC Charter School, Woodlawn. Through frequent lectures (~ every 3-4 weeks), these students are exposed to astrophysical topics and concepts not normally not covered in a school curriculum (such as particle acceleration at shocks), to be followed by research projects in areas including high-energy astrophysics. The aim is to develop their critical thinking, and introduce them to research methods and techniques. This will prepare them for a STEM career, particularly one that prioritizes research. In this talk I will highlight the various projects, educational resources and results achieved.'

Collaborations

Keywords and Comments
'school projects; under-represented students; educational resources; teacher training; outreach', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Extreme19: when art and science make the front page

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 577

Presenter
Elisa Prandini
Author and Co-Author
Elisa Prandini | Michele Doro | Manuela Mallamaci | Barbara Montolli | Daria Mauri,

Abstract
'Back in mid 2018, we were organizing Extreme19, a conference on astro-particle physics held in Padova on the topic of extremely energetic emission from galaxies. For the preparation of the graphical material in support of the conference we seeked for a collaboration with talented art students. To this purpose, we joined the Italian programme 'PCTO' (percorsi per le competenze trasversali e per l'orientamento) of high school student stages in job centers. Emily, Beatrice, and Chiara from the high school "Liceo Artistico Modigliani" in Padova accepted our invitation and started a 6-month stage at the Padova University in close contact with us. The challenge was to interbreed our scientific description of a relativistic jet of a powerful galaxy and their artistic assimilation and subsequent representation of it. During this period, they elaborated excellent and innovative graphical material used for the webpage as well as the conference poster. The quality of the graphics was indeed excellent: one of their drawings became the cover of the February 2020 issue of the prestigious Nature Astronomy journal.'

Collaborations

Keywords and Comments
'education; school projects; art and science', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Making particle physics and cosmology accessible for high school students

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 578

Presenter
Hannes Stoppel
Author and Co-Author
Hannes Stoppel,

Abstract
'One often needs to decide how far to introduce students to topics from the abstract scientific and mathematical perspective. It goes hand in hand with Stoffdidaktik (Dilling et al., 2020).\r\nReferring to this question we developed and tested educational materials on Particle Physics and Cosmology for students of grade 9 to 12 at secondary and upper secondary level, and for gifted students in special courses academies as Deutsche Schülerakademie or competitions like Jugend forscht, taking their prior knowledge into consideration. Our material contains, among other things, experiments supported by DESY and the University of Wuppertal. The theoretical parts of our course material include Maxwell's equations and the Klein-Gordon equation (according to Ellwanger, 2012), which require basic knowledge in differential equations and group theory (according to Wong, 2013).\r\nTo evaluate the results and the material and the courses from a cognitive as well as a psychological point of view, we used students' notebooks, their learning diaries, questionnaires, and interviews collected over a school year (Stoppel, 2019).\r\nThe Poster Presentation will take a look at the scientific content, emphasizing educational and psychological aspects.\r\n\r\nDilling, F., Stricker, I., Tran, N. C., & Vu, D. P. (2020). Development of Knowledge in Mathematics and Physics Education. In S. F. Kraus & E. Krause (Eds.), MINTUS. (pp. 299–344). Wiesbaden: Springer. \r\nEllwanger, U. (2012). From the universe to the elementary particles. Berlin: Springer. \r\nStoppel, H.-J. (2019). Beliefs und selbstreguliertes Lernen. Wiesbaden: Springer.\r\nWong, C. W. (2013). Introduction to Mathematical Physics (2. ed.). Oxford: Oxford Univ. Press.'

Collaborations
, Max-Planck-Gymnasium Gelsenkirchen

Keywords and Comments
'School projects; particle; cosmology; experimental and theoretical parts; psychological aspects', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Cosmic rays and the structure of the universe studied in Cosmic Ray Extremely Distributed Observatory with citizen science

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 30 Schools and tools | O&E
Presenter Forum Table

Presenter
Robert Kaminski
Author and Co-Author
Robert Kaminski | for the CREDO Collaboration, Janusz Firla

Abstract
'Discovering the secrets of invisible cosmic particles and using them to study the structure of the universe is a citizens\' initiative supported by the Cosmic Ray Extremely Distributed Observatory (CREDO). The method of operation is the parallel participation in research of all citizens: experienced scientists and people without scientific experience, aiming to the full immersion of all ages, geographic location and disabling factors preventing peoples with functional diversity from participating. For several years, CREDO has been conducting an intensive information campaign (scientific and popularization), thanks to which several thousand people on all continents collect data using free CREDO applications for smartphones (Android and iOS). Moreover, every year in schools in Poland competitions "Particle Hunters" are organized. Since 2020, CREDO has been carrying out activities to make such scientific activities available to the peoples with functional diversity. As an example smartphone applications are updated and activities are planned for the blind and visually impaired. Those are:\r\n\r\n\xa0\xa0\xa01. workshops and presentations on the use of sound to explore and analyze the invisible universe,\r\n\xa0\xa0\xa02. preparing and organizing people for joint activities supporting the acquisition of fascination with space through action games, educational platforms, selected information programs, creating new tools for discovering the mysteries of the cosmos and developing science about it,\r\n\xa0\xa0\xa03. organizing and networking an international community of experts in the field of sonification and space sciences. The result of this activity will be larger or smaller social groups or individuals who are increasingly familiar with space sciences, collecting more and more data, participation of non-scientists in scientific publications, popularizing the mainstream of space sciences among people at risk of exclusion.'

Collaborations
, Cosmic Ray Extremely Distributed Observatory (CREDO) Collaboration

Keywords and Comments
'citizen science; Cosmic Ray Extremely Distributed Observatory; functional diversity; CREDO applications for smartphones; Particle Hunters in schools; sonification and space sciences', 'The main results covered by this article will be summarised in a highlight talk to be presented by a representative speaker of the CREDO Collaboration, if only the Conference Organizers agree that such a talk is given (an appropriate request will be sent

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Development of a portable SiPM scintillator tracker for cosmic rays

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 30 Schools and tools | O&E
Presenter Forum Table

Presenter
Roberta Pillera
Author and Co-Author
Roberta Pillera, Fabio Gargano | Mario Nicola Mazziotta | Leonardo Di Venere | Francesco Loparco | Serena Loporchio | Elisabetta Bissaldi | Francesco Giordano | Davide Serini | Corrado Altomare | Salvatore De Gaetano

Abstract
'A crucial aspect for outreach activities in cosmic-ray physics is the ability to bring the audience in contact with the experiments and let them visualize the underlying physics. A possible option is the use of portable detectors, which can be easily transported and operated in the various places where outreach activities take place (schools, theaters, etc.), and are equipped with a fast data acquisition system for real-time event visualization. We have developed a tracker for cosmic rays composed of scintillator bars with embedded wavelength shifting (WLS) fibers coupled to Silicon Photomultipliers (SiPMs). The SiPMs are read out with Caen DT5702 Front-End boards and the data acquisition is performed with custom C++/python based software. The DAQ is controlled by a Raspberry Pi 4 single computer board, equipped with a GPS for precise timing and position information and a Sense HAT board for environmental monitoring. This results in a simple, portable system allowing online track visualisation and cosmic ray rate measurements.'

Collaborations

Keywords and Comments
", "

ICRC 2021

Conference Office icrc2021@desy.de
Webpage icrc2021.desy.de

Branch O & E | Outreach and Education

Subcategory Outreach and Education

QuarkNet High School Cosmic Ray Projects

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 30 Schools and tools | O&E
Presenter Forum Table

Presenter
Mark Adams
Author and Co-Author
Mark Adams | for QuarkNet,

Abstract
'QuarkNet High School teachers and students perform experiments with cosmic ray muons. Their data is available to all on the i2u2.org site; enable measurements of muon flux, speed, and lifetime. The pandemic restricted access to many detectors, so QuarkNet provided virtual resources allowing users to carry out simpler experiments with already uploaded data. Users can also request groups maintaining active detectors to modify setups in order to collect customized data. Some QuarkNet high school groups have also carried out more complex projects, e.g. Solar Eclipse 2017, MUSE at Fermilab, storm tracking, and g-2, that required assembling entire physics collaborations.'

Collaborations
, QuarkNet

Keywords and Comments
'QuarkNet; high school teachers; cosmic ray muons', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Multi-messenger Astroparticle Physics for the Public via the astroparticle.online Project

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 29 Outreach online | O&E
Presenter Forum Table

Presenter
Victoria Tokareva
Author and Co-Author
Victoria Tokareva | Yulia Kazarina | Andreas Haungs | Dmitriy Kostunin | Alexander Kryukov | Evgeny Postnikov | Vladimir Samoliga | Alexey Shigarov | Dmitry Shipilov | Dmitriy Zhurov,

Abstract
"Many projects want to share knowledge on particle and astroparticle physics (in particular, cosmic ray physics), however multi-messenger astroparticle-physics is still a young research field and hardly covered in educational curricula or in outreach. The astroparticle.online project, founded in 2018 within the framework of the German-Russian Astroparticle Data Life Cycle Initiative (GRADLCI), encompasses an endeavor to address this issue.\r\nWithin the project, scientists from Karlsruhe Institute of Technology (KIT), Irkutsk State University (ISU) and Moscow State University (MSU) developed a range of educational materials: articles, video lectures, tests, problems to solve, laboratory works and pre-trained neural networks for particle recognition. The project is supported by the KASCADE Cosmic-ray Data Center (KCDC) and GRADLCI data aggregation platform, where one can retrieve and analyze open scientific data from various experiments..\r\nThe main audience of the project’s activities are high school and undergraduate students. All the educational materials are available online at the project's web portal https://www.astroparticle.online/, they are used both in online and offline masterclasses organized by the project members, and also as the supplementary content by educational organizations - for example, in the ISU course 'Introduction to experimental methods in high energy astrophysics'. Over the time that the project has been operating, more than 120 students took part in its activities.\r\nThis contribution will cover the experience gained while running the project for more than 3 years now, our challenges, developments and future plans."

Collaborations
other (fill field below), GRADLCI

Keywords and Comments
'outreach; multi-messenger astroparticle physics; cosmic rays; GRADLCI; KASCADE; KCDC', ''

ICRC 2021

Conference Office icrc2021@desy.de
Webpage icrc2021.desy.de

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Outreach activities at the Pierre Auger Observatory

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 29 Outreach online | O&E
Presenter Forum Table

Presenter
Karen Salomé Caballero Mora
Author and Co-Author
Karen Salomé Caballero Mora | For the Pierre Auger Collaboration,

Abstract
'The Pierre Auger Observatory, sited in Malargüe, Argentina, is the largest observatory available for measuring ultra-high-energy cosmic rays (UHECR).\xa0 The Auger Collaboration has measured and analysed an unprecedented number of UHECRs. Along with making important scientific discoveries, for example, the demonstration that cosmic rays above 8 EeV are of extragalactic origin and the observation of a new feature in the energy spectrum at around 13 EeV, outreach work has been carried out across the 17 participating countries and online.\xa0 This program ranges from talks to a varied audience, to the creation of a local Visitor Center, which attracts ~8000 visitors annually, to initiating masterclasses.\xa0 Permanent and temporary exhibitions have been prepared both in reality and virtually.\xa0 Science fairs for elementary- and high-school students have been organised, together with activities associated with interesting phenomena such as eclipses.\xa0 In addition, we participate in international events such as the International Cosmic Day, Frontiers from H2020, and the International Day of Women and Girls in Science. Part of the Collaboration website is aimed at the general public. Here the most recent articles published are summarised. Thus the Collaboration informs people about work in our field, which may seem remote from everyday life. Furthermore, the Auger Observatory has been a seed for scientific and technological activities in and around Malargüe. Different outreach ventures that already have been implemented and others which are foreseen will be described.'

Collaborations
Auger,

Keywords and Comments
'Cosmic Rays; Pierre Auger; outreach; education; astroparticle physics.', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Discovering cosmic rays with OCRA: outreach activities for students and teachers

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 579

Presenter
Sabine Hemmer
Author and Co-Author
Sabine Hemmer | Carla Aramo | Elisabetta Bissaldi | Valerio Bocci | Bianca Bottino | Mario Buscemi | Lorenzo Caccianiga | Gabriella Cataldi | Francesco Dimiccoli | Federico Di Pierro | Carmelo Evoli | Alessia Giampaoli | Giuseppe La Vacca | Alessandro Men,

Abstract
'The Outreach Cosmic Ray Activities (OCRA) project offers a platform for all outreach activities focusing on cosmic rays within the Italian Istituto Nazionale di Fisica Nucleare (INFN). Created in 2018, OCRA now counts 21 of the institute's divisions all over Italy as members. The project's core activity is the participation of all its members in the International Cosmic Day, organized by DESY, inviting high school students to carry out hands-on measurements of the cosmic ray flux and learn about the related physics background. Two students from each division are then selected to participate in the annual OCRA science camp, a three-day full immersion into the life of a physicist. \r\nThe national activities are complemented by local initiatives of the OCRA member groups: workshops and secondments, science competitions and the development of new detectors for outreach activities offer a multitude of possibilities for students to engage with our researchers and to explore the world of cosmic rays. \r\nSince spring of 2020 OCRA offers also a series of online laboratories on its website https://web.infn.it/OCRA/, designed not only to be used by students individually but also to be offered in the classroom by teachers. \r\nThis talk will give an overview on all activities offered by OCRA with a particular focus on the 2020 online event organized in occasion of the International Cosmic Day, that saw the participation of more than 3000 students.'

Collaborations
other (fill field below), OCRA

Keywords and Comments
'student activities; teacher activities; International Cosmic Day; online laboratories', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Virtual tours to the KATRIN experiment

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 29 Outreach online | O&E
Presenter Forum Table

Presenter
Manuel Klein
Author and Co-Author
Manuel Klein | Kathrin Valerius | Leonard Köllenberger | Philipp Niemann | Philipp Schrögel | Christian Humm | Yannic Scheuermann,

Abstract
'The KArlsruhe TRItium Neutrino (KATRIN) experiment performs a model-independent measurement of the electron neutrino mass with a design sensitivity of 0.2 eV (90% CL) after three full years of measurement time. KATRIN measures near the endpoint of the tritium beta spectrum, using the MAC-E filter principle by virtue of its 70 m long beamline. Its technological challenges include the high-luminosity tritium source, the cryogenic pumping section and the 20 m long ultra-high vacuum vessel of the main spectrometer.\r\n\r\nGuided tours to the KATRIN beamline with supporting presentations are frequently offered to make the experiment, astroparticle physics and scientific research in general accessible to the public and students in particular. However, the on-site access is limited by the operation of high voltage and magnets, safety regulations for the tritium laboratory and the ongoing pandemic. This fuelled the development of three virtual presentation tools:\r\na 40-minute-long video tour with live commentary via zoom was created using cellphone-made footage of the beamline and archive footage of the transport and commissioning of its key components;\r\na 3D panorama of five locations at the beamline for virtual reality headsets or browsers providing a live-action guide or free exploration was developed with the NaWik (National Institute for Science Communication);\r\nand a browser interface for a low-poly model of the full beamline is work-in-progress.\r\nIn this talk, we will present all three tools and their making, including first results of the NaWik-research on the knowledge transfer potential of the 3D panorama.\r\n\r\nSupported by BMBF (Ø05A20VK3), the Helmholtz Association, the Klaus Tschira Foundation, the KIT centre KCETA, and the Excellence Strategy of the German Federal and State Governments.'

Collaborations

Keywords and Comments
'KATRIN; NaWik; KIT; Netzwerk Teilchenwelt; Neutrino; Neutrinomass; virtual tour; outreach; web interface; 3D panorama; science in presentations; self-made video; low-poly; knowledge transfer; students', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Outreach, Education and Communication Initiatives of the CTA Observatory

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 580

Presenter
Alba Fernández-Barral
Author and Co-Author
Alba Fernández-Barral | Megan Grunewald | for the CTA Observatory,

Abstract
'The Cherenkov Telescope Array Observatory (CTAO) will be the first ground-based gamma-ray observatory for the exploration of the extreme Universe that will be open to all scientific communities as a resource for data from unique, high-energy astronomical observation. The CTAO will have tens of telescopes located on two array sites, covering the entire gamma-ray sky: CTA-North located at the Roque de los Muchachos Observatory (La Palma, Spain) and CTA-South near the Paranal Observatory (Atacama Desert, Chile). In this talk, we will present the Outreach, Education and Communication (OEC) programme and activities carried out at the global and site levels. \r\nWe will, first, present the CTAO's approach to education, covering the educational activities and materials we use to bring the gamma-ray Universe into the classroom, as well as the "Physicists On-Call" programme that puts CTA experts in contact with educational centres and astronomical associations around the world. Moreover, we will delve into the initiatives under the CTAO's Astrodiversity project, which aims to create and support activities within the inclusion and diversity framework, including the annual "Women of CTA" event and best practices for the colour-blind and visually-impaired. Finally, we will discuss the latest developments and releases, including an open seminar series for researchers and the general public, as well as the CTAO's ongoing series of films to explore the science, technology, sites and people behind the construction of the largest, most powerful gamma-ray observatory on the planet.'

Collaborations
, CTA Observatory (CTAO)

Keywords and Comments
'high-energy outreach; education; diversity; inclusion; films; good practices; gender;', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Online Masterclass built on the KASCADE Cosmic ray Data Centre

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 581

Presenter
Katrin Link
Author and Co-Author
Katrin Link | Victoria Tokareva | Andreas Haungs | Doris Wochele | Frank Polgart | Donghwa Kang | Paras Koundal | Olena Tkachenko | Jürgen Wochele,

Abstract
'During the ongoing Covid-19 pandemic, people all over the world were forced to think about new ways of interacting with each other and this has especially challenged academics in their outreach activities with pupils. New online formats needed to be developed, and we used this opportunity to design and implement an (not only) online Masterclass using data from the KASCADE experiment. The masterclass is built on the KASCADE Cosmic Ray Data Centre and uses Jupyterhub and Notebooks for data analysis. We gained first practical experience during the International Cosmic Day with students at the age of 14-19 years. The Masterclass includes lectures on cosmic ray physics and data analysis, which are then consolidated in a hands-on part. By performing a cosmic-ray composition analysis on KASCADE data, the participants gain experience in using the KCDC open data web platform, working in the Jupyter environment, preprocessing data from a real astroparticle physics experiment, programming Python and performing exploratory data analysis.\r\nIn this presentation, we will describe the content of the masterclass as well as the choice of implementation tools (such as platform, programming language and libraries) and organizational aspects of the event.'

Collaborations

Keywords and Comments
'Masterclass; KCDC; Jupyter; KASCADE-Grande; Cosmic Ray; Outreach;', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

The online laboratories for OCRA - Outreach Cosmic Ray Activities INFN project

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 29 Outreach online | O&E
Presenter Forum Table

Presenter
Carla Aramo
Author and Co-Author
Carla Aramo | Roberta Antolini | Valerio Bocci | Mario Buscemi | Lorenzo Caccianiga | Attanasio Candela | Gabriella Cataldi | Roberta Colalillo | Fabio Convenga | Maria Rita Coluccia | Francesco de Palma | Pasquale Di Nezza | Giuseppe Di Sciascio | Carmel, OCRA Collaboration

Abstract
'OCRA – Outreach Cosmic Ray Activities was born in 2018 as a national outreach project of INFN with the aim of collecting, within a national framework, the numerous public engagement activities in the field of cosmic ray physics already present at a local level in the divisions and laboratories. Since spring of 2020 OCRA offers also a series of online laboratories on its website https://web.infn.it/OCRA/, designed not only to be used by students individually but also to be offered in the classroom by teachers. \r\nThe cosmic rays path present on the website will be presented together with the online laboratories on the measurement of muons, from the one related to the dependence on the zenith angle made during the International Cosmic Day up to measurements of the flux dependency on the altitude in the atmosphere and in the water. Also, a laboratory allowing to analyze public data of the Pierre Auger Observatory will be presented. In addition, some teaching methods included in the "Teachers\' area" of the OCRA website will be described. \r\nThe developed cosmic ray path was also used to organize an online course for teachers of Italian high schools with the purpose of accompanying teachers when approaching the subject for the first time. About 70 teachers participated for a total of 9 lessons.'

Collaborations
other (fill field below), OCRA

Keywords and Comments
'online; didactics; cosmic ray; muons', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Astro-photography as an effective tool for Outreach and Education: IACT in exposition

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 30 Schools and tools | O&E
Presenter Forum Table

Presenter
Simone Iovenitti
Author and Co-Author
Simone Iovenitti | Chiara Righi | Stefano Orsenigo | Riccardo Sgarro,

Abstract
'In our epoch, images are a powerful way to convey a message to a large audience. Through the use of amazing astronomical photographs, science can be communicated effectively at different levels, to a very diverse audience of all ages. In fact, astrophotography combines aesthetic appeal with the illustration of the science behind astronomical phenomena. This is the aim of the exhibit “A che punto è la NOTTE - A scientific exposition of astrophotography” organized by us in Italy, in October 2020, with the partnership of the cultural association PhysicalPub. Many different authors, both single individuals and professional or amateur observatories, were asked to send their best pictures. The 54 astronomical images chosen by a scientific committee, categorised in three different topics (night landscape, deep sky, instrumentation), were seen by more than 2000 visitors and 11 school groups (despite the difficult period due to the COVID pandemic). A free audio-guide, available on-line through a web-application developed on purpose, delivered scientific explanations of images for self-guided tours. Conferences and guided tours were also organized.\r\nThe highlight of the exhibit were four mirrors from the MAGIC telescope and an ASTRI scale-model that allowed an in-depth description of how an Imaging Atmospheric Cherenkov Telescope (IACT) works, introducing the science of VHE cosmic radiation.\r\nWe will summarize the main difficulties in organizing this event and the feedback we had from the visitors. The exhibit is still available online, visiting the website mostrascientifica.it or listening to the scientific audio-guide (English and Italian) at guida.mostrascientifica.it.'

Collaborations

Keywords and Comments
'Astro-photography; exhibit; exposition; iact; outreach; web-app; Physicalpub;', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Completing Aganta Kairos: Capturing Metaphysical Time on the Seventh Continent

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 582

Presenter
Jim Madsen
Author and Co-Author
Jim Madsen | Laurent Mulot | Christian Spiering, Andrea Dixon | John Hardin | Josh veitch-michaelis | Martin Wolf

Abstract
'This presentation will provide an overview of the art project Aganta Kairos (To Fish the Metaphysical Time). It celebrates the neutrino, the ghost particle, which is considered as a cosmic messenger by scientists, and as a link between people who care about their relationship to the cosmos and question their origins, for the artist. The artwork is based on a performance of celebration and seeks to build a human community crossing different knowledges and interpretations of the universe. This crossing of knowledges is realized during the performance of placing the plaque, held with witnesses, and during subsequent exhibitions. Images, sounds, videos and sculpture testify to the diversity of approach to questioning our origins ranging from traditional western science to ancient shamanism. The sites were selected to cover the globe and, for the South Pole, Mediterranean and Lake Baikal, their connection to ongoing neutrino experiments. In December 2020, a plaque was installed at South Pole IceCube Laboratory, the seventh and final site. Images and video from the South Pole installation will be featured.'

Collaborations
IceCube,

Keywords and Comments
", "

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Neutrino Education, Outreach and Communications Activities: Captivating Examples from IceCube

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 29 Outreach online | O&E
Presenter Forum Table

Presenter
Madeleine O'Keefe
Author and Co-Author
Jim Madsen | Katherine Shirey | Jocelyn Argueta | Ellen Bechtol | Madeleine O'Keefe,

Abstract
'The IceCube Neutrino Observatory at the South Pole has tremendous emotional appeal—the extreme Antarctic environment coupled with the aura of a pioneering experiment that explores the universe in a new way. However, like with most cutting-edge experiments, it is still challenging to translate the exotic, demanding science into accessible language. We present three examples of recent successful education, outreach, and communication activities that demonstrate how we leverage efforts and sustain connections to produce engaging results. We describe our participation in the PolarTREC program that pairs researchers with educators to provide deployments in the Antarctic and how we have sustained relationships with these educators to produce high quality experiences to reach target audiences even during a pandemic. We focus on three examples from the last year: a summer enrichment program for high school students that was also modified for a 10-week IceCube after school program, a virtual visit to the South Pole for the ScienceWriters 2020 conference, and a series of short videos in English and Spanish suitable for all ages that explain traveling, living, and working at the South Pole.'

Collaborations
IceCube,

Keywords and Comments
", "

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Towards Equitable, Diverse, and Inclusive science collaborations: The Multimessenger Diversity Network

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 583

Presenter
Ellen Bechtol
Author and Co-Author
Jim Madsen | Ellen Bechtol,

Abstract
'The Multimessenger Diversity Network (MDN), formed in 2018, extends the basic principle of multimessenger astronomy – that working collaboratively with different approaches enhances understanding and enables previously impossible discoveries – to equity, diversity, and inclusion (EDI) in science research collaborations. With support from the National Science Foundation INCLUDES program, the MDN focuses on increasing EDI by sharing knowledge, experiences, training, and resources among representatives from multimessenger science collaborations. Representatives to the MDN become engagement leads in their collaboration, extending the reach of the community of practice. An overview of the MDN structure, lessons learned, and how to join will be presented.'

Collaborations
IceCube,

Keywords and Comments
'Equity; Diversity; Inclusion', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

The 2021 Open-Data release by the Pierre Auger Collaboration

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 30 Schools and tools | O&E
Presenter Forum Table

Presenter
Viviana Scherini
Author and Co-Author
Viviana Scherini | for the Pierre Auger Collaboration,

Abstract
'The Pierre Auger Observatory is used to study the extensive air-showers produced by cosmic rays above 10^{17} eV. The Observatory is operated by a Collaboration of more than 400 scientists, engineers, technicians and students from more than 90 institutions in 18 countries.\r\n\r\nThe Pierre Auger Collaboration is committed to the public release of data for the purpose of re-use by a wide community including professional scientists, in educational and outreach initiatives, and by citizen scientists. \r\n\r\nThe 2021 Open Access release of data collected at the Observatory consists of 10% of the samples used for results reported at the International Cosmic Ray Conference 2019. This fraction amounts to more than 20000 showers measured with the surface-detector array and more than 3000 showers recorded simultaneously by the surface and fluorescence detectors. Data are available in pseudo-raw (JSON) format and as a summary CSV file containing the reconstructed parameters.\r\n\r\nA dedicated website is used to host the datasets that are available for download. Their detailed description, along with auxiliary information needed for data analysis, are given. An online event display is also available. Simplified codes derived from the ones used for published analyses are provided by means of Python notebooks prepared to guide the reader to an understanding of the physics results. \r\n\r\nIn this paper, we describe the data that is being released, discuss the notebooks available and show some of the material that is immediately accessible to the user at https://www.auger.org/opendata.'

Collaborations
Auger,

Keywords and Comments
'Ultra-high energy cosmic rays; Pierre Auger Observatory; Open-data release; Surface detector and hybrid datasets; Reconstructed open data; Raw open data; Data and analysis tools; Events visualization;', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

The Fermi Masterclass Online Edition 2020

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 29 Outreach online | O&E
Presenter Forum Table

Presenter
Silvia Raino
Author and Co-Author
Francesco Longo | Davide Serini | Raffaella Bonino | Pasquale Lubrano | Dario Gasparrini | Sara Cutini | Luca Latronico | Leonardo Di Venere | Mario Nicola Mazziotta | Francesco Loparco | Isabella Mereu | Fabio Gargano | Elisabetta Bissaldi | Francesco de,

Abstract
'The Fermi Masterclass is an international outreach event designed to give high-school students the unique opportunity to discover the world of High-Energy Astrophysics. Since 2017, various Italian universities and research institutes, guided by the National Institute for Nuclear Physics (INFN), organized a "full immersion" day of dedicated lectures and exercises in which students analysed real data collected by the LAT experiment aboard the Fermi satellite. Over the years, foreign institutes from Slovenia, Sweden and the U.S. also joined the effort, giving the students the unique opportunity to interact with each other as in real international collaborations.\r\nThe 4th edition of the Fermi Masterclass was scheduled to take place in April 2020. However, due to the pandemic emergency, the Masterclass was initially postponed, and finally took place as an online edition on December 10th, 2020.\r\nHere we present the structure and organization of this first virtual event, including an interactive part of exercises accessible to the students through dedicated web platforms.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'School projects', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

2’ science: A Science Communication Project for Astrophysics

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 29 Outreach online | O&E
Presenter Forum Table

Presenter
Dimitrios Kantzas
Author and Co-Author
Dimitrios Kantzas | Stella Boula | Marios Kalomenopoulos,

Abstract
"Two-minute science (2'science) is a science communication project supported by early-career Greek astrophysicists. With this endeavor, which started in December 2020, we try to bridge the gap between the scientific community and the public. This project is based on the simple idea of writing short articles with an approximate reading time of two minutes. These articles cover several topics and their difficulty scales to cover a broad audience range, from young students to experienced adults. We support the idea of “ask an expert” in astrophysics in Greece, where any reader can pose a question. We offer the appropriate answer either by writing it ourselves or by contacting the field experts from the Greek astronomical society. Furthermore, our previous science communication experience leads us to design educational activities for students and/or adults based on pedagogical means. A successful one was an “escape-zoom” titled “Escape to Other Worlds”, a digital version of an escape room. Further activities are astronomy workshops for teenagers, online talks to schools, and our participation in a scientific podcast to trigger the public interest in astrophysics. We communicate this work through social media, where several thousands of people already follow our work."

Collaborations

Keywords and Comments
'outreach; science communication; 2sciencegr;', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

#meetTheMAGICians: Science communication and visibility of young researchers

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 29 Outreach online | O&E
Presenter Forum Table

Presenter
Juliane van Scherpenberg
Author and Co-Author
Juliane van Scherpenberg, Marina Manganaro | Alicia López-Oramas | on behalf of the MAGIC collaboration

Abstract
'Among the many activities organized by the Outreach working group of the MAGIC (Major Atmospheric Gamma-ray Imaging Cherenkov) Collaboration, we would like to present the ongoing project #meetTheMAGICians. Under this hashtag, used on our social media pages (@MAGICtelescopes), we collect live streaming events on astroparticle physics topics, series of social media posts, videos and other contents. In addition to increasing the visibility of the MAGIC collaboration, a central goal of #meetTheMAGICians is to strongly connect the communication of our science to the individual achievements of our researchers. It is a community-wide challenge to increase the individual recognition of early career scientists in large international science collaborations. In this project, we give young members of the MAGIC collaboration the chance to increase their visibility in the astroparticle community by highlighting their individual contributions to our research. At the same time, we aim to communicate to the general public how exciting and diverse astroparticle physics can be, and to stimulate in young students the curiosity towards the extreme Universe. We will present an overview on the present status of the project, and an analysis of both successes and remaining challenges.'

Collaborations
MAGIC,

Keywords and Comments
'outreach; science communication; social media; early career scientist; visibility; researchers; live streams', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

A scientific and educational experience to engage high school students to gamma-ray physics

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 586

Presenter
Carla Aramo
Author and Co-Author
Carla Aramo | Piera Romano,

Abstract
'In this paper we introduce an original scientific and educational experience conducted with Italian 16/17 years-old students attending Scientific Lyceum "Mangino" of Pagani (Italy). It was inserted in an Italian Educational Program PCTO (i.e. Percorsi per le Competenze Trasversali e per l\'Orientamento), active in High Schools on a national level, with the aim to make students consolidate and expand the curricular content’s knowledge via internships in private or public working environments. For this specific item, concerned CTA-PCTO (Cherenkov Telescope Array-PCTO), the students, led by a teacher and an INFN researcher, venture out into the innovative technology and the future scientific achievements of CTA, which will be the first ground-based gamma-ray observatory and the world’s most sensitive and powerful gamma-ray instrument. All the activities carried out during the CTA-PCTO were organized as an action-research to develop an alternative, effective, and motivating approach to the study of astroparticle physics, and in particular of gamma-ray physics. In this way students benefited to the scientific and technology information of CTA and its telescopes, and they were engaged in producing different didactic items, also useful to introduce CTA technologies to other students. They created a paper model of the CTA\'s Large-Sized Telescope (LST), realized a crossword puzzle and write an article, and finally, they presented their work to the general public during the "European Researchers\' Night" in November 2020. The mere need to report their results has produced remarkable results in their ability to write and communicate on scientific items.'

Collaborations
CTA,

Keywords and Comments
'gamma-ray; CTA; didactic', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Making cosmic particle accelerators visible and audible

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 587

Presenter
Stefan Ohm
Author and Co-Author
Stefan Ohm | Konrad Rappaport | Carsten Nicolai | Till Mundzeck, Matthias Fuessling | Sylvia Jiechen Zhu | Andrew Taylor | Dan Parsons

Abstract
'In a collaboration between astroparticle physicists, animation artists from the award-winning Science Communication Lab, and musician Carsten Nicolai (a.k.a. Alva Noto), two cosmic particle accelerators have been brought to life: the massive binary star Eta Carinae, and the exploding star, which resulted in the gamma-ray burst GRB190829A. For Eta Carinae, the computer-generated images are close to reality because the measured orbital, stellar and wind parameters were used for this purpose. Particle acceleration in the jet of GRB190829A has also been animated at a level of detail not seen before. The internationally acclaimed multimedia artist Carsten Nicolai, who uses the pseudonym Alva Noto for his musical works, exclusively composed the sound for the animations. The multimedia projects aim at making the discoveries more accessible to the general public, and to mediate scientific results and their reference to reality from an artistic point of view.'

Collaborations

Keywords and Comments
'', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

The REINFORCE Project

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 588

Presenter
Rémy Le Breton
Author and Co-Author
Rémy Le Breton, Vincent Bertin | Paschal Coyle | Gwenhaël De Wasseige | Hervé Glotin | Carlo Guidi | Feifei Huang | Séverine Martini | Antoine Kouchner | Christian Tamburini | Véronique Van Elewyck

Abstract
'Large research infrastructures have opened new observational windows, allowing us to study the structure of matter up to the entire Universe. However, society hardly observes these developments through education and outreach activities. This induces a gap between frontier science and society that may create misconceptions about the content, context, and mission of public funded science.\r\n\r\nIn this context, the main goal of the European Union’s Horizon 2020 “Science with and for Society” REINFORCE project (REsearch INfrastructure FOR Citizens in Europe) is to minimize the knowledge gap between large research infrastructures and society through Citizen Science. A series of activities is being developed on the Zooniverse platform, in four main fields of frontier physics involving large research infrastructures: gravitational waves with the VIRGO interferometer, particle physics with the ATLAS detector at LHC, neutrinos with the KM3NeT telescope, and cosmic rays at the interface of geoscience and archeology. Using real and simulated data, Citizen Scientists will help building a better understanding of the impact of the environment on these very high precision detectors as well as creating new knowledge. \r\n\r\nThis poster describes the REINFORCE project, with a special emphasis on the Deep Sea Hunter demonstrator involving the KM3NeT neutrino telescope, in order to show practical examples of Citizen Science activities that will be proposed through the project.'

Collaborations
KM3NeT, REINFORCE

Keywords and Comments
'REINFORCE; Citizen Science; Zooniverse', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

“A scuola di Astroparticelle”: a synergy between school education and scientific research

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 589

Presenter
Roberta Colalillo
Author and Co-Author
Roberta Colalillo | Carla Aramo | for OCRA Collaboration (https://web.infn.it/OCRA/collaborazione/),

Abstract
"The outreach program “A scuola di Astroparticelle” was proposed in 2016 by the\r\nNational Institute of Nuclear Physics (INFN – Napoli Division) in collaboration with the Physics Department “Ettore Pancini” of the Federico II University in Napoli, CNR-SPIN and CNR-ISASI Institutes. Its main goal is to engage teachers and students of High Secondary Schools in astroparticle physics projects. For the third edition (2018/19), the activities, which are also part of the Italian Educational Program PCTO – “Percorsi per le Competenze Trasversali e per l'Orientamento”, involved 18 schools for a total of 21 projects on several topics. Some projects were strictly related to astroparticles as cosmic rays, while others were more technical, as the development of particle detectors, or cross-disciplinary projects. Students worked for the entire school year and prepared for the final event. More than 600 students attended the event and presented their work to a jury with a poster and an oral presentation in plenary sessions.\r\nSince 2018, the program is part of OCRA - Outreach Cosmic Ray Activities - a national outreach project of INFN with the aim of collecting, within a common framework, the numerous outreach activities in cosmic-ray field carried out at the local level.\r\nThe fourth edition (2019-20), in spite of the difficult situation due to the COVID-19 pandemic, has also seen the participation of 22 schools that carried out part of the activities in an online format. \r\nSome projects will be presented in detail as the one performed using public data of the Pierre Auger Observatory."

Collaborations
other (fill field below), OCRA Collaboration - https://web.infn.it/OCRA/collaborazione/

Keywords and Comments
'school project; astroparticle; Auger Observatory public data', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

MoCRiS a low-cost stratospheric balloon platform to measure the particle flux of cosmic ray showers in the high atmosphere.

Time 19 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 30 Schools and tools | O&E
Presenter Forum Table

Presenter
Valerio Bocci
Author and Co-Author
Valerio Bocci | Antonino Brosio | Gabriele Galbato | Francesco Iacoangeli | Domenico Liguori | Maria Antonella Tripodi | For the OCRA collaboration,

Abstract
'In June 2019 from the region of Calabria (Italy) our group launched the Stratospheric Balloon MoCRiS (Measurement of Cosmic Ray in Stratosphere) that reached up to 35111 meters. MoCRiS is a didactical project that uses a Light Balloon with a payload of only 2.7 Kg payload box included. The capsule is Lithium-ion batteries operated and fully instrumented with sensors for temperature and pressure, two Hi-Res Camera for pictures and videos, GPS tracker and two ArduSiPM scintillation detectors, made by the INFN group in Rome, used to measure particles flow. ArduSiPM is very economical, light (<150 g), and with low power consumption (<1 Watt). These characteristics are optimal for balloons and “in space” applications (e.g. CubeSat), and very attractive for educational use, even on the ground. During the school year, the students of the scientific high school "Stefano Patrizi" (at Cariati, Cosenza, Italy), participated in the definition of the project by following theoretical and practical lessons on aerospace techniques and particle physics with particular regard to cosmic ray showers in atmosphere. The mission was completely successful by experimentally verifying the pressure-to-height relation, the height of the thermal inversion in the atmosphere, reaching and exceeding the maximum Regener-Pfotzer level of the shower development. The instrumental and didactic platform created is easily replicable even with upgrades. We are expanding the collaboration with other schools for further launches. MoCRiS is an activity of OCRA (Outreach Cosmic Ray Activities) project, a platform of INFN for all outreach activities focusing on cosmic rays.'

Collaborations

Keywords and Comments
'Scintillator; SiPM; Instrumentation;Stratosphere measurements;outreach;school projects', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Astronomy Outreach and Education in Namibia: H.E.S.S. and beyond

Time 13 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 29 Outreach online | O&E
Presenter Forum Table

Presenter
Hannah Dalgleish
Author and Co-Author
Hannah Dalgleish, Heike Prokoph | Garret Cotter | Michael Backes | Eli Kasai

Abstract
'Astronomy plays a major role in the scientific landscape of Namibia. Because of its excellent sky conditions, Namibia is not only frequently visited by astrophotographers but is also home to ground-based observatories like the High Energy Spectroscopic System (H.E.S.S.), in operation since 2002. Located near the Gamsberg mountain, H.E.S.S. performs groundbreaking science by detecting very-high-energy gamma-rays from many different objects. The fascinating stories behind many of them are featured regularly in the “Source of the Month”, a blog-like format intended for the general public with more than 170 features so far. Together with this digital format, H.E.S.S. outreach activities have always been covered locally, e.g. via ‘open days’ and guided tours on the H.E.S.S. site itself. An overview of the H.E.S.S. outreach activities will be presented in this contribution, along with discussions relating to the current landscape of astronomy outreach and education in Namibia. We will also touch on some of the significant activity in the country in recent months, which aims to use astronomy as a means for capacity-building and sustainable development. Finally, as we take into account the future prospects of radio astronomy in the country, momentum for a wider range of astrophysics research is clearly building – this presents a great opportunity for the astronomy community to come together to capitalise on this movement and further support astronomy outreach and education in Namibia.'

Collaborations
H.E.S.S., AMT

Keywords and Comments
'outreach; education; sustainable development; capacity-building; Namibia; Africa', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Students work like astroparticle physicists with Cosmic@Web

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 592

Presenter
Philipp Lindenau
Author and Co-Author
Philipp Lindenau | Carolin Schwerdt | Michael Walter,

Abstract
'Cosmic@Web is an online learning resource developed at DESY Zeuthen, Germany as part of the outreach activities in the framework of Netzwerk Teilchenwelt. Via Cosmic@Web, high school and university students can access data from astroparticle physics experiments and experience the workflow of scientific research in this field by pursuing their own or suggested research questions. Data from various experiments located in different areas of the world can be used to study cosmic weather effects and muon properties. The analysis can be performed without any coding experience. The graphical interface allows to visualize data in several plot types and offers possibilities of data fitting as well as data reduction and corrections.\r\nSo far Cosmic@Web has been used by German high school students during internships at research institutes like DESY, for a research component as part of their high school degree as well as within projects in software development and coding.\r\nThis talk will present examples of workflow with Cosmic@Web, particularly linking aspects of astroparticle physics – especially the measurement of cosmic muons – with other established contents of high school physics curricula. Furthermore, the acceptance of the tool by students and teachers as well as their feedback during and after its introduction in dedicated training workshops will be discussed.'

Collaborations
other (fill field below), Netzwerk Teilchenwelt

Keywords and Comments
'high school; data analysis; experiment; learning ressource; muons; Cosmic@Web; Netzwerk Teilchenwelt', ''

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Technological semiotic mediators in didactic to approach cosmic rays and improve students' scientific knowledge

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 593

Presenter
Ilaria VERONESI
Author and Co-Author
Francesco Saverio Tortoriello | Roberta Colalillo | Ilaria VERONESI | Carla Aramo,

Abstract
'The “Mathematical High School” research project is an extracurricular educational path dedicated to high school students developed by the Department of Mathematics of the University of Salerno (Italy). In this context, an experimental research-laboratory in the field of astroparticle physics was presented in collaboration with the National Institute of Nuclear Physics (INFN) – Napoli Division (Italy). The laboratory activities concerned the analysis of the data detected by the Cosmic Ray Cube (CRC), a muon detector designed in the Gran Sasso (Italy) laboratories together with a dedicated software for the data acquisition, available also for mobile devices. The pandemic emergency due to covid-19 and the consequent closure of schools with the activation of distance learning, led the researchers and teachers involved in the laboratory activities, to re-elaborate and develop the activities in a convenient format for e-learning platforms. The course also pursued to create a bridge between the worlds of research, universities and schools, to aim at creating the necessary synergies needed to stimulate and to activate participation of students, also with the use of the most recent scientific discoveries.\r\nThe didactic impact of the activities will be illustrated in this work. It will describe not only the involvement in the development of fascinating topics not usually carried out in Italian curricula, but also the skills acquired thanks to the development of interdisciplinary themes that highlight how the different fields of the scientific world such as mathematics, physics, chemistry, astrophysics, engineering, cooperate for the advancement of knowledge in research.'

Collaborations

Keywords and Comments
'Technology-enhanced learning; interdisciplinarity; astroparticle physics; mathematics', ''

Conference Office icrc2021@desy.de
Webpage icrc2021.desy.de

Branch O & E | Outreach and Education

Subcategory Outreach and Education

Draw me a Neutrino: the first art contest organized by the KM3NeT Collaboration

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 594

Presenter
Marco Circella
Author and Co-Author
Meriem Bendahman | Juande Zornoza | Marco Circella | Gogita Papalashvili | Revaz Shanidze | Gwenhaël De Wasseige | Jessica-Sheay Verrall | Harold Yepes Ramirez | Tzamarioudaki Katerina | Paschal Coyle | Cristiano Bozza | Soebur Razzaque | Sara Rebecca Go,

Abstract
'While the KM3NeT neutrino detector is currently being deployed in the Mediterranean Sea, the Collaboration has been searching for illustrations of the neutrinos it will detect. The participants to the contest were invited to submit their best interpretation of a neutrino using any technique or support. Each neutrino flavour corresponded to a different age category. \r\nMore than 500 drawings were submitted from 16 different countries and the winners were selected based on the originality and creativity of the realization, as well as the harmony with the properties and origin of the neutrinos.\r\nAfter announcing the results in an online ceremony with the participation of a large international audience, the winning drawings have been put on display in a dedicated KM3NeT Virtual Neutrino Art Centre.\r\nIn this contribution, we will review the interest and motivation for a large experimental collaboration to organize such a contest. We will also present the results of an impact study carried out during the contest.'

Collaborations
KM3NeT,

Keywords and Comments
'neutrino astronomy; drawing contest', ''

Branch	O_Exhibition
Subcategory	Industry Fair

CAEN s.p.a.

Time
Session
Presenter Forum Table 511

Presenter
Ferdinando Giordano
Author and Co-Author
Ferdinando Giordano,

Abstract
'/'

Collaborations

Keywords and Comments
", "

Branch O_Exhibition

Subcategory Industry Fair

Amsterdam Scientific Instruments B.V.

Time
Session
Presenter Forum Table 512

Presenter
Hans Radhoe
Author and Co-Author
Hans Radhoe,

Abstract
'/'

Collaborations

Keywords and Comments
", "

Branch O_Exhibition

Subcategory Industry Fair

Hamamatsu Photonics Deutschland GmbH

Time
Session
Presenter Forum Table 513

Presenter
Christoph Seibel
Author and Co-Author
Christoph Seibel,

Abstract
'/'

Collaborations

Keywords and Comments
'', ''

Branch O_Exhibition

Subcategory Science Fair

International Elementary Particle Laboratory/STEAM Program

Time
Session
Presenter Forum Table 514

Presenter
Waleska Aldana Segura
Author and Co-Author
Waleska Aldana Segura | Felix Julian,

Abstract
'International Elementary Particle laboratory working with STEAM program to promote science advocacy, awareness and interest.\r\nWe present the International Elementary Particle Laboratory where new pedagogical models have been established successfully. Over the last 15 years, the laboratory participates in significant International Collaborations like DUNE and MINERvA of the Fermi National Accelerator Laboratory and prominent outreach programs like STEAM Program binationally with Guatemala.\r\nThe hands-on model has allowed, during the pandemic, to plan, to design and remotely construct over 30 original prototypes for radiation detection.\r\nAlso, at the same time, outreach strategies have been implemented like the Leon Lederman Seminar Series and participate in online workshops like Falling Walls, Berlin Science Week Physics with presentations like Flight in the Little Prince World.\r\nDuring the Science Fair, we want to introduce a small video to show the work and some preliminary obtained results in the radiation detection innovation.'

Collaborations

Keywords and Comments
", "

ICRC 2021

Conference Office icrc2021@desy.de
Webpage icrc2021.desy.de

Branch O_Exhibition

Subcategory Science Fair

KATRIN outreach from KIT

Time
Session
Presenter Forum Table 515

Presenter
Manuel Klein
Author and Co-Author
Manuel Klein,

Abstract
'Discover the KATRIN experiment online inside your browser!\r\nThe KArlsruhe TRItium Neutrino (KATRIN) experiment performs a model-independent measurement of the electron neutrino mass via the tritium beta spectrum near its energetic endpoint.\r\nKATRIN employs the MAC-E filter principle in a 70 meter long beamline, including a 20 meter long main spectrometer and a high-luminosity tritium source.\r\nThis contribution to the Science Fair takes you on a virtual trip to the KATRIN experiment and shows you the scale and complexity of its beamline in five 3D panoramas.\r\nTake the guided tour (in German) or discover the technology and history of KATRIN in free exploration and at numerous info points – maybe even some scientists from the KATRIN collaboration will drop by and talk about their work.\r\nIn a second application, you can further take an interactive look at the KATRIN detector section and its layered setup.'

Collaborations

Keywords and Comments
'', ''

Branch O_Exhibition

Subcategory Science Fair

The Cherenkov Telescope Array Observatory Virtual Exhibition Experience

Time
Session
Presenter Forum Table 516

Presenter
Alba Fernández-Barral
Author and Co-Author
Megan Grunewald | Alba Fernández-Barral,

Abstract
'The Cherenkov Telescope Array Observatory (CTAO) will be the first ground-based gamma-ray observatory and the world's largest and most sensitive instrument for the exploration of the high-energy Universe. Not only will it break new ground in our understanding of the Universe, it will be the first of its kind to be open to the world-wide astronomical and particle physics communities as a resource for data from unique, very-high energy astronomical observations. The CTAO is launching its new virtual exhibition for the ICRC, which will host a wide variety of materials and multimedia for visitors to explore. Additionally, scheduled live broadcasts or chat sessions with our experts will allow participants to ask questions and discuss the scientific prospects of CTA. And no exhibit would be complete without free giveaways!'

Collaborations

Keywords and Comments
", "

Branch O_Exhibition

Subcategory Science Fair

Exploring the High Energy Universe - a planetarium dome show a introducing the CTA

Time
Session
Presenter Forum Table 517

Presenter
Michael Burton
Author and Co-Author
Michael Burton,

Abstract
'This is a short (10-min) full dome planetarium show which introduces the high energy universe that gamma-ray astronomy probes, and then describes the next generation telescope for the field – the Cherenkov Telescope Array.\r\nThis show was written and produced at the Armagh Observatory and Planetarium (AOP) during the lock down and is designed for the public. It has yet to be shown in our Dome, however, as we are still closed due to Covid.\r\nThis presentation will be a flat-screen projection of the full dome show, which results in a circular field of view with the principal subject matter in the lower portion of the field. Of course this lacks the full immersive experience of being under the dome, nevertheless the story can still be told.\r\nOnce lockdown is over and we are able to play the show in our dome in Armagh we will publicly (and freely) release it worldwide via the Digistar cloud, so that it may be played in any Digistar planetarium. \r\nScript Michael Burton, production PhD student Kerem Osman Cubuk, Narration Senior Education Officer Heather Alexander, all of the Armagh Observatory and Planetarium.'

Collaborations
CTA,

Keywords and Comments
'', ''

Branch O_Exhibition

Subcategory Science Fair

Doing your PhD in Multimessenger Astronomy

Time
Session
Presenter Forum Table 518

Presenter
Wiebke Schubotz
Author and Co-Author
Wiebke Schubotz,

Abstract
'Hello there!\r\nWe want to introduce you to the International Helmholtz-Weizmann Research School for Multimessenger Astronomy (MMS)! The topic of multimessenger astronomy, the exploration of the Universe using a multitude of cosmic messengers, has led to several groundbreaking discoveries during the last few years. Thus, the MMS was opened in 2019 and serves as a platform for a coordinated PhD on this topic. It offers a world-class international training environment with theoretical and experimental expertise in the various messengers (electromagnetic radiation, neutrinos, gravitational waves, cosmic particles). It is an international school with partner institutions in Germany (DESY, University of Potsdam, Humboldt University) and Israel (Weizmann Institute of Science). The collaboration between students and researchers is facilitated through various meetings and events. As a MMS student you will have access to data from leading observatories such as the Cherenkov Telescope Array, the IceCube neutrino observatory or the Zwicky Transient Facility. An accompanying course program and planned exchange visits (once COVID-19 is over) offer the chance for professional and personal qualification. The next round of applications will start in October 2021. For more information, visit our website or talk to us at ICRC 2021!'

Collaborations
, The International Helmholtz-Weizmann Research School for Multimessenger Astronomy

Keywords and Comments
'', ''

Branch O_Exhibition

Subcategory Science Fair

The Einstein Telescope – the next-generation gravitational wave observatory

Time
Session
Presenter Forum Table 519

Presenter
Achim Stahl
Author and Co-Author
Achim Stahl | Harald Lück,

Abstract
'Based on the success of the current generation of gravitational wave detectors, we are planning the construction of a new observatory with 10-fold sensitivity and an extended frequency range. It is called the Einstein Telescope. It is a new research infrastructure designed to observe the entire Universe using gravitational waves. ET will be a multi-interferometer observatory covering the whole gravitational wave spectrum observable from Earth. It will achieve a greatly improved sensitivity by increasing the size of the interferometer from the 3km arm length of the Virgo detector to 10km and by implementing a series of new technologies. These include a cryogenic system to cool some of the main optics to 10 – 20K, new quantum technologies to reduce the fluctuations of the light, and a set of infrastructural and active noise-mitigation measures to reduce environmental perturbations.\r\nPlease visit us, to discuss about the science and technologies of the project.'

Collaborations
, Einstein Telescope

Keywords and Comments
", "

Branch O_Exhibition

Subcategory Science Fair

Making cosmic particle accelerators visible and audible

Time
Session
Presenter Forum Table

Presenter
Stefan Ohm
Author and Co-Author
Stefan Ohm,

Abstract
'In a collaboration between astroparticle physicists, animation artists from the award-winning Science Communication Lab, and musician Carsten Nicolai (a.k.a. Alva Noto), two cosmic particle accelerators have been brought to life: the massive binary star Eta Carinae, and the exploding star, which resulted in the gamma-ray burst GRB190829A. For Eta Carinae, the computer-generated images are close to reality because the measured orbital, stellar and wind parameters were used for this purpose. Particle acceleration in the jet of GRB190829A has also been animated at a level of detail not seen before. The internationally acclaimed multimedia artist Carsten Nicolai, who uses the pseudonym Alva Noto for his musical works, exclusively composed the sound for the animations. The multimedia projects aim at making the discoveries more accessible to the general public, and to mediate scientific results and their reference to reality from an artistic point of view'

Collaborations

Keywords and Comments
'', ''

Branch O_Exhibition

Subcategory Science Fair

HIRSAP – the Helmholtz International Research School for Astroparticle Physics and Enabling Technologies

Time
Session
Presenter Forum Table

Presenter
Irmgard Langbein
Author and Co-Author
Katrin Link | Irmgard Langbein,

Abstract
'HIRSAP is a graduate school of the Karlsruhe Institute of Technology (KIT) in Germany and the Universidad Nacional de San Martín (UNSAM) in Buenos Aires, Argentina and was installed in April 2018.\r\nIt is dedicated to the development and application of cutting-edge particle detection techniques and corresponding analysis methods in high-energy astroparticle physics.\r\nMore than 20 students from Karlsruhe and Buenos Aires are working together with leading physicists and engineers in the fields of particle detection technologies, data analysis, simulation, and model building. A key element of HIRSAP is the close cooperation of the partner institutes and the joint supervision of PhD students from both universities. PhD students are staying twice for several months at the respective partner institute which gives them the option of receiving Double Doctoral Degree of both universities. \r\nAnother key element is the truly international and structured doctoral education program. Courses are offered that range from broad overview lectures to highly specialized hands-on classes at research level.'

Collaborations

Keywords and Comments
'', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Application of the verified neutron monitor yield function for GLE analysis

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 441

Presenter
Alexander Mishev
Author and Co-Author
Alexander Mishev, Ilya Usoskin | Sergey Koldobsky | Gennady Kovaltsov, | Leon Kocharov

Abstract
'Systematic studies of solar energetic particles (SEPs) provide a basis to understand their acceleration and propagation in the interplanetary space. During solar eruptive processes, such as solar flares and/or coronal mass ejections solar ions can be accelerated to high energy. In the majority of cases, the maximum energy of the accelerated solar ions is several tens of MeV/nucleon, but sometimes it exceeds 100 MeV/nucleon and can even reach GeV/nucleon range. In this case, the energy is sufficiently high to initiate an atmospheric cascade in the Earth’s atmosphere, whose secondary particles can reach the ground, being eventually registered by ground-based detectors, specifically neutron monitors. This particular class of events is known as ground-level enhancements (GLEs). Several methods for analyses of GLEs, using neutron monitor data were developed over the years. Here, we present a method for assessment of the spectral and angular features of the GLEs using data from the world-wide neutron monitor (NM) network, namely by modeling the global NM network response with the new verified yield function. The method is based on consecutive steps, specifically detailed computations of asymptotic acceptance cones and geomagnetic cut-off rigidity for each station used in the analysis and optimization of the global NM network response over experimental and modeled count rate increase. The method is compared with other methods, including in-situ measurements of SEPs. A very good agreement between our method and space-borne measurements performed by PAMELA space probe, specifically the derived fluence of solar protons during GLE 71 was achieved, confirming verification of the method.'

Collaborations

Keywords and Comments
'ground level enhancement; neutron monitor; data analysis', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Pulse height-length analysis of data from neutron monitors DOMC/DOMB with a new data acquisition system

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 442

Presenter
Stepan Poluianov
Author and Co-Author
Markus Similä, Ilya Usoskin | Stepan Poluianov | Alexander Mishev | Gennady Kovaltsov, | Du Toit Strauss

Abstract
'Two high-altitude polar neutron monitors DOMC and DOMB (Dome C, Concordia station, Antarctic plateau, 3233 m a.s.l.) received a major electronics upgrade in 2019. While a typical standard neutron monitor data acquisition (DAQ) system only registers the number of pulses from a cosmic-ray particle detector, the new system digitizes all pulses with 2 MHz sampling rate and stores this information in raw data files. This feature makes it possible to conduct a pulse height-length analysis of the neutron monitor data on a routine basis. In this study, we have analysed several months of the cosmic-ray data recorded with the new DAQ system during 2019-2020 (more than 10 million pulses). We identified several pulse branches corresponding to different processes: (a) secondary particles from individual cosmic-ray cascades, (b) noise, (c) double pulses originated from particles of the same local cascade, (d) high multiple pulses likely related to atmospheric muons, (e) double pulses potentially caused by contamination by neutrons scattered in the neighbouring instrument. We also studied the waiting time distributions of pulses and have shown that two peaks can be clearly distinguished: (1) at about 1 millisecond, which is related to the intra-cascade particles, and (2) at 30-1000 milliseconds related to different uncorrelated cosmic-ray cascades. Our conclusions are supported by theoretical estimates of the waiting times in different scenarios.'

Collaborations

Keywords and Comments
'neutron monitor; multiplicity; DOMC; DOMB;', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Analyses of the Secondary Cosmic Ray using CCD camera in high-altitude observatories and Antarctica stations

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 22 Atmospheric effects of CR | SH
Presenter Forum Table

Presenter
guillaume hubert
Author and Co-Author
guillaume hubert,

Abstract
'Charge-Coupled Device (CCD) and Array Pixel Sensors (APS) can be used to image radiation-induced energy deposition. The high sensitivity of depleted silicon to ionizing radiation constitutes an opportunity to investigate radiation effects while it is a nuisance to astronomer activities. CCD and APS provide a better combination of spatial and intensity resolution for radiation events than other available types of detector. \r\nThis paper proposes to analyze radiation events observed in the CCD camera and more specifically analyses of charge deposition spectra and spatially extensive events. Measurements were performed in the Pic du Midi from 2011 to 2015 and in the Concordia Antarctica station since 2018. Coupled transport models (i.e. particle transport and charge transport in semiconductors) allow investigating contributions to charge collection spectra as a function of the particle nature, i.e. neutron, proton and muon. \r\nCoupled measurements and simulations allow to access to the detected secondary CR flux and the charge deposition pattern. Results showed that high charge level events seen on atmospheric sites can be considered as hadronic component (mainly neutrons and protons) while low charge levels and punctual events are induced by muons which are able to generate up to 3 fC in the CCD camera. Hence, thanks to double level of measurement sites, muon discrimination from other secondary particles has been investigated. Cross-comparison analyses based on CCD and neutron spectrometers operated in both station/observatory investigate secondary CR dynamic.'

Collaborations

Keywords and Comments
", "

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Simultaneous observation of cosmic rays with muon detector and neutron monitor at the Syowa station in the Antarctic

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 24 Ground-based measurements of low-energy GCRs | SH
Presenter Forum Table

Presenter
Chihiro Kato
Author and Co-Author
Chihiro Kato, Shoko Miyake | Kazuoki Munakata | Ryuho Kataoka | Paul Evenson | Shunta Asano | Akira Kadokura

Abstract
'Since February 2018, simultaneous observation of cosmic ray (CR) muon and neutron is continued. The operation is quite stable and its duty cycle is higher than 94%. These detectors are showing their usefulness by responding to, for example, a peculiar CME event in August 2018. There is another interesting event in September 2019. A Sudden Stratospheric Warming (SSW) was observed and muon counts responded to the SSW. This response is caused by that muon counts on the ground are affected by high altitude temperature. Temperature effect on CR muon now can be corrected with high altitude temperature data. There is, however, some matter of research about how the method works. This event seems to be valuable to improve correction method. We describe a character of muon and neutron data accumulated during the last three years and discuss potential use in studying atmospheric effect on CR muon and neutron count rates.'

Collaborations

Keywords and Comments
'cosmic ray;atmospheric effect;', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Multiple Particle Detection in a Neutron Monitor

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 24 Ground-based measurements of low-energy GCRs | SH
Presenter Forum Table

Presenter
Paul Evenson
Author and Co-Author
Paul Evenson | John Clem | Pierre-Simon Mangeard | David Ruffolo | Alejandro Sáiz | Achara Seripienlert | Seunarine Surujhdeo,

Abstract
'Magnetic activity on the sun influences the flux of galactic cosmic rays at Earth in the process known as solar modulation. While most pronounced at 1 GeV and below, it also operates at much higher energy, still exhibiting solar magnetic polarity dependence. An observational gap exists between approximately 18 GeV (the highest geomagnetic cutoff) neutron monitor data and greater than 50 GeV muon observations. Detecting multiple neutrons from the same primary particle has recently been used to monitor the primary energy spectrum using data from a single neutron monitor. Over the past few years we have used details of the timing distribution from individual neutron detectors and pairwise correlations among adjacent detectors to improve the energy resolution of this technique. We present a further extension of our observations to pattern recognition of events comprising hits in multiple detectors in order to identify and study cases where more than one secondary particle from the same primary interacts in the neutron monitor. Our particular focus at present is to separate interactions of energetic hadrons from those generated by cores of small air showers.'

Collaborations

Keywords and Comments
'Solar Modulation; Neutron Monitor', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

A major update of the International GLE Database: Correction for the variable GCR background

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 443

Presenter
Ilya Usoskin
Author and Co-Author
Ilya Usoskin | Sergey Koldobskiy | Gennady Kovaltsov | Agnieszka Gil | Inna Usoskina | Teemu Willamo | Askar Ibragimov,

Abstract
'The main detector to provide data to study highly energetic (above ~400 MeV) solar particles is the network of ground-based neutron monitors (NMs). Solar events recorded on the ground are called ground-level enhancements (GLEs). All GLE-related data from the NM network are collected in the International GLE Database (IGLED, https://gle.oulu.fi), which provides formal NM count-rate increases above the constant pre-increase level which is due to galactic cosmic rays (GCR). However, the basic formal assumption that the GCR background level remains constant throughout a GLE event is often violated. We have carefully revised the IGLED and provided a new data set of detrended NM count-rate increases that accounts for the variable GCR background. This had led to a significant revision of the corresponding integral omnidirectional fluences of solar particles reconstructed from the GLE data. The database of the detrended NM count rate is revised for most GLE events since 1956. Integral omnidirectional fluences were re-assessed for 58 GLE events and parametrised for 52 reasonably strong events by applying the modified Ellison-Ramaty spectral shape. This forms the basis for more precise studies of parameters of SEP events and thus for solar and space physics.'

Collaborations

Keywords and Comments
'Neutron monitors; solar energetic particles', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Direct Determination of a Bare Neutron Counter Yield Function

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 444

Presenter
Waraporn Nuntiyakul
Author and Co-Author
Waraporn Nuntiyakul, Pierre-Simon Mangeard | David Ruffolo | Paul Evenson | John Bieber | John Clem | Allan Hallgren | James Madsen | Roger Pyle | Alejandro Sáiz | Serap Tilav

Abstract
"Ground-based neutron counters are a standard tool for detecting atmospheric showers from GeV range primary cosmic rays of either solar or galactic origin. Bare neutron counters, a type of lead-free neutron monitor, function much like standard neutron monitors but have different yield functions primarily because they are more sensitive to neutrons of lower energy. When operated together with standard monitors, the different yield functions allow estimates to be made of the energy spectrum of galactic or solar particles. In 2010 a new array of 12 bare neutron detectors was installed at the South Pole to operate together with the neutron monitor there. Prior to installation, two of the detectors were operated on a ship that traveled from Sweden to Antarctica and back from November 2009 to April 2010. The purpose of this latitude survey was to use Earth's magnetic field, which blocks cosmic rays below the local cutoff rigidity (momentum per unit charge), as a spectrometer allowing the response function versus rigidity of these bare counters to be determined. By comparing the measured response function to direct measurements of the cosmic ray spectrum taken by the PAMELA spacecraft, we were able to make a direct determination of the yield function for the bare counters."

Collaborations

Keywords and Comments
'neutron monitor; bare neutron detector; primary cosmic ray spectrum; solar modulation; yield function; latitude survey', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Validation of Monte Carlo Yield Function of a Semi-Leaded Neutron Monitor using Latitude Survey Data in 2019 and 2020

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 445

Presenter
Achara Seripienlert
Author and Co-Author
Achara Seripienlert, Waraporn Nuntiyakul | David Ruffolo | Pierre-Simon Mangeard | Alejandro Sáiz | Sidarat Khamphakdee | Kanokkarn Fongsamut | Peng Jiang | Pongpichit Chuanraksasat | Paul Evenson | KAZUOKI MUNAKATA | James Madsen | Boonrucksar Soonthornthum | Siramas Komonji

Abstract
'A neutron monitor (NM) is a ground- (or sea-) based detector of the flux of cosmic ray particles in space. The high-energy cosmic rays in the GeV primary range interact in the upper atmosphere, producing a cascade of subatomic particles, some of which reach Earth’s surface. A neutron monitor is mostly sensitive to the neutron component of the atmospheric cascade. The standard-design neutron monitor (NM64) contains lead, the nuclei of which fragment when struck by a high-energy particle. Some of the fragments are neutrons, moderated and trapped by polyethylene, acting as a reflector and moderator. These neutrons can then be detected by induced nuclear fission of 10B in a 10BF3 gas proportional counter. The Changvan neutron monitor is a portable neutron monitor assembled in Thailand and housed in a standard insulated shipping container to conduct long-term research in polar regions. There are three proportional counters housed in the insulated shipping container, but the central counter lacks the lead producer. Since the detector has a non-standard semi-leaded design, we examine the response functions of the Changvan for neutrons and other atmospheric secondary particles with varying angles of beam generating particles. Deadtime, the specific time after each event during which the electronics cannot record another event, is also applied to the responses. This will allow us to find the yield function from the simulation. We can validate the Monte Carlo model using the latitude survey data, as a step toward using the unleaded/leaded count rate ratio from a single detector at a fixed location to study spectral variations.'

Collaborations

Keywords and Comments
", "

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Quality survey of Neutron Monitor data sources for 1951-2019

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 446

Presenter
Pauli Väisänen
Author and Co-Author
Pauli Väisänen | Ilya Usoskin | Kalevi Mursula,

Abstract
'Long-term measurements from the global neutron monitor (NM) network allow to study galactic cosmic ray (GCR) variations for the last seven decades. However, the network offers data of quite different quality from the many sources. Historically, NM data is distributed through different data repositories, which include the Neutron Monitor Database (NMDB), World Data Center for Cosmic Rays (WDCCR), The Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation (IZMIRAN) repositories and individual homepages of stations/teams.\r\n\r\nHere we present a detailed quality survey by comparing the consistency of hourly resolution NM datasets of different origin. The analysis includes 300 datasets from 147 NMs in 1951-2019. As the main result of the survey, we found that the data of individual stations are not often uniform across the different sources. This results in problems with the reliability and reproducibility of scientific results. Our survey also underlines that special efforts should be given to a proper documentation of the datasets. This is particularly true for the oldest data that are in danger of getting lost to time. We also offer a list of currently recommended data sources for each station, based on their comparison with a ``prime'' dataset composed from long-lived NM stations that fulfil specific quality criteria.'

Collaborations

Keywords and Comments
'Neutron monitor; Galactic Cosmic Ray Variation; Data; Data quality', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

First results of the SA Agulhas II mobile mini-neutron monitor: Instrumental characterization and environmental sensitivity

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 24 Ground-based measurements of low-energy GCRs | SH
Presenter Forum Table

Presenter
Du Toit Strauss
Author and Co-Author
Du Toit Strauss | Frederic Effenberger | Adri Burger | Stefan Lotz | Konstantin Herbst | Helena Kruger | Corrie Diedericks | Cobus van der Merwe,

Abstract
'A newly redesigned version of a mini-neutron monitor (NM), with updated and more sensitive electronics, was installed on the South African Antarctic research vessel, the SA Agulhas II, at the end of 2019. The 2019/2020 relief voyage to the SANAE (South African Antarctic base) research station was used to test the performance of the instrument. Results indicate that the new design, featuring a specially designed cradle with movement dampeners, worked well. However, due to the placement of the instrument, two unanticipated effects were observed: (i) A very strong temperature dependence at low temperature and (ii) occasional high-frequency interference, possibly due to an ice radar antenna. Both of these effects are studied in detail, with preliminary findings presented here. Because of these effects, the mini-NM will be moved to a more suitable location onboard the ship in the near future (covid permitting) and will, hopefully, provide long-term cosmic ray measurements in the southern oceans.'

Collaborations

Keywords and Comments
'neutron monitor', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Determination of Yield Functions of Neutron Counters at the South Pole from Monte-Carlo Simulation

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 447

Presenter
Audcharaporn Pagwhan
Author and Co-Author
Audcharaporn Pagwhan, Achara Seripienleart | Waraporn Nuntiyakul | Paul Evenson | Pierre-Simon Mangeard | Alejandro Sáiz | David Ruffolo | Seunarine Surujhdeo

Abstract
"Neutron monitors (NM64) are ground-based cosmic ray detectors that measure the flux of primary cosmic rays at the GeV-energy range by counting (primarily) secondary neutrons in atmosphere cascades. They have a lead producer to generate evaporation neutrons that are moderated before being detected in a $^{10}BF_{3}$ or ^{3}He gas-filled proportional counter. By omitting the lead, a so-called “bare detector” responds to lower energy particles on average and can be used in concurrence within NM64 to estimate the primary cosmic rays' energy spectrum. This research uses Monte-Carlo FLUKA simulation to refine our understanding of two types of bare neutron detector and three NM64 units located inside and outside, respectively, of the Amundsen-Scott station at the South Pole. One bare design uses paraffin and wood to moderate high-energy neutrons, and another bare design has no moderator. All bares are mounted together in a single assembly. The bares and NM64 all use 3He gas-filled proportional counters. In our previous work, the energy-dependent effective area (yield function) of the paraffin-moderated bares was directly determined from a ship-borne latitude survey in 2009 - 2010. The influence of the container and the environment on the ship significantly affects the measured yield function. In this work, we use simulations to relate the measured yield functions to the actual configuration at the South Pole and apply our results to study spectral variations of solar energetic particles during Ground Level Enhancements."

Collaborations

Keywords and Comments
'Neutron monitor; FLUKA simulation;', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

New neutron monitor altitude-dependent yield function and its application to an analysis of neutron-monitor data

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 24 Ground-based measurements of low-energy GCRs | SH
Presenter Forum Table

Presenter
Sergey Koldobskiy
Author and Co-Author
Alexander Mishev | Sergey Koldobskiy | Gennady Kovaltsov | Ilya Usoskin,

Abstract
'An updated yield function (YF) of a standard NM64 neutron monitor (NM) is computed and extended to different atmospheric depths from sea level to 500 g/cm^2 ($\\sim$5.7 km altitude) and is presented as lookup tables and a full parametrization. NM YF was computed using the PLANETOCOSMICS simulation tool based on the GEANT4 package, applying the NRLMSISE-00 atmospheric model. The yield function was validated using the cosmic-ray spectra directly measured in space by the AMS-02 experiment during the period May 2011 through May 2017 and confronted with count rates of all NM64-type NMs being in operation during this period. Using this approach, the stability of all the selected NMs was analyzed for the period 2011–2017. Most of NMs appear very stable and suitable for studies of long-term solar modulation of cosmic rays. However, some NMs suffer from instabilities like trends, apparent jumps, or strong seasonal waves in the count rates.'

Collaborations

Keywords and Comments
'neutron monitor; yield function; solar energetic particles; solar modulation', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Commissioning of CALLISTO spectrometers in Peru and observations of type III Solar Radio Bursts

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 448

Presenter
Jose Bazo
Author and Co-Author
Jose Bazo | Javier Rengifo | Veronica Loaiza-Tacuri | Walter Guevara Day,

Abstract
'Two radio spectrometer stations belonging to the e-CALLISTO network were installed in Peru by the Astrophysics Directorate of CONIDA. Given their strategic location near the Equator, it was possible to observe the Sun evenly throughout the whole year and the detector was unique in its time-zone coverage. The receiver located nearby the capital city of Lima took data in the metric and decimetric bands looking for radio bursts. To assess the suitability of the sites and the performance of the antennas, we analysed the radio ambient background and measured their radiation pattern and beam-width. To show the capabilities of the facilities to study solar dynamics in these radio frequencies we have selected and analysed type III Solar Radio Bursts. We have characterised the most common radio bursts with the following mean values: a negative drift rate of -25.8 $\\pm$ 3.7 MHz/s, a duration of 2.6 $\\pm$ 0.3 s and 35 MHz bandwidth in the frequency range of 114 to 174 MHz. In addition, for some events, it was possible to calculate a global frequency drift, which on average was 0.4 $\\pm$ 0.1 MHz/s.'

Collaborations

Keywords and Comments
'instrumentation: spectrographs; Sun: radio radiation', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

ICaRO: a new cosmic ray detector at Izaña Atmospheric Observatory

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 449

Presenter
Juan José Blanco Avalos
Author and Co-Author
Juan José Blanco Avalos | Juan Ignacio García-Tejedor | Óscar García-Población | Sindulfo Ayuso de Gregorio | Iván Vrublevskyy | Alejandro López-Comazzi | Almudena Gomis Moreno | David Moure García | Emilio Cuevas | África Barreto Velasco | Ramón Ramos,

Abstract
'A twin detector of ORCA, the cosmic ray detector operating at Juan Carlos I Spanish Antarctic Base, is foreseen to be installed at Izaña Atmospheric Observatory (IZO) during the second part of 2021. IZO belongs to the State Meteorological Agency of Spain (AEMET) and it is located at the top of a mountain plateau in Teide volcano at Tenerife Island (28º18'N, 16º29'W, 2373 m a.s.l.) at vertical cut-off rigidity of 11.5 GV. ICaRO (Izaña Cosmic Ray Observatory) is composed of a BF3-based 3NM64 (ICRO), 3 bare BF3 counters (ICRB). The neutron monitor is complemented by a muon telescope sharing a common room in a single stack. The muon telescope follows the MITO approach, and thus is composed of two scintillator layers, Top and Bottom. It is able to provide muon counting rate and muon impact points on the scintillator layers. MITO's layers are 1.365 m apart with the two BF3 sets, ICRO and ICRB, in between. As such, the lead surrounding ICRO acts as filter for particles traversing throughout Top and Bottom. ICaRO will provide counting rates of neutrons in two energy thresholds, muon counting rate and muon incoming directions throughout the detector volume.'

Collaborations

Keywords and Comments
'Neutron Monitor; Solar Activity; Cosmic Ray; Solar Energetic Particles', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Development of the Solar Neutron TRACking (SONTRAC) Concept

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 450

Presenter
J. Grant Mitchell
Author and Co-Author
J. Grant Mitchell, Georgia de Nolfo | Alessandro Bruno | Jeffrey Dumonthier | Iker Liceaga-Indart | Jason Link | Jason Legere | Richard Messner | James Ryan | George Suarez | Teresa Tatoli

Abstract
'Fast neutrons (> 0.5 MeV) are ubiquitous in nature, originating from nuclear interactions in environments including the solar corona, within planetary atmospheres, and in the lunar regolith. However, measurements of fast neutrons of solar origin are extremely limited due to the challenges imposed by high backgrounds and the relatively short lifetime of free neutrons before they undergo beta decay. Traditional double-scatter neutron spectrometers require an incident neutron to elastically scatter in two widely spaced detectors, allowing the reconstruction of the incident neutron's energy and direction onto an annulus. While double-scatter spectrometers are well-proven, they suffer from low effective area due to spacecraft size constraints as well as limited resolution due to the possibility of the recoil protons escaping the detector volume. The Solar Neutron TRACking (SONTRAC) concept overcomes these limitations through the use of stacked planes of plastic scintillating fibers arranged in an orthogonal configuration, to measure the ionization tracks of recoil protons. The recoil protons' energy and direction supplant the need to measure the neutron's time-of-flight between detectors, thereby dramatically increasing the effective area and detection efficiency. SONTRAC employs modern, miniature silicon photomultipliers (SiPM) to measure the light output from the fibers. SiPMs offer significant advantages over other photodetectors such as photomultiplier tubes due to their compact size and low bias voltages. The SONTRAC concept, combined with recent developments, including the development of a new fiber-bundle without an epoxy binder, testing of new high-performance application-specific-integrated-circuits, and development of new readout and reconstruction techniques are presented.'

Collaborations

Keywords and Comments
'Neutron Spectroscopy; Solar Neutrons; Solar Flares; Silicon Photomultipliers', ''

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Subcategory Experimental Methods & Instrumentation

Response functions of semi-leaded neutron monitor count rates and leader rates from latitude surveys during 2019-2020

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 451

Presenter
Panutda Yakum
Author and Co-Author
Panutda Yakum, Sidarat Khamphakdee | Waraporn Nuntiyakul | David Ruffolo | Paul Evenson | Pierre-Simon Mangeard | Alejandro Saiz | Chanoknan Banglieng | Achara Seripienlert | Peng Jiang | Pongpichit Chuanraksasat | Kazaoki Munakata | James Madsen | Boonrucksar Soonthorn

Abstract
'We have developed a portable “Changvan” neutron monitor with three counters for latitude surveys to investigate cosmic ray spectral variations. This uses the NM64 design except the middle counter lacks the lead producer, so we call this a “semi-leaded” neutron monitor. The Changvan was operated on two voyages on the Chinese icebreaker Xuelong between China and Antarctica during 2019 and 2019-2020. The standard measurement during a latitude survey is the count rate as a function of geomagnetic cutoff rigidity, i.e., the response function of the total count rate. Repeated measurements with the same detector over different phases of the solar cycle provide precise information about cosmic ray spectral variation. In addition, we have tested two techniques to track spectral variations, which have or could be implemented at fixed stations. 1) The count rate ratio of unleaded vs. leaded counters varies strongly with geomagnetic cutoff rigidity, indicating sensitivity to the cosmic ray spectrum. This measurement could be implemented at fixed stations and may have advantages relative to using a "bare" counter in that this "unleaded" counter is shielded from the environment by the reflector and has a higher count rate due to the adjacent lead. 2) We use histograms of the time delay between successive neutron counts to determine the leader fraction, as previously used to monitor short-term and solar-cycle spectral variations. Thus we report measurements of the response functions of the count rates and leader rates of the unleaded and leaded counters during these two latitude surveys.'

Collaborations

Keywords and Comments
'neutron monitor; latitude survey; Leader fraction; time delay histograms', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

New empirical methods for correction of meteorological effects on cosmic ray muons

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 22 Atmospheric effects of CR | SH
Presenter Forum Table

Presenter
Mihailo Savic
Author and Co-Author
Mihailo Savic,

Abstract
'Flux of muon component of secondary cosmic rays is affected by varying conditions in the atmosphere. Dominant effects are barometric and temperature effect which reflect variations of atmospheric pressure and atmospheric temperature respectively. Precise modeling and correction for these meteorological effects significantly increases sensitivity of Earth-based muon detectors to variations of primary cosmic ray flux. \r\nWe are presenting two recently developed empirical methods for correction of meteorological effects on cosmic ray muons. First method is based on principal component analysis, while second employs multivariate analysis using machine learning techniques. Both methods are applied for correction of barometric and temperature effects, but can easily be generalized to take more atmospheric parameters into account.\r\nWe apply these corrections to muon count rates measured by Belgrade cosmic ray station and study their effect on sensitivity of detection of periodic and aperiodic flux variations of primary cosmic rays. Comparison with the most widely used method for correction of meteorological effects – integral method, as well as with neutron monitor data, demonstrates very high effectiveness of presented methods.'

Collaborations

Keywords and Comments
'cosmic ray muons; meteorological effects; atmospheric correction; principal component analysis; machine learning', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Performance of the ISOIS/EPI-Hi instrument on NASA's Parker Solar Probe for measuring ions between ~1 and ~100 MeV/nuc

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 452

Presenter
M.E. Wiedenbeck
Author and Co-Author
M.E. Wiedenbeck | E.R. Christian | C.M.S. Cohen | A.C. Cummings | G.A. de Nolfo | A.W. Labrador | R.A. Leske | D.J. McComas | R.A. Mewaldt | J.G. Mitchell | N.A. Schwadron | E.C. Stone,

Abstract
'On the Parker Solar Probe (PSP) mission, energetic ions accelerated at the Sun, in the interplanetary medium, and in the outer heliosphere are measured above ~1 MeV/nuc by the EPI-Hi sensor system, which is one of two energetic-particle instruments that make up the Integrated Science Investigation of the Sun (ISOIS) suite. EPI-Hi uses three solid-state detector telescopes to measure elemental composition, energy spectra, angular distributions, and He isotopic composition. A unique challenge for these measurements is the large dynamic range of intensities that is anticipated, ranging from solar-minimum quiet-time conditions up to ~0.8 au from the Sun to large shock-acceleration events that could be encountered as PSP penetrates to within 10 solar radii of the photosphere. To handle this range of intensities, EPI-Hi uses a "dynamic thresholds" system in which the flight software can autonomously modify trigger thresholds and coincidence requirements in several steps as count rates change. This avoids excessive dead time by reducing geometrical factors, particularly for abundant species (primarily H, He, and electrons). Simulations are being carried out using Geant4 models of the telescopes in order to intercalibrate measurements made by the different telescopes and in the different dynamic threshold states. We illustrate the EPI-Hi measurement capabilities using Geant4 simulation results and comparisons with data available from the early orbits of PSP.'

Collaborations

Keywords and Comments
'solar energetic particles; Parker Solar Probe; ISOSI; EPI-Hi', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Simulation of Solar Neutron Flux in the Earth's Atmosphere

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 22 Atmospheric effects of CR | SH
Presenter Forum Table

Presenter
Fernando Monterde Andrade
Author and Co-Author
Fernando Monterde Andrade | Luis Xavier González Méndez, Bertha Jania Newton Bosch | Sebastian Perea Contreras | José Francisco Valdés Galicia | Oscar Gustavo Morales Olivares | Yasushi Muraki | Yutaka Matsubara | Kyoko Watanabe | Takashi Sako

Abstract
'We studied the evolution of the solar neutron flux in the Earth’s atmosphere. Simulations based on the CORSIKA and FLUKA codes were performed for this purpose. We analyzed the neutron (n) emission of three flares (X17, M3.9 and X1.3), observed by the Solar Neutron Telescope at Sierra Negra (SNT-SN) and the FIB scintillator of the Space Environment Data Acquisition-Attached Payload (FIB SEDA-AP) on board of the International Space Station (ISS). As Solar Cosmic Rays (SCR), solar neutrons are able to produce air showers in the Earth’s atmosphere; we focused our analysis on the hadronic component to study the secondary n into the total n flux. Our results are consistent with observational data.'

Collaborations

Keywords and Comments
'Solar neutrons detection; particle flux simulation', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

A study on the cosmic ray intensity variation using scintillation counters for air shower observation.

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 22 Atmospheric effects of CR | SH
Presenter Forum Table

Presenter
Toshiyuki Nonaka
Author and Co-Author
Katsuya Yamazaki | Toshiyuki Nonaka | Akitoshi Oshima, for the Telescope Array Collaboration | for the GRAPES-3 collaboration

Abstract
"We report a study on the conversion of a giant cosmic ray observatory for air shower observation to observe cosmic ray intensity variations caused by solar activity, anisotropy associated with interplanetary disturbances, and detection of sudden cosmic ray events on the earth's surface. In this report, we use data from the surface detectors operated by the Telescope Array experiment located at 39^{\\circ}N, 112^{\\circ}W (total detector area: 2250 m^{2}). In order to evaluate the cosmic ray intensity variations, we will compare the data with some of the corrections considered and with available world wide database such as Nagoya Muon detector and other observatories that have been in stable operation at different geographic longitudes. Finally, we will report on the intensity variations due to weather and solar activity recorded during the observation period."

Collaborations
Telescope Array, GRAPES-3

Keywords and Comments
'Modulation; Forbush decrease; Air shower; Intensity variation', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

The asymptotic directions of approach and the magnetic rigidity cutoff of cosmic ray particles calculated for different airports

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 22 Atmospheric effects of CR | SH
Presenter Forum Table

Presenter
Marek Siłuszyk
Author and Co-Author
Marek Siłuszyk | Krzysztof Iskra | Witold Woznak | Michal Borkowski | Tomasz Zienkiewicz,

Abstract
"The calculation of asymptotic directions of approach of cosmic ray particles is an important tool in the determination of the rigidity cutoff for a given geographical site. We present the computations results of the asymptotic latitude and longitude and the magnetic rigidity cutoff for the airports located in: Apatity, Oulu, Warsaw, Lae, Buenos Aires Wellington and Mc Murdo at different latitudes and longitudes. We study the numerical integration of equations of charged particles motion of cosmic radiation in the Earth's magnetic field. The initial distance from the center of the Earth was taken as 20 km above the surface. At about this altitude, most cosmic rays undergo nuclear collisions. Calculations were made based on the model of the International Geomagnetic Reference Field (IGRF) in 2015."

Collaborations

Keywords and Comments
'IGRF; GCR; magnetic cutoff rigidity; trajectory of particles', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Development and Production of Modular Cosmic Ray Telescopes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 453

Presenter
Xiaochun He
Author and Co-Author
Xiaochun He | Carola Butler | Sawaiz Syed | Patrick Tarrant | Nan Chen | Ting-Can Wei,

Abstract
'While the quest of searching for the origins of the most energetic cosmic rays and the associated dynamics continues, there is a growing interest in recent years of the use of the cosmic rays for practical applications following the advancement of particle detection technologies. One of these important applications is to study the correlations between the cosmic ray flux variations and the space and earth weather at global scale in real-time at low cost. Key to these efforts is improving the understanding the correlation patterns to increase the accuracy, reliability, and timeliness of space-earth-weather forecasts. A state-of-the-art portable and modular cosmic ray muon and neutron detector prototype has been developed at Georgia State University for the measurement of cosmic ray muon and neutron flux variations simultaneously. The detector consists of three layers of plastic scintillator and a neutron-cell with liquid scintillator mounted on an extruded aluminum frame. The scintillation light is collected through embedded wavelength shifting fibers which are coupled to silicon photomultipliers (SiPM) for signal readout. The modular, portable and low cost nature of this cosmic ray telescope provides a technological choice to quantify the cosmic ray flux variation around the globe in an unprecedented spacial and time resolution. In the talk, we will highlight the details of the detector design, assembly and mass production. An initial test result will also be presented.'

Collaborations
other (fill field below), to be established as a consortium of global cosmic ray detector network

Keywords and Comments
'portable cosmic ray detector; space and earth weather monitoring; global detector network; low cost cosmic ray detector', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

Geant4 Modeling of the EPI-Hi Instrument on Parker Solar Probe to Calculate Solar Energetic Electron Spectra

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 454

Presenter
A.W. Labrador
Author and Co-Author
A.W. Labrador, J.G. Mitchell | E.R. Christian | C.M.S. Cohen | A.C. Cummings | G.A. de Nolfo | R.A. Leske | D.J. McComas | I. McMahon | R.A. Mewaldt | J.S. Rankin | N.A. Schwadron | E.C. Stone | J.R. Szalay | M.E. Wiedenbeck

Abstract
'Parker Solar Probe (PSP) can observe solar energetic electrons closer to the Sun than was possible on previous missions, and the EPI-Hi instrument, which is a part of the IS$\\odot$IS energetic particle instrument suite aboard PSP, can make electron spectrum observations at relativistic energies. EPI-Hi itself is composed of three telescopes (HET, LET1, and LET2) composed of stacks of silicon detectors. These three telescopes can identify solar energetic protons and other elements which stop in the stack via the delta-E vs. residual energy technique. However, solar energetic electrons scatter strongly in each telescope, making the delta-E vs. residual energy technique ineffective at returning electron energy spectra. We have modeled the EPI-Hi telescopes using Geant4 to study the detector responses to electrons from ~0.5 to ~8 MeV. In this paper, we describe a response matrix approach to calculating electron energy spectra for each of the telescopes. We demonstrate the application of this approach to various simulated input spectra, through which the Geant4 models produce simulated detector responses, and we then propagate these responses through an inverted response matrix to reconstruct the simulated input spectra accurately. We also show examples of this approach applied to SEP electron events detected by Parker Solar Probe.'

Collaborations

Keywords and Comments
'Instrument Simulation; Solar Energetic Particles; Electrons', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Methods & Instrumentation

A web application for monitoring cosmic rays and solar activity

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 455

Presenter
David Pelosi
Author and Co-Author
David Pelosi | Nicola Tomassetti | Matteo Duranti,

Abstract
"The flux of cosmic rays in the heliosphere is subjected to variations that are related to the Sun's magnetic activity. To study this effect, updated time series of multichannel observations are needed. Here we present a web application that collects real-time data on solar activity proxies, interplanetary plasma parameters, and charged cosmic-ray data. The data are automatically retrieved on daily basis from several space missions or observatories. With this application, the data can be visualized and download into a common format. Along with observational data, the application aims to provide real-time calculations for the solar modulation of cosmic rays in the heliosphere."

Collaborations

Keywords and Comments
", "

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Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Behaviour of different periodicities in galactic cosmic particles as observed by ACE during solar cycles 23 and 24

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 21 Short-term modulation | SH
Presenter Forum Table

Presenter
Pieter Kotze
Author and Co-Author
Pieter Kotze,

Abstract
'Pieter Kotzé\r\nSpace Physics, North-West University, Potchefstroom, South Africa\r\n\r\nPeriodicities in galactic cosmic particles like C, N, O and Fe as observed by the ACE satellite between 2000 and 2019 have been analyzed using various spectral analysis techniques. Daily mean energetic particle measurements are used to identify how several harmonics of the ~ 27-day synodic rotation period change during each individual year. Lomb-Scargle and Morlet wavelet spectral analysis of galactic cosmic particle data at different energies revealed in particular that the fourth harmonic (~7-day) of the solar rotation period occurs exceptionally strong during the minimum of solar cycle 23 (2008, 2009) when A< 0 (solar dipole pointing South) in comparison to the minimum of cycle 24 (2018,2019) when A> 0 (solar dipole pointing North). The results obtained in this investigation showed that galactic cosmic particles as observed by the ACE satellite exhibit peculiar short-term periodicity behaviour as a result of solar polarity dependent magnetic drifts during a negative minimum which is in line with previous results using neutron monitor data from Hermanus and Jungfraujoch (P Kotzé, Solar Physics, 2020).'

Collaborations

Keywords and Comments
'Spectral analysis; Lomb-Scargle; wavelets; galactic cosmic particles; solar cycle', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Halloween GLEs on October-November 2003, spectra and angular distribution- new revised results

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 456

Presenter
Alexander Mishev
Author and Co-Author
Alexander Mishev, Ilya Usoskin | Leon Kocharov

Abstract
'Precise studies of solar energetic particles provide an important basis to understand their acceleration and propagation in the interplanetary space. A specific interest is paid to solar protons possessing with energy high enough to induce an atmospheric cascade in the Earth's atmosphere, whose secondary particles can reach the ground, being eventually registered by ground-based detectors e.g. neutron monitors. This particular class of events is known as ground-level enhancements (GLEs). The solar cycle 23 provided several very strong GLEs. The first strong GLE event of the cycle was observed on 14 July 2000 (the Bastille day event), while the last was observed on 13 December 2006. In addition, the period of late October - early November 2003 was characterized by strong cosmic-ray variability and a sequence of three GLEs, which is the focus of this study. Here we performed a precise analysis of neutron-monitor records and derived the spectral and angular characteristics of the solar energetic particles for these events. We modelled the particle propagation in the Earth's magnetosphere and atmosphere using a newly computed and verified neutron-monitor yield function computed for different altitudes above sea level. The solar-protons spectra and pitch angle distributions were obtained in their dynamical development throughout the events. We briefly discussed the revealed features of the Halloween events.'

Collaborations

Keywords and Comments
'solar energetic particles; neutron monitor; data analysis', 'Here we present new revised results of Halloween GLEs employing newly computed and verified NM yield function and verified method for data analysis.'

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Diurnal anisotropy enhancement due to non-Earth directed coronal mass ejections

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 457

Presenter
David Ruffolo
Author and Co-Author
Nutthawara Buatthaisong | David Ruffolo | Alejandro Sáiz | Chanoknan Banglieng | Warit Mitthumsiri | Tanin Nutaro | Waraporn Nuntiyakul,

Abstract
'In addition to solar modulation according to the ~11-year sunspot cycle and the ~22-year solar magnetic cycle, the time profile of the Galactic cosmic ray flux can also exhibit short-term (~2-week) modulation events. These are distinct from Forbush decreases in that they are more symmetric in time and are not associated with the local passage of an interplanetary shock and/or coronal mass ejection (CME). Using data from the Princess Sirindhorn Neutron Monitor at the summit of Doi Inthanon, Thailand, with the world's highest geomagnetic cutoff rigidity for a fixed station (16.7 GV), we have examined the solar diurnal anisotropy and find that it exhibits strong peaks during such short-term modulation events, which are indeed stronger than the diurnal anisotropy variation from sunspot minimum to maximum. We attribute these short-term modulation events to non-Earth directed CMEs, and propose specific CME associations for notable events. We propose that even when not directed to the observer, CMEs (possibly single, multiple, or interacting) that propagate beyond the observer can temporarily inhibit the access of cosmic rays. The local diffusion coefficient is apparently undisturbed, but the reduced inflow past the CME coupled with an unabated flux decrease near the Sun due to adiabatic deceleration leads to a temporary, strong gradient that generates the strong anisotropy. We contrast the physics of these short-term events with the overall ~11-year solar modulation, which has a greater effect on the Galactic cosmic ray flux but a weaker effect on its anisotropy.'

Collaborations

Keywords and Comments
'neutron monitor; diurnal anisotropy; coronal mass ejection; solar modulation', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Continuously Measurements of Energy Spectra of Cosmic-Ray-induced-neutrons on the Concordia Antarctic Station for the period 2015-2021

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 24 Ground-based measurements of low-energy GCRs | SH
Presenter Forum Table

Presenter
guillaume hubert
Author and Co-Author
guillaume hubert,

Abstract
'The CHINSTRAP (Continuous High-altitude Investigation of the Neutron Spectra for Terrestrial Radiation Antarctic Project) supported by the French Polar Agency (IPEV) aims at recording cosmic-ray (CR) induced-neutron spectra at the Concordia station since December 2015. The neutron spectrometer measures the neutron spectrum over a wide energy range from meV up to tens of GeV with a short time resolution. Several parameters can influence the measurement, including systematic and environmental effects such as the atmospheric pressure, the hydrometric environment close to the instrument and the atmospheric water vapor.\r\nThis paper presents CR induced neutrons measurements analyses from 2015 to 2021 in Concordia, integrating corrections to take into account environmental and systematic effects. Long-term and short-term analyses are proposed, applied to count rate, fluxes and spectra. A study focuses on solar event occurred in September 2017 recorded in Concordia. Analyses are completed with data recorded in the Pic du Midi observatory (French Pyrenees, at 2885 m above sea level) for the period 2012-2021. The situation is different because the atmospheric vapor content and their variations are significant, involving environmental or systematic effects on CR measurements in the orders of 10 %. \r\nA last part investigates the contribution of modelling to data analyses and the ability to deduce the solar modulation from neutron spectra and the radiation field extrapolation using nuclear transport in atmosphere. An underlying objective is also to improve physical models allowing analyses of continuous and simultaneously measurements of CR induced neutrons spectra in both high-altitude stations.'

Collaborations

Keywords and Comments
", "

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Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Solar Neutron Decay Protons Observed in November 7, 2004

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 23 Solar Events observed on/near Earth | SH
Presenter Forum Table

Presenter
Yasushi Muraki
Author and Co-Author
Yasushi Muraki | Valdes Galicia | Emesto Ortiz | Yutaka Matsubara | Shoichi Shibata | Takashi Sako | Satoshi Masuda | Munetoshi Tokumaru | Tatsumi Koi | Akitoshi Oshima | Takasuke Sakai | Tsuguya Naito | Pedro Miranda,

Abstract
"We report here an interesting event that was detected by solar neutron telescopes installed at high altitudes in Bolivia (5250 m a.s.l.) and Mexico (4600 m a.s.l.). The event was observed on November 7th 2004 in association with a large solar flare of magnitude X2.0. Some features of our detectors and in two satellites (GOES 11 and SOHO) reveal the presence of electrons and protons as possible products of neutron decay. Solar neutron decay protons (SNDPs) were recorded previously by the ISEE3 satellite on June 3rd, 1982 . On October 19th, 1989, the ground level detectors installed in Goose Bay and Deep River also detected SNDPs. Therefore this is the second examples such evidence was registered on the Earth's surface. The authors wish to report this work quickly to alert the solar neutron community to the results reported here."

Collaborations

Keywords and Comments
'solar neutrons; solar neutron decay protons; Solar Energetic Particles', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

A Peculiar ICME Event in August 2018 Observed with the Global Muon Detector Network

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 24 Ground-based measurements of low-energy GCRs | SH
Presenter Forum Table

Presenter
KAZUOKI MUNAKATA
Author and Co-Author
KAZUOKI MUNAKATA | For the GMDN collaboration,

Abstract
'We demonstrate that global observations of high-energy cosmic rays contribute to understanding unique characteristics of a large-scale magnetic flux rope (MFR) causing a magnetic storm in August 2018. Following a weak interplanetary shock on 25 August 2018, a MFR caused an unexpectedly large geomagnetic storm. It is likely that this event became geoeffective because the MFR was accompanied by a corotating interaction region (CIR) and compressed by high-speed solar wind following the MFR. In fact, a Forbush decrease was observed in cosmic-ray data inside the MFR as expected, and a significant cosmic-ray density increase exceeding the unmodulated level before the shock was also observed near the trailing edge of the MFR. The cosmic-ray density increase can be interpreted in terms of the adiabatic heating of cosmic rays near the trailing edge of the MFR, as the corotating interaction region prevents free expansion of the MFR and results in the compression near the trailing edge. The second order anisotropy observed during the density increase clearly indicates an intensity enhancement of cosmic rays with approximately 90 degree pitch angle as expected from the betatron acceleration. A northeast-directed spatial gradient in the cosmic-ray density was also derived during the cosmic-ray density increase, suggesting that the center of the heating near the trailing edge is located northeast of Earth. This is one of the best examples demonstrating that the observation of high-energy cosmic rays provides us with information of the three-dimensional macroscopic picture of the interaction between coronal mass ejections and the ambient solar wind, which is essential for prediction of large magnetic storms.'

Collaborations
other (fill field below),

Keywords and Comments
'Space Weather; galactic cosmic rays in ICME; cosmic ray observations with muon detectors and neutron monitors', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Geoeffective space weather events signatures in cosmic rays during the ascending phase of the solar cycle 24

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 458

Presenter
Agnieszka Gil
Author and Co-Author
Agnieszka Gil | Renata Modzelewska | Szczepan Moskwa | Agnieszka Siluszyk | Marek Siłuszyk | Anna Wawrzaszek | Anna Wawrzynczak,

Abstract
"Solar originating events are continually evident in galactic cosmic ray (GCR) flux registered at the ground by neutron monitors and in situ by space probes. We analyze time intervals of sporadic Forbush decreases during the ascending phase of solar cycle 24. We consider cosmic rays flux, as well as, solar, heliospheric and geomagnetic activity parameters, around these periods, using different mathematical tools. Moreover, for this epoch of solar activity we compute geoelectric field for the Poland's region using a 1-D layered conductivity Earth model. Against the background of the above-mentioned parameters, we analyze the number of failures in southern Poland transmission lines. Our results reveal the increase in the superposed averaged number of failures around the appearance of solar transients visible in the GCR flux, suggesting their potential coupling."

Collaborations

Keywords and Comments
'galactic cosmic rays; space weather; transmission lines', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Forbush decrease on September 6-13, 2017 observed by the Tanca water-Cherenkov detector

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 21 Short-term modulation | SH
Presenter Forum Table

Presenter
Renan de Aguiar
Author and Co-Author
Renan de Aguiar, for the LAGO Collaboration | Anderson Campos Fauth

Abstract
"Solar activity was intense in September 2017 and its effects were observed in detectors placed in the Earth's surface. Three halo Coronal Mass Ejections (CME) hit the planet and caused magnetic storms. The effects of the CMEs on the flux of galactic cosmic rays at ground level were observed by the Tanca detector, which is one of the water-Cherenkov detectors (WCD) that make up the Latin American Giant Observatory (LAGO). In this paper we present the detection of Forbush events observed by Tanca during the month of September 2017. This WCD is installed on the campus of the University of Campinas, in Brazil, having three photomultiplier tubes that detect Cherenkov photons produced by cosmic radiation in 11400 liters of ultra pure water. We present the description and performance of the experimental apparatus and the observation on days 6$^\\textrm{th}$, 8$^\\textrm{th}$ and 13$^\\textrm{th}$ of the Forbush events originated by the CMEs. A decrease in the cosmic rays flux due to a stream interaction region was also observed on 14$^\\textrm{th}$ September. These results were compared with observations made by neutron monitors and indices of the Earth’s magnetic activity."

Collaborations
other (fill field below), LAGO

Keywords and Comments
'solar physics; cosmic rays; muons', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Solar magnetic polarity effect on neutron monitor count rates from latitude surveys versus Antarctic stations

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 459

Presenter
Kledsai Poopakun
Author and Co-Author
Kledsai Poopakun, Waraporn Nuntiyakul | David Ruffolo | Paul Evenson | Peng Jiang | Pongpichit Chuanraksasat | Marc Duldig | John Humble | Suyeon Oh

Abstract
'The Galactic cosmic ray spectrum manifests subtle variations over the 22-year solar magnetic cycle in addition to more pronounced variations over the 11-year sunspot cycle. We conducted numerous latitude surveys by operating a neutron monitor onboard an icebreaker that traveled across a wide range of geomagnetic cutoff rigidities. Here we revisit our previous work to study spectral changes using 13 annual latitude surveys from 1994 to 2007 by comparing with neutron monitor data from Mawson instead of McMurdo, which closed in 2017, in order to allow a comparison with more recent latitude surveys. We confirm linear trends between count rates at different geomagnetic cutoff rigidities and changes in slope before and after the polarity reversal in 2000 as an effect of solar magnetic polarity. We performed two more latitude surveys (in 2019 and 2019-20) with a monitor similar to the 3NM64 in the previous surveys but without lead rings around the central tube, a so-called “semi-leaded neutron monitor.” We also found similar results for the relationship between the count rate of the semi-leaded neutron monitor and that of the Jang Bogo and Mawson neutron monitor stations in Antarctica.'

Collaborations

Keywords and Comments
'neutron monitor; solar modulation; solar magnetic polarity; crossover; latitude survey', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Spectral parameterization of GCR observations and reconstruction of solar modulation parameters derived from the Convection-Diffusion approximation

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 20 GCR long-term modulation | SH
Presenter Forum Table

Presenter
Moshe Godfrey Mosotho
Author and Co-Author
Moshe Godfrey Mosotho | Du Toit Strauss,

Abstract
'Galactic cosmic rays (GCRs) entering the heliosphere and propagating towards Earth are subject to various modulation processes including drifts, convection, adiabatic energy changes, and diffusion as a result of the turbulent solar wind. This transport can be described by the Parker equation (Parker, 1965). A widely used first-order approximation of the Parker equation is the Force-Field approximation (FFA), while a similar approximation, the Convection-Diffusion approximation (CDA) is rarely applied. Using PAMELA and AMS-02 observations, the validity of the FFA and the CDA in the energy range 1 MeV to 20 GeV was investigated. The resulting modulation parameters and the effective diffusion coefficient, derived from both approximations over a complete 11-years solar cycle, were compared. Our results show that the CDA appears to be significantly more accurate than the FFA in reproducing the measurements, while the resulting transport parameters are highly dependent on the choice of the local interstellar spectrum and the assumed diffusion coefficient parameters. Based on these findings, we therefore propose to use the CDA as a more suitable approximation than the widely used FFA for space weather applications, especially for dosimetric studies where an accurate GCR parametrization is essential.'

Collaborations
other (fill field below), No answer

Keywords and Comments
'Galactic cosmic-rays; Solar modulation', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Solar Modulation During the Descending Phase of Solar Cycle 24 Observed with CALET on the International Space Station

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 20 GCR long-term modulation | SH
Presenter Forum Table

Presenter
Shoko Miyake
Author and Co-Author
Shoko Miyake | for the CALET Collaboration,

Abstract
'The CALorimetric Electron Telescope (CALET) installed on the International Space Station has multiple event trigger modes for measuring cosmic-ray (CR) particles and gamma rays, and the observations of the low-energy CRs have been successfully performed by a Low-Energy Electron (LEE) shower trigger mode that is active only at high geomagnetic latitude. Continuous measurements of low-energy CRs with LEE trigger of the CALET have detected the charge sign dependence of the solar modulation. In this talk, we present the latest results of the low-energy electron fluxes observed by CALET during the descending phase of the solar cycle 24. We also present the long-term variations of count rates of the CR electrons and protons, discussing the charge sign dependence of the solar modulation.'

Collaborations
CALET,

Keywords and Comments
'Solar Modulation', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Periodic variations of GCR intensity and anisotropy related to solar rotation by ACE/CRIS, STEREO, SOHO/EPHIN and neutron monitors observations

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 21 Short-term modulation | SH
Presenter Forum Table

Presenter
Renata Modzelewska
Author and Co-Author
Renata Modzelewska | Agnieszka Gil,

Abstract
'We study the periodic variations of GCRs related to solar rotation based on neutron monitor, ACE/CRIS, STEREO and SOHO/EPHIN measurements. Now there is an opportunity to re-analyze the polarity dependence of the amplitudes of the recurrent GCR variations in 2007-2009 for negative A < 0 polarity and in 2017-2019 for A > 0. We use the Fourier analysis method to study the periodicity in the GCR fluxes. Since the GCR recurrence is a consequence of solar rotation, we analyze not only GCR fluxes, but also solar and heliospheric parameters examining the relationships between the 27-day GCR variations and heliospheric, as well as, solar wind parameters. We find that the polarity dependence of the amplitudes of the 27-day variations of the GCR intensity and anisotropy for NMs data is kept for the last two solar minima: 23/24 (2007-2009) and 24/25 (2017-2019) with greater amplitudes in A > 0 solar magnetic polarity. ACE/CRIS, SOHO/EPHIN and STEREO measurements are not governed by this principle of greater amplitudes in A > 0 polarity. GCR recurrence caused by the solar rotation for low energy (< 1GeV) cosmic rays is more sensitive to the enhanced diffusion effects, resulting in the same level of the 27-day amplitudes for positive and negative polarities. While high energy (> 1GeV) cosmic rays registered by NMs, are more sensitive to the large-scale drift effect leading to the 22-year Hale cycle in the 27-day GCR variation, with the larger amplitudes in the A > 0 polarity than in the A < 0.'

Collaborations

Keywords and Comments
'', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Galactic cosmic ray modulation in the heliosphere based on Australian muon telescopes data. Recurrent variations of cosmic rays intensity and anisotropy

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 460

Presenter
Renata Modzelewska
Author and Co-Author
Renata Modzelewska | Harjit Ahluwalia,

Abstract
'We study the galactic cosmic ray modulation in the heliosphere based on Australian muon telescopes data. We analyze the modulation parameters of galactic cosmic ray transport in the heliosphere retrieved from GCR anisotropy for solar cycle 24 covering the period 2006-2018. \r\nWe use the Fourier analysis and wavelet methods to study the periodicity in the GCR intensity and anisotropy. We re-analyze the polarity dependence of the recurrent 27-day GCR variations for high energy cosmic rays (Rm~60 GV) in 2007-2009 for negative A<0 solar magnetic polarity and 2017-2018 for positive A>0. Results will be confronted with current modulation theories. We examine the diffusion-convection-drift implications and the solar cycle and solar magnetic polarity dependence of cosmic ray modulation for muon data.'

Collaborations

Keywords and Comments
'', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

New reconstruction of the event-integrated spectra for GLE events

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 23 Solar Events observed on/near Earth | SH
Presenter Forum Table

Presenter
Sergey Koldobskiy
Author and Co-Author
Sergey Koldobskiy | Osku Raukunen | Rami Vainio | Gennady Kovaltsov | Ilya Usoskin,

Abstract
'Here we report the new reconstruction of the event-integrated spectra of solar energetic particles (SEP) detected by neutron monitor (NM) network and satellite experiments (mainly GOES data) during ground-level enhancement (GLE) events. The reconstruction of SEP particle fluences is based on the "bow-tie" method employing the latest advances in NM data analysis (time-dependent GCR background and the use of the NM yield function directly verified with the AMS-02 experiment data) and a detailed study of different uncertainties. For the pre-GOES period, we used all available SEP datasets. As a result of this work, we obtained integral fluences of SEPs in the energy range from 30 MeV to a few GeV for 58 moderate and strong GLE events since 1956. The results were fitted with the modified Band-function (a double power-law function with two exponential cutoffs) which is continuous together with its derivative. An easy-to-use presentation of SEP fluences in the form of an analytical expression forms a solid basis for new studies in different fields, such as the influence of SEPs on the atmosphere and a statistical study of extreme solar activity.'

Collaborations

Keywords and Comments
'solar energetic particles; ground-level enhancements; SEP; GLE', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Galactic cosmic-ray hydrogen spectra in the 40-300MeV range measured by the High-energy Particle Detector (HEPD) on board the CSES-01 satellite during the current solar minimum

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 20 GCR long-term modulation | SH
Presenter Forum Table

Presenter
Matteo Martucci
Author and Co-Author
Matteo Martucci,

Abstract
'The High-Energy Particle Detector (HEPD) onboard the China Seismo-Electromagnetic Satellite (CSES-01) - launched in February 2018 - is a light and compact payload suitable for measuring electrons (3-100 MeV), protons (30-300 MeV), and light nuclei (up to a few hundreds of MeV) with a high energy resolution and a wide angular acceptance. The very good capabilities in particle detection and separation, together with the Sun-synchronous orbit, make HEPD well suited for galactic particles and solar modulation studies. We report here some insights on the data-analysis techniques employed for this kind of study; as a result, semiannual galactic hydrogen differential energy spectra between 40 and 250 MeV for the period between the end of the 24th and the start of the 25th solar activity cycle, are presented . Moreover, a brief discussion on the comparison with theoretical spectra obtained from the HelMod 2D Monte Carlo model is also presented.'

Collaborations
other (fill field below), Limadou

Keywords and Comments
'Solar Modulation; Cosmic Rays; HEPD', 'on behalf of the Limadou Collaboration\r\nhttp://cses.roma2.infn.it/node/53'

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

The High-Energy Particle Detector (HEPD) as a space weather monitoring instrument on board the CSES-01 satellite

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 461

Presenter
Francesco Palma
Author and Co-Author
Francesco Palma,

Abstract
'CSES-01 (China Seismo-Electromagnetic Satellite) is the first element of an\r\nextended constellation of LEO (Low Earth Orbit) satellites, dedicated to monitoring\r\nperturbations of electromagnetic fields, plasma and charged particle fluxes induced\r\nby natural sources and artificial emitters in the near-Earth space. One of the eight\r\npayloads on board CSES-01 is the Italian High-Energy Particle Detector (HEPD),\r\nwhich is equipped with a silicon tracker and a range calorimeter to detect electrons\r\n(3-100 MeV), protons (30-250 MeV), and light nuclei. Since the launch of CSES-01\r\nin February 2018, HEPD has already returned valuable information about variations\r\nin the Earth-Sun interaction during geomagnetic-storm transients. One of such events\r\nwas the G3-class geomagnetic storm that impacted the Earth’s magnetosphere in late\r\nAugust 2018, causing a temporary rearrangement of the charged particle environment\r\naround the planet. In this work, the HEPD response to this magnetospheric\r\ndisturbance is presented on the base of electron rate variation measurements in the\r\nouter Van Allen radiation belts. The study of such events is crucial to better\r\nunderstand mechanisms taking place during solar events and to prevent their harmful\r\neffects on technological and anthropic systems, as well as on human health. The\r\npresented results confirm the HEPD capabilities in monitoring the near-Earth\r\nenvironment and contributing to establish a nowcasting/forecasting network in the\r\nnearest possible future.'

Collaborations
other (fill field below), Limadou

Keywords and Comments
", "

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Proton fluxes inside the South Atlantic Anomaly measured by the High-Energy Particle Detector (HEPD) on board the CSES-01 satellite during the 2018-2021 period

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 462

Presenter
Matteo Martucci
Author and Co-Author
Matteo Martucci,

Abstract
'Despite notable improvements made in the last decades, the characterization of the near-Earth proton radiation environment is incomplete, with major uncertainties affecting the description of high-energy particles (>50 MeV) in the South Atlantic Anomaly (SAA) region. \r\nThe High-Energy Particle Detector (HEPD) on board the China Seismo-Electromagnetic Satellite (CSES-01), launched on February 2018 on a Low-Earth Orbit and with an altitude of about 507 km, is a light and compact payload suitable for measuring electrons (3-100 MeV), protons (30-300 MeV), and light nuclei (up to a few hundreds of MeV) with a high energy resolution and a wide angular acceptance. Thanks to its good identification performance, it can carry out precise and comprehensive measurement of particle fluxes, including angular information. The observations of HEPD could be fundamental not only for space weather purposes, but because they could help set important constraints on trapping and interaction processes in the Earth’s atmosphere and magnetosphere. Furthermore, they enable the testing and validation of current theoretical and empirical models of the inner radiation belt, like the NASA AP9. In this contribution, we report a preliminary analysis of >30 MeV protons detected inside the SAA region between 2018 and 2021.'

Collaborations
other (fill field below), Limadou

Keywords and Comments
'Trapped Protons; SAA; HEPD', 'on behalf of the Limadou Collaboration\r\nhttp://cses.roma2.infn.it/node/53'

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Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Measurement of the neutron travel time distribution inside a neutron monitor

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 463

Presenter
Kullapha Chaiwongkhot
Author and Co-Author
Kullapha Chaiwongkhot, David Ruffolo | Wittawat Yamwong | Jirawat Prabket | Pierre-Simon Mangeard | Chanoknan Banglieng | Ekawit Kittiya | Waraporn Nuntiyakul | Warit Mitthumsiri

Abstract
'Using a setup for testing a prototype for a satellite-borne cosmic-ray ion detector, we have operated a stack of scintillator and silicon detectors on top of the Princess Sirindhorn Neutron Monitor (PSNM), an 18-counter NM64 detector at 2560-m altitude at Doi Inthanon, Thailand. Monte Carlo simulations have indicated that about 15% of the neutron counts by PSNM are due to interactions (mostly in the lead producer) of GeV-range protons among the atmospheric secondary particles from cosmic ray showers, which can be detected by the scintillator and silicon detectors. Detection of incoming charged particles associated with neutron counts in the NM64 allows a measurement of the travel time distribution of such neutrons as they scatter and propagate through the NM64, processes that are nearly the same whether the interaction was initiated by an energetic proton (for 15% of the count rate) or neutron (for 80% of the count rate). This travel time distribution underlies the time delay distribution between successive neutron counts, from which we can determine the leader fraction (inverse multiplicity), which has been used to monitor Galactic cosmic ray spectral variations over ~1-40 GV. In the present experiment we have measured both the coincidence rate of incident charged shower particles with neutron counts in the NM64 and the neutron travel time distribution. We utilize these measurements to validate Monte Carlo simulations of atmospheric secondary particle detection by the NM64 and the resulting yield functions used to interpret the count rate and the leader fraction.'

Collaborations

Keywords and Comments
'neutron monitor; Monte Carlo simulation; leader fraction; spectral variation', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

COSMIC RAY VARIATIONS in November–December, 2012

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 464

Presenter
Anna Lukovnikova
Author and Co-Author
Anna Lukovnikova,

Abstract
'Using ground-based observations of cosmic rays (CR) from the World Network of Neutron Monitor Stations and a method of spectrographic global survey, we have examined variations in rigidity spectrum and galactic CR in November–December 2012.'

Collaborations

Keywords and Comments
'Neutron Monitors; rigidity spectrum; COSMIC RAY VARIATIONS', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Measurement of the re-entrant lepton spectrum with the High-Energy Particle Detector on board CSES-01

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 466

Presenter
Alessandro Sotgiu
Author and Co-Author
Alessandro Sotgiu,

Abstract
'The High-Energy Particle Detector (HEPD-01) is one of the two particle detectors installed on board the China Seismo-Electromagnetic Satellite (CSES-01). The instrument consists of different subdetectors, including two planes of double-sided silicon microstrip sensors, a calorimeter constituted by 16 plastic scintillators and a layer of LYSO crystals, and a scintillator veto system surrounding the calorimeter. \r\nThe detector is dedicated to the measurement of proton (30-250 MeV) and electron (3-100 MeV) fluxes, and their variations induced by short-time perturbations of the radiation belts due to solar, terrestrial, or anthropic phenomena. Although the detector is capable to measure particles with a galactic origin, due to its energy range and to the CSES-01 polar orbit, HEPD collects particles below the local geomagnetic cutoff for a large fraction of its total live time. \r\nIn this work, the differential spectrum of re-entrant leptons (the downward-moving component of secondary electrons and positrons produced in the interactions of cosmic ray protons with the atmosphere) is measured in the near-equatorial region (altitude about 500 km) in the energy interval between 5 and 100 MeV where there is a lack of recent experimental data.'

Collaborations
, Limadou

Keywords and Comments
'', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Study of the anisotropy of cosmic rays during the periods of the minima of the 24th solar cycle using the muonography method according to the data of the URAGAN muon hodoscope

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 24 Ground-based measurements of low-energy GCRs | SH
Presenter Forum Table

Presenter
Igor Yashin
Author and Co-Author
Igor Yashin | Ivan Astapov | Nataliya Barbashina | Alexei Gvishiani | Victor Getmanov | Anna Dmitrieva | Anna Kovilyaeva | Natalia Osetrova | Anatoly Soloviev | Victor Shutenko,

Abstract
"Muon hodoscope URAGAN (MEPhI, Moscow) with an area of 45 sq. m is capable of real time detection of the tracks of all muons arriving from the upper celestial hemisphere with a high spatial and angular accuracy (1 cm and 1 degree, respectively). The spatial-angular distribution of the muons flux, measured by means of the URAGAN hodoscope for a certain period of time (1 min.) and expressed in values of the R.M.S. deviation from an averaged reference matrix is a one-minute angular matrix corrected for the barometric and temperature effects and contains information on the current variation the flux of cosmic muons associated with modulation processes in the heliosphere, magnetosphere and atmosphere of the Earth. Such a matrix, by analogy with X-ray radiography, is a muonograph of the Earth's atmosphere and near-terrestrial space. The sequence of muonographs converted to the GSE coordinate system allows one to study in real time the dynamics of cosmic ray anisotropy and to identify in advance geoeffective processes in the heliosphere associated with solar activity. The paper discusses the results of the analysis of the anisotropy of the CR muon flux at the minima of the 24th SC in 2009-2010 and 2018-2019."

Collaborations

Keywords and Comments
'solar-terrestrail physics; hodoscope; muon detector; muon f lux; coronal mass ejections; the Sun', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

A full solar cycle of proton and helium measurements

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 20 GCR long-term modulation | SH
Presenter Forum Table

Presenter
Nadir Marcelli
Author and Co-Author
Nadir Marcelli | Mirko Boezio | Riccardo Munini | Alex Lenni | Donald Ngobeni | O.P.M Aslam | Driaan Bisschoff | Marius Potgieter,

Abstract
'Time-dependent energy spectra of galactic cosmic rays (GCRs) carry fundamental information regarding their origin and propagation. When observed at the Earth, these spectra are significantly affected by the solar wind and the imbedded solar magnetic field that permeates the heliosphere, changing significantly over an 11-year solar cycle. Energy spectra of GCRs measured during different epochs of solar activity provide crucial information for a thorough understanding of solar and heliospheric phenomena. The PAMELA experiment had collected data for almost ten years (15 June 2006 - 23 January 2016), including the minimum phase of solar cycle 23 and the maximum phase of solar cycle 24. Here, we present spectra for protons and helium nuclei measured by the PAMELA instrument from 2006 to 2014. Time profiles of the proton-to-helium flux ratio at various rigidities are also presented, allowing the study of all characteristic features resulting from their different mass-to-charge ratio and the difference in the shape of their respective local interstellar spectra.'

Collaborations

Keywords and Comments
", "

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Role of heavier-than-helium nuclei in neutron monitor response: latest results

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 468

Presenter
Sergey Koldobskiy
Author and Co-Author
Sergey Koldobskiy | Ilya Usoskin | Gennady Kovaltsov,

Abstract
'Heavier-than-proton nuclei are responsible for up to 50% of neutron monitor (NM) response depending on the solar modulation and geomagnetic rigidity cutoff for given NM. Therefore, careful consideration of these species is important for careful analysis of NM data, including the reconstruction of the solar modulation potential using NM network data. Recently, the AMS-02 experiment allowed us to directly verify the NM response to heavy particles. In this work, we compare the expected contribution of heavy nuclei into the NM response considering different models of the local interstellar spectrum and different levels of solar activity.'

Collaborations

Keywords and Comments
", "

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Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Time-Delay Measurements from Antarctic Neutron Monitor Stations Indicate Weak Spectral Changes during 27-day Variations

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 21 Short-term modulation | SH
Presenter Forum Table

Presenter
Pradiphat Muangha
Author and Co-Author
Pradiphat Muangha, David Ruffolo | Alejandro Sáiz | Chanoknan Banglieng | Paul Evenson | Surujhdeo Seunarine | Suyeon Oh | Jongil Jung | Marc Duldig | John Humble

Abstract
'Using neutron time-delay data from neutron monitors (NMs), we can extract the leader fraction, *L*, of neutron counts that do not follow a previous neutron count in the same counter tube due to the cosmic ray shower. *L* is the inverse of the neutron multiplicity and serves as a proxy of the cosmic ray spectral index over the rigidity range of the NM response function. We have outfitted several Antarctic NMs with special electronics to collect neutron time delay distributions. We present a comparative analysis of *L* during two time periods: 1) during December 2015 to January 2017, for NMs at South Pole (SP), McMurdo (MC), and Jang Bogo (JB), and 2) during February 2020 to February 2021, for NMs at SP, JB, and Mawson (MA). To first order *L* varies in concert with the count rate *C*, reflecting unrolling of the Galactic cosmic ray (GCR) spectrum as part of solar modulation during the declining phase of solar cycle 24 and during solar minimum. However, during 27-day variations in *C* due to high-speed solar wind streams (HSSs) and corotating interaction regions (CIRs), *L* usually had a very weak variation. Our results indicate weak GeV-range GCR spectral variation due to HSSs and CIRs, relative to the flux variation, in contrast with the strong observed spectral variation due to solar modulation.'

Collaborations

Keywords and Comments
'neutron monitor; solar modulation; corotating interaction regions; high-speed solar wind streams', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Modeling of the TeV cosmic-ray anisotropy based on intensity mapping in an MHD-simulated heliosphere

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 469

Presenter
Takashi K. Sako
Author and Co-Author
Takashi K. Sako | For the Tibet ASgamma Collaboration,

Abstract
"Arrival directions of galactic cosmic rays observed at the Earth are not completely uniform; at TeV energies there are small yet significant anisotropic features with amplitudes of roughly 0.1% such as large-scale deficit and excess regions called “Loss-Cone” and “Tail-In”, respectively. The origin of the anisotropy has not been known yet, although the anisotropy is considered to reflect how cosmic rays propagate through magnetic fields in the heliosphere and the surrounding interstellar medium. Recent studies make use of the ‘intensity-mapping’ method, in which heliospheric magnetic field structures are reconstructed by MHD simulations, trajectories of cosmic rays are calculated in the MHD-simulated heliosphere, and then the cosmic-ray intensity distribution observed at the Earth is mapped onto that at the outer boundary ideally outside the heliosphere based on Liouville's theorem.\r\nIn this presentation, we preform the modeling of the TeV cosmic-ray anisotropy outside the heliosphere using experimental data taken by the Tibet AS$\\gamma$ experiment. In the intensity-mapping process, we take into account for the first time the rigidity distribution of cosmic-ray particles observed by the experiment. We also discuss the influence of the heliospheric modulation on the cosmic-ray intensity distribution by varying the distance of the outer boundary from the Sun in the intensity-mapping process."

Collaborations
, The Tibet ASgamma Collaboration

Keywords and Comments
", "

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Precision Measurement of Periodicities in the Daily Proton Fluxes with the Alpha Magnetic Spectrometer

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 21 Short-term modulation | SH
Presenter Forum Table

Presenter
Yi Jia
Author and Co-Author
Yi Jia,

Abstract
'The detailed measurement of the daily proton fluxes from May 20, 2011 to October 29, 2019 with the Alpha Magnetic Spectrometer on the International Space Station, is presented. We observed that the proton fluxes exhibit daily, monthly, and yearly variations. Beginning from 2015, we observed periodicities of 27, 13.5, and 9 days. The rigidity dependence of these periodicities is presented.'

Collaborations
AMS,

Keywords and Comments
'', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Observation of Z>2 trapped nuclei by AMS on ISS

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 470

Presenter
Martha Valencia
Author and Co-Author
Martha Valencia | Francesca Giovacchini | Alberto Oliva, for the AMS collaboration

Abstract
'The Alpha Magnetic Spectrometer collected over 150 billion cosmic rays events during the first 8.5 years of operation aboard the International Space Station. A component of Z>2 ions with rigidities below the rigidity cutoff and located in the South Atlantic Anomaly have been measured both in the down-going and up-going direction.'

Collaborations
AMS,

Keywords and Comments
", "

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Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Statistical Survey of Reservoir Phenomenon in Energetic Proton Events Observed by Multiple Spacecraft

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 19 SEP Acceleration and Propagation | SH
Presenter Forum Table

Presenter
Yang Wang
Author and Co-Author
Yang Wang | Dan Lyu | Boxi Xiao | Gang Qin | Yushui Zhong | Lele Lian,

Abstract
'In this work, reservoir phenomenon in the decay phase of gradual solar energetic particle (SEP) events are investigated with two Helios and IMP 8 spacecraft from January 1976 to March 1980, and with two STEREO and SOHO spacecraft from January 2010 to September 2014. Using these data, sixty-two reservoir events of solar energetic protons were identified, and the effects of perpendicular diffusion and magnetic mirror on the formation of the reservoir phenomenon have been studied. We find that the reservoir events could be observed in almost all longitudes in the ecliptic at 1 AU, and thus the perpendicular diffusion in the interplanetary space is an important mechanism to explain the uniform distribution of SEPs. Furthermore, in the 1976 April 30 event, the effects of magnetic mirror associated with an interplanetary coronal mass ejection (ICME) were observed during the reservoir phenomenon. Therefore, the effects of magnetic mirror could also help to form the reservoir phenomenon. This study could improve the understanding of the propagation of SEPs in the interplanetary space.'

Collaborations
SOHO, STEREO; Helios; IMP 8

Keywords and Comments
'Particle emission ; Particle acceleration; Particle transport; Coronal mass ejections;', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

The effects of magnetic boundary on the uniform distribution of energetic particle intensities observed by multiple spacecraft

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 471

Presenter
Yang Wang
Author and Co-Author
Yang Wang | Dan Lvy | Gang Qin | Boxi Xiao,

Abstract
'In the decay phase of solar energetic particle (SEP) events, particle intensities observed by widely separated spacecraft usually present comparable intensities (within a factor of 2-3) that evolve similarly in time. The phenomenon of SEP events is called reservoir, which could be observed frequently in intensive gradual SEP events. In this work, we examine the effects of magnetic boundary on the formation of reservoir phenomenon in energetic proton and electron events. In the 1978 January 01 and the 2000 November 08 SEP events, we find the effects of magnetic boundary associated with the reservoir phenomenon were observed simultaneously in the sheath of magnetic cloud (MC)/interplanetary coronal mass ejection (ICME). Based on the observations, we suggest that the effects of magnetic boundary could be due to the magnetic mirrors and/or the small diffusion coefficients in the sheath region, and could help to form the reservoir phenomenon in both energetic proton and electron events in some large SEP events.'

Collaborations
Voyager, ACE; Ulysses; Helios

Keywords and Comments
'Particle emission ; Particle acceleration; Particle transport; Coronal mass ejections;', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Evolution of electron spectrum during March 2012 by ARINA spectrometer data

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 472

Presenter
Vladimir Mikhailov
Author and Co-Author
Sergey Aleksandrin, Temir Zharaspayev | Vladimir Mikhailov

Abstract
'Electron fluxes with energies of 3-30 MeV were analyzed using data from the ARINA satellite experiment. The changes in the spectrum of high-energy electrons in March 2012 were analyzed.'

Collaborations

Keywords and Comments
", "

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Parker Solar Probe's Measurements of the November 29, 2020 Large Solar Energetic Particle Event

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 19 SEP Acceleration and Propagation | SH
Presenter Forum Table

Presenter
Christina Cohen
Author and Co-Author
E.R. Christian | Christina Cohen | A.C. Cummings | A.J. Davis | M.I. Desai | G.A. de Nolfo | J. Giacalone | M.E. Hill | C.J. Joyce | A.W. Labrador | R.A. Leske | W.H. Matthaeus | D.J. McComas | R.L. McNutt Jr. | R.A. Mewaldt | D.G. Mitchell | J.G. Mitchel,

Abstract
'On November 29, 2020 active region 12790 was located just beyond the east limb of the Sun as viewed by Earth. It erupted at 12:34UT with an M4.4 flare (as measured by GOES) and launched a coronal mass ejection (CME) traveling ~1700 km/s. Not surprisingly, this fast CME drove a shock that accelerated particles up to tens of MeV/nuc. More unusual was that these solar energetic particles (SEPs) quickly filled the inner heliosphere and the event was observed by spacecraft distributed around the Sun, including Parker Solar Probe (PSP), STEREO-A, Solar Orbiter, and those near Earth such as ACE and SOHO. This was the first large SEP event detected by the Integrated Science Investigation of the Sun (ISOIS) suite on PSP and its first opportunity to make measurements of heavy ion spectra up to tens of MeV/nuc. Here we present an overview of event characteristics as determined by ISOIS, including H, He, O, and Fe spectra, composition as a function of energy, and temporal variations of the energetic particle intensities throughout the event.'

Collaborations

Keywords and Comments
'Solar energetic particles; particle acceleration; particle transport', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Disturbances in communication and radar work on the air traffic control tower of the military airport in Deblin.

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 473

Presenter
Krzysztof Iskra
Author and Co-Author
Krzysztof Iskra | Justyna Tomaszewska | Marek Siłuszyk | Michał Borkowski | Jan Baranski | Magdalena Baranska | Tomasz Zienkiewicz | Tomasz Seredyn,

Abstract
"We study the impact of electromagnetic conditions in the Sun, in interplanetary space and the Earth's magnetosphere (that is the so-called space weather) on possible disturbances with radar work and loss of communication with aircraft on the air traffic control tower (ATC) of the military airport in Dęblin.\r\nAt the beginning, the period of maximum solar activity in 2014 was examined\r\nAn analysis was performed using solar parameters such as: sunspot numbers(SSN), sunspot areas SSA,the solar flare index (SFI), the 10.7-cm solar radio flux, coronal mass ejection (CME), interplanetary parameters i.e. heliospheric magnetic field (HMF), proton temperature, proton density, solar wind (SW) speed,SW pressure, and geomagnetic parameters i.e.: geomagnetic field, DST index, Ap index, Kp index ,local K index from Belsk and their possible impact on radar disorders and loss of communication.\r\nThe preliminary results obtained indicate the possible impact of an increase in solar activity and associated disturbances in interplanetary space and the Earth's magnetosphere on the work of radars and communication between the ATC tower and the aircraft Our research are continued and are important from the point of view of flight safety for both manned and unmanned aircraft."

Collaborations

Keywords and Comments
'space weather ;loss of communication with aircraft', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Measurement of interplanetary magnetic field in short period using the cosmic-ray Sun shadow measured by LHAASO

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 474

Presenter
Yuncheng Nan
Author and Co-Author
Yuncheng Nan | Songzhan Chen | Cunfeng Feng | for the LHAASO Collaboration,

Abstract
"The interplanetary magnetic field (IMF) between the Sun and the Earth induces the displacement of the cosmic-ray Sun shadow from the optical position. Previously, the average IMF has been measured by the ARGO-YBJ and the Tibet-ASgamma experiments through several years of data. With the improvement of the sensitivity, the first pool of WCDA in LHAASO, which has obtained nearly one year's scientific data, has observed the Sun shadow with significance exceeds 70 standard deviation. Using the data collected by WCDA from July 26 to August 22, 2019, we measured the displacements of Sun shadow at the energy of 6.2 TeV every two or three days. Combining with the simulation of Sun shadow, the IMF is measured and is comparable with the satellite observations. This is the first time to measure the IMF using Sun shadow in a short period, and the expectation for space weather forecast is discussed."

Collaborations
Lhaaso,

Keywords and Comments
'IMF；Sun shadow', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Relativistic Electron Precipitation Observations with CALET on the International Space Station

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 475

Presenter
Alessandro Bruno
Author and Co-Author
Alessandro Bruno | Georgia A. de Nolfo | Anthony Ficklin | T. Gregory Guzik | Lauren Blum | for the CALET Collaboration,

Abstract
'The CALorimetric Electron Telescope (CALET) is a high-energy astroparticle physics experiment installed on the International Space Station, and taking data since October 2015. While designed for studying the origin and the propagation of galactic cosmic rays, CALET is also able to provide a continuous monitoring of space-weather phenomena affecting the near-Earth environment, including solar energetic particle and relativistic electron precipitation (REP) events. In this work we present preliminary results of the REP observations made over a four-year acquisition time (2015-2019), investigating their correlations with the interplanetary and geomagnetic conditions. We also took advantage of a multi-spacecraft study using the twin Van Allen Probe measurements to complement CALET detections in low-Earth orbit, enabling a more complete picture of the global precipitation rates and drivers.'

Collaborations
CALET,

Keywords and Comments
"Relativistic Electron Precipitation; Space Weather; Earth's Radiation Belts", "

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Galactic Cosmic Ray increase associated to an interplanetary magnetic cloud observed by HAWC

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 24 Ground-based measurements of low-energy GCRs | SH
Presenter Forum Table

Presenter
Alejandro Lara
Author and Co-Author
Alejandro Lara,

Abstract
'We present the observation of an anomalous increment of the galactic cosmic ray (GCR) flux observed by the HAWC array during October 2016. We propose that an anisotropy of the GCR flux caused by a magnetic flux rope (MFR) i. e., by the helical magnetic field of an interplanetary coronal mass ejection observed at 1 AU at the same time, was responsible for the GCR increment.\r\nWe computed the trajectory of protons with energy in the 10 to 60 GeV range traveling inside the helicoidal magnetic field observed in situ. The direction of these particles changes towards the axis of the MFR resulting in an anisotropy of the GCR flux along this axis.\r\nThis model shows that the alignment between the MFR axis and the HAWC´s asymptotic direction, combined with the high sensitivity of HAWC, allowed us to observe the effect of the passage of the MFR on the GCR flux.\r\nWe present the HAWC observation associated with the passage of the MFR as well as the heliospheric circumstances around such phenomenon.'

Collaborations
HAWC,

Keywords and Comments
'Interplanetary Coronal mass ejections: magnetic clouds; magnetic flux rope; cosmic ray modulation', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Solar Energetic Particles measured by the Alpha Magnetic Spectrometer during solar cycle 24

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 23 Solar Events observed on/near Earth | SH
Presenter Forum Table

Presenter
Light Christopher
Author and Co-Author
Maura Graziani, Light Christopher

Abstract
'During its 8.5 years of operations on board the International Space Station, AMS has detected several solar energetic particle (SEP) events produced during M- and X-class flares and fast coronal mass ejections. AMS is able to study these SEPs at high energies, below a few GeVs, with unprecedented accuracy. These unique features of the observed SEPs will be presented.'

Collaborations
other (fill field below), AMS

Keywords and Comments
'', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Search for neutrinos associated with solar flare

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 477

Presenter
Kohei Okamoto
Author and Co-Author
Kohei Okamoto | Nakano Yuuki | Ito Shintaro,

Abstract
"The importance of search for neutrino generation during solar flare has been discussed for last 50 years while the detection has not been succeeded yet. Since neutrinos are not affected by interplanetary magnetic field, neutrinos associated with solar flares (solar flare neutrino) provides us information about a particle acceleration mechanism during solar flare. According to theoretical predictions, the solar flare neutrino flux on the earth depends on the location of a solar flare on the Sun. Super-Kamiokande(SK), the world's largest underground water Cherenkov detector, has observed neutrinos since 1996. The predicted probability of detection in SK is $8.5 x 10^{-1}$ event/flare for a solar flare which occurs on the opposite side of Sun surface from the earth (rear side), and $1.0 x 10^{-3}$ event/flare from a solar flare of the other side (front side). In order to reduce atmospheric neutrino background for solar flare neutrino search, we have set the search window for the production time of neutrino during a solar flare occurred on front side of the Sun by analyzing data recorded by solar satellites, such as GOES, RHESSI, and Geotail [*Sol Phys* 295, 133 (2020)]. We used Coronal Mass Ejection(CME) event catalog which is made by NASA from SOHO satellite data to determine a search window for solar flare neutrino search from solar flare occurred on rear side of the Sun. In this presentation, we will present the current status of solar flare neutrino search in SK."

Collaborations
other (fill field below), Super-Kamiokande

Keywords and Comments
'Solar flare ;Particle acceleration; Neutrino', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Precision Measurement of Daily Helium Fluxes by the Alpha Magnetic Spectrometer

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 478

Presenter
cristina consolandi
Author and Co-Author
cristina consolandi,

Abstract
'The precision measurement of the daily helium fluxes from May 20, 2011 to October 29, 2019 with the Alpha Magnetic Spectrometer on the International Space Station, is presented. The period of observation covers half solar cycle 24 from the ascending phase through its maximum going toward its minimum. Time variation of the fluxes on different time scales associated to the solar activity, are shown. We found that the p/He flux ratio is inversely proportional to the proton flux in a similar way in daily and longer time scales. Detailed time variations of fluxes and ratio will be presented.'

Collaborations
AMS,

Keywords and Comments
'Galactic cosmic rays; helium; proton over helium flux ratio; time dependent; solar modulation', 'AMS02 Collaboration'

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Galactic Cosmic-Ray Intensities During three Solar Minima

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 20 GCR long-term modulation | SH
Presenter Forum Table

Presenter
Richard Mewaldt
Author and Co-Author
Richard Mewaldt,

Abstract
'The Cosmic-Ray Isotope (CRIS) and Solar Isotope Spectrometer (SIS) on the Advanced Composition Explorer(ACE) have measured energy spectra of cosmic-ray elements and isotopes since launch in 1997. We report energy spectra of abundant elements from C to Ni during solar minimum conditions from the 1997, 2009, and 2019-2020 solar minima and compare peak intensities with solar-wind conditions in these 3 minima. In 2010 we reported that peak intensities from the 2009 solar minimum were the highest of the space era (coinciding with the weakest interplanetary magnetic field of the space era). During Nov.2019-January 2020 ACE data show 200 MeV/nuc intensities of C-Fe reached, and in some cases exceeded those in 2009.This talk reports GCR intensities from 1997-2021 and discusses their dependence on solar-wind properties.'

Collaborations
other (fill field below), ACE GCR Team

Keywords and Comments
'GCR Energy Spectra; Solar minimum Peak GCR Intensities;\r\nDiscussion of solar modulation Effects', 'There are nine co-authors from Caltech, JPL, Washington U., and NASA/Goddard'

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

High-resolution two-dimensional map of the solar-time anisotropy obtained by the GRAPES-3 large-area muon telescope

Time 21 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 24 Ground-based measurements of low-energy GCRs | SH
Presenter Forum Table

Presenter
Tatsumi KOI
Author and Co-Author
H Kojima | Tatsumi KOI | Isao Morishita | Y Muraki | Toshiyuki Nonaka | Shoichi Ogio | Hisanori Takamaru | for the GRAPES-3 Collaboration,

Abstract
'In analyzing the anisotropy of galactic cosmic rays below 1 TeV, graphs\r\nwith time as the horizontal axis frequently represent the cosmic ray\r\nintensity variations. Therefore, the anisotropy is often misinterpreted\r\nas a "temporal variation," even though essentially regarded as a\r\n"spatial distribution."\r\n\r\nThis paper presents a high-resolution two-dimensional map of the\r\nsolar-time anisotropy using the GRAPES-3 large-area muon telescope at\r\nOoty, South India, which has an excellent capability of observing the\r\nmuon intensity in 169 subregions within a 45-degree zenith angle with a\r\ntemporal resolution of 4 minutes.'

Collaborations
, GRAPES-3

Keywords and Comments
'Solar modulation; muon telescope', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Periodicities Observed in Neutron Monitor Counting Rates Throughout Solar Cycles 20-24

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 21 Short-term modulation | SH
Presenter Forum Table

Presenter
Alejandro López Comazzi
Author and Co-Author
Alejandro López Comazzi, Juan José Blanco Ávalos

Abstract
'Neutron monitor cosmic rays and Sun Spot Number (SSN) measurements from 1964 to 2019 corresponding with the Solar Cycles 20–24 have been used. A Global Neutron Monitor (GNM) has been built as virtual representative station to characterize solar activity. Morlet wavelet analysis was applied to the GNM and SSN in order to determine possible periodicities. This analysis was applied both to\r\nthe whole studied interval (1964–2019) and to each Solar Cycle separately. The 27-day period and its second harmonic, related to solar synodic rotation, a periodicity between 45 and 84 days, the Rieger\r\nperiod and nearly annual period have been detected in all SCs in the two analyzed magnitudes. On a larger scales, 1.3–, 1.7–,11– and 19–year periods were obtained in GNM counting rates and 2.4-, 3.3–, 5.6- and 11-year period in SSN. A time lag analysis between GNM and SSN have also been performed.\r\nThe result obtained in this study confirms previous works: in the even SCs, the maximum value of cross-correlation function occurs in a lag of 4—6 days while in the odd SCs in a lag of 100—300 days. This fact implies that the modulation of cosmic rays by solar activity is different for odd and\r\neven cycles.'

Collaborations
other (fill field below), SRG-UAH

Keywords and Comments
'Cosmic Rays; Neutron Monitors; Sunspot Number', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Precision measurement of daily electrons fluxes by AMS¶

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 479

Presenter
Weiwei Xu
Author and Co-Author
Weiwei Xu | Fabian Machate | maura graziani | Tong Su,

Abstract
'The detailed measurement of the daily electron fluxes from May 20, 2011 to October 29, 2019 with the Alpha Magnetic Spectrometer on the International Space Station, is presented. Time variation of the fluxes on different time scales associated with the solar activity over half solar cycle 24 is shown. The measured effect of charge sign dependent effects on particles with the same mass is discussed.'

Collaborations
AMS,

Keywords and Comments
'', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

New Data from the ISOIS instrument Suite on Parker Solar Probe

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 480

Presenter
Eric Christian
Author and Co-Author
Eric Christian | David McComas | Christina Cohen | Alan Cummings | Andrew Davis | Mihir Desai | Georgia A. de Nolfo | J. Giacalone | M.E. Hill | C.J. Joyce | A.W. Labrador | R.A. Leske | W.H. Matthaeus | R.L. McNutt Jr. | R.A. Mewaldt | D.G. MItchell | J.,

Abstract
'NASA's Parker Solar Probe (PSP) mission's first eight orbits include perihelia as close as ~11 million km (~16 solar radii), much closer to the Sun than any prior human-made object. Onboard PSP, the Integrated Science Investigation of the Sun (ISOIS) instrument suite makes groundbreaking measurements of solar energetic particles (SEPs). Here we discuss the near-Sun energetic particle radiation environment over PSP's first two and a half years, which reveal where and how energetic particles are energized and transported. We find a great variety of energetic particle events accelerated both locally and remotely. These include co-rotating interaction regions (CIRs), "impulsive" SEP events driven by acceleration near the Sun, and events related to Coronal Mass Ejections (CMEs). These ISOIS observations made so close to the Sun provide critical information for investigating the near-Sun transport and energization of solar energetic particles, which has been difficult to resolve from prior observations. The Parker Solar Probe ISOIS data are made public soon after the receipt at Earth (which can be many months after the observations). We will also discuss how to get access to the data.'

Collaborations

Keywords and Comments
'Solar Energetic Particles; acceleration; inner heliosphere;', ''

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Subcategory Experimental Results

STUDY OF THE MODULATION OF GALACTIC POSITRONS AND ELECTRONS FROM 2006-2016 WITH THE PAMELA EXPERIMENT

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 481

Presenter
Vladimir Mikhailov
Author and Co-Author
Vladimir Mikhailov, Mirko Boezio | Riccardo Munini | Donald Ngobeni | O.P.M Aslam | Marius Potgieter | Driaan Bisschoff | Sergey Aleksandrin | Sergey Koldobskiy

Abstract
'The PAMELA experiment had operated almost ten years on board of the Resurs DK1 satellite. The satellite was launched on 15 June 2006 and placed in orbit with an inclination of 70° and an altitude of 350–610 km. The experiment continuously measured electron and positron fluxes of galactic cosmic rays in a wide energy range from 50 MeV to hundreds of GeV. The spectra of electrons and positrons were analysed from the end of 23th until the beginning of 24th solar cycle including the prolonged deep solar minimum period from 2006 to the end of 2009 and the solar magnetic polarity reversal period in 2012-2014. Here, we present these spectra along with a comparison with experimental data obtained by the AMS-02 instrument, which has been operating in orbit since 2011, and with numerical solutions of a comprehensive three-dimensional drift model of solar modulation. The comparison of observations and modelling provides valuable insight into how the diffusion process changes and to what extent drift effects occur during a complete solar cycle.'

Collaborations
PAMELA,

Keywords and Comments
'electrons; positrons; magnetic spectrometer; heliospheric modulation', ''

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Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Variation of proton fluxes of galactic cosmic rays during 2012-2020 according to data from the Russian spacecraft in geostationary orbit

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 482

Presenter
Evgeny Bondarev
Author and Co-Author
Evgeny Bondarev | Alexander Koziukov | Grigory Protopopov | Pavel Chubunov | Andrey Repin | Valentina Denisova | Alexey Tsurgaev,

Abstract
'In this paper, we study the effect of solar modulation over the past decade, and also conduct a comparative analysis with the data provided by the GOES spacecraft.\r\nThe measurements were carried out using the Russian spacecraft on the geostationary orbit. The detector has 5 channels for detecting protons with energies E $\\geq$ 3.5 MeV, E $\\geq$ 15 MeV and also with energies E = 13.7-23 MeV, E = 23-42 MeV , E = 42-112 MeV.'

Collaborations

Keywords and Comments
'Galactic cosmic rays; solar modualtion', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Study of the solar modulation for the cosmic ray isotopes with the PAMELA experiment

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 483

Presenter
Alex Lenni
Author and Co-Author
Alex Lenni | Mirko Boezio | Riccardo Munini | Wolfgang Menn | Nadir Marcelli | Marius Potgieter | Driaan Bisschoff | Donald Ngobeni | O.P.M Aslam,

Abstract
'The space-borne PAMELA experiment was launched on the 15th June 2006 on board the Russian satellite Resurs-DK1 from the Baikonur cosmodrome. From the beginning PAMELA performed high-precision measurements of cosmic rays over a wide energy range until January 2016. Owing to its long-duration operation, PAMELA had turned out to be an optimal detecting apparatus for studies of the solar modulation of cosmic rays over time. The PAMELA collaboration has already published time-dependent proton, Helium and electron spectra as well as the positron to electron ratio over ten years of data. These results are fundamentally important in the fine-tuning of propagation and modulation models of cosmic rays through the Heliosphere.\r\n\r\nIn this talk, the yearly average spectra for proton, Deuterium, Helium3 and Helium4 are presented for the 23rd solar minimum (July 2006 - January 2009) and the first part of the 24th solar maximum (until September 2014). The isotopic composition was measured between 0.1 and 1.1 GeV/n using two different detector systems. As expected, the measured spectra display a rising trend towards solar minimum followed by a decreasing trend which has continued as solar maximum approached. The subsequent time-dependent ratio of these isotopes is also presented. \r\n\r\nAccording to solar modulation studies, a non-constant ratio is expected due to the different charge-to-mass ratios (and therefore the appropriate rigidities) and the different shapes of the respective local interstellar spectra. Additionally, it is of interest to analyze the observed spectra with state-of-the-art solar modulation models to obtain a deeper understanding of the relative importance of the mechanisms responsible for the propagation of cosmic rays in the Heliosphere over time.'

Collaborations
PAMELA,

Keywords and Comments
", "

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Energy Balance at Interplanetary Shocks: In-situ Measurement of the Fraction in Supra-thermal and Energetic Ions with ACE and Wind

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 19 SEP Acceleration and Propagation | SH
Presenter Forum Table

Presenter
Liam David
Author and Co-Author
Liam David | Federico Fraschetti, Joe Giacalone | Robert Wimmer-Schweingruber | Lars Berger | David Lario

Abstract
'Energetic particles generated by interplanetary shocks can drain a non-negligible fraction of the upstream ram pressure. We have selected a sample of shocks observed in-situ at 1 AU by the ACE and Wind spacecraft from the CfA Interplanetary Shock Database, which provides high-resolution data on solar wind plasma, shock parameters, and the local magnetic field. Time-series of the non-Maxwellian (supra-thermal and higher-energy) particle energy spectra were acquired for each event, averaged for one hour before and after the shock time, and integrated over velocity space to ascertain their partial pressure. Using the Rankine-Hugoniot MHD jump conditions, we find that the fraction of the total upstream energy flux density transferred to non-Maxwellian particles can reach about 15-35%. Notably, our sample shows that neither the Alfven Mach number nor the angle between the shock normal and upstream magnetic field are correlated with the energy drained by the particles. The findings are also insensitive to the offset of the time interval used for the partial pressure estimate. We obtain similar results, although with larger error bars, using shock parameters from the IPShocks database.'

Collaborations

Keywords and Comments
'particle acceleration; interplanetary shocks', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Can the number of relativistic solar proton 1 AU crossings be determined from neutron monitor data?

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 23 Solar Events observed on/near Earth | SH
Presenter Forum Table

Presenter
Silvia Dalla
Author and Co-Author
Silvia Dalla | Alessandro Bruno | Timo Laitinen | Georgia A. de Nolfo | James Ryan | Adam Hutchinson | Charlotte Waterfall,

Abstract
'Energetic protons released during solar eruptive events experience scattering during their interplanetary propagation and may cross the spherical surface of radius 1 AU multiple times. Knowledge of N_cross, the average number of 1 AU crossings per particle, is therefore important to deduce the total number of protons in interplanetary space during solar energetic particle events, for example for comparison with the number of interacting protons at the Sun during gamma-ray flares. It has been proposed that for relativistic protons N_cross can be obtained by comparing the relative fluences measured in the sunward and anti-sunward directions by the worldwide network of neutron monitors during ground level enhancements (GLEs). For four recent GLE events, we use neutron monitor data to derive N_cross using the latter approach and we compare the results with those of full-orbit test particle simulations of relativistic protons in a Parker spiral magnetic field, including the effects of scattering and drifts. We show that the approach based on neutron monitor data significantly underestimates N_cross during highly-anisotropic SEP events. This is due to the data sampling only a very small portion of the 1 AU sphere.'

Collaborations

Keywords and Comments
'Solar relativistic protons; particle acceleration; particle propagation; solar energetic particles; Ground Level Enhancements', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

Test particle simulations of SEPs originating from an expanding shock-like source

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 484

Presenter
Adam Hutchinson
Author and Co-Author
Adam Hutchinson | Silvia Dalla | Timo Laitinen | Charlotte Waterfall,

Abstract
'Solar Energetic Particles (SEPs) are known to be accelerated at Coronal Mass Ejection (CME)-driven interplanetary shocks. Traditionally their propagation has been described via focussed transport approaches, limited to 1 or 2 spatial dimensions. We use 3D test particle simulations, which naturally incorporate the effect of drifts and of the Heliospheric Current Sheet (HCS), to simulate the propagation of SEPs from a moving shock-like source. We investigate the effect of an expanding shock-like source propagating through interplanetary space, as opposed to an SEP source within the corona, on the observable properties of SEPs at 1 au and at locations nearer the Sun. We derive intensity profiles, anisotropies and longitudinal and latitudinal distribution of SEPs, with the aim of supporting observations from Solar Orbiter and Parker Solar Probe'

Collaborations

Keywords and Comments
'SEPs; Particle Propagation; Shock accelerated particles; Interplanetary Transport', ''

Branch SH | Solar & Heliospheric

Subcategory Experimental Results

MODULATION OF LONG-TERM COSMIC RAY VARIATIONS DURING SOLAR ACTIVITY MINIMUM OF THE 24TH SOLAR CYCLE

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 485

Presenter
Lev Dorman
Author and Co-Author
Lev Dorman | Lev Pustilnik,

Abstract
'*The observed weakening of the global magnetic field of the Sun, which began at the end of the 22nd cycle of solar activity (SA) raise the question of the response of this phenomenon in cosmic rays (CR) propagating in the heliosphere. Weak long-term modulation in the 23rd and 24th cycles of SA is the result of the trend of the solar field in cycles with different signs of the total magnetic field of the Sun (qa±1) for particles in the rigidity range we studied (1-25GV). The work was carried out on the material of continuous CR observations (1957-2020) by a network of neutron monitors, telescopes, and stratospheric balloon probes. The spectrum of CR variations in the minimum of 24/25 (2019-2020) was determined using the global spectrographic method developed by us. The spectral characteristics of the variations of the anomalous 24th SA cycle are compared (base 1.1987-12.1987) with the corresponding characteristics of the previous SA cycles (19-23). At SA minimum of 24/25 a flat (confirming the drift modulation theory for qA+1) maximum of the CR flow is observed from 2018 to the present time. At the same time, the amplitude of variations for low-energy particles (observed in the stratosphere) exceeds the value of the base period variations by ~8% and is 0.8% of the amplitude of the CR variations at the minimum of 23/24 in 2009. Max particle flow medium and high energies observed in neutron monitors and telescopes 1-2% lower than that of 23/24. If distribution of achieving minimum 23/24 particles of different energies indicated the beginning of a new cycle in CR.'

Collaborations

Keywords and Comments
'minimum of solar activity; CR modulation', ''

Branch SH | Solar & Heliospheric

Subcategory Future projects

Performance of the current and extended global NM network for solar particle registration and analysis

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 486

Presenter
Alexander Mishev
Author and Co-Author
Alexander Mishev, Ilya Usoskin

Abstract
'Over the years the global neutron monitor network (NMN) was extensively and successfully used to study variable fluxes of Galactic cosmic rays accelerated solar ions, the latter known as energetic solar particles. Recently, the NMN has been used also for space weather purposes, specifically event alerts, and to provide crucial information necessary for the assessment of the exposure to radiation at flight altitudes. Here, we discuss the current status and applications of the global NMN, specifically its capability to study solar energetic particles, including assessments of their spectral and angular distributions during large strong solar proton events e.g. ground level enhancements. Several examples are presented, accordingly. We also discuss the existing gaps in the network and propose an improvement of the network, namely a plan for an extension of the existing network with several new monitors, in order to provide a more precise analysis of strong solar proton events and to respond to the enhanced need for the current space weather services. We discuss the ability of the optimized global neutron monitor network to study different populations of solar energetic particles and to provide reliable space weather services.'

Collaborations

Keywords and Comments
'neutron monitor; solar energetic particles; space weather', 'Program for extension of the current global neutron monitor network.'

Branch SH | Solar & Heliospheric

Subcategory Future projects

SOlar Neutron and Gamma-ray Spectroscopy Mission: SONGS

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 487

Presenter
Kazutaka Yamaoka
Author and Co-Author
Kazutaka Yamaoka, Tajima Hiroyasu | Daiki Nobashi | Masaki Usami | Kikuko Miyata | Takaya Inamori | Kazuhiro Nakazawa | Koji Matsushita | Kazuya Ito | Satoshi Masuda | Hiromitsu Takahashi | Kyoko Watanabe

Abstract
'Fast neutrons generated by the interaction between ions and the solar atmosphere are important observation probles to clarify the ion acceleration mechanism in the Sun, but so far neutrons have been detected from only 12 X-class solar flares in the highland on the ground due to the influence of atmospheric absorption. As for observations in space, SEDA-AP at the International Space Station continued to operate until 2018 and succeeded in neutron detections from 52 solar flares, but there are currently no dedicated space missions. In order to overcome this situation, we have been designing and developing 3U CubeSat and novel neutron / gamma ray sensors since 2018 with the aim of performing satellite observations from outer space. The sensor consists of the multi-layered plastic scintillator bars readout with Si PM, which is a semiconductor photosensor, and detects fast neutrons from the tracks of ejected protons by elastic scattering. Furthermore, by placing a GAGG scintillator array at the bottom, it is designed to be sensitive to gamma rays based on the principle of the Compton camera. In this presentation, we will report on the scientific purpose and the development status of CubeSat and neutron / gamma-ray sensors.'

Collaborations

Keywords and Comments
'Microsatellite; Solar flares; Neutron and gamma-rays; scintillators; semiconductor photosensor', ''

Branch SH | Solar & Heliospheric

Subcategory Outreach and Education

Health threat from cosmic radiation during manned missions to Mars

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 488

Presenter
Alexandra D Bloshenko
Author and Co-Author
Alexandra D Bloshenko | Jasmin M. Robinson | Rafael A. Colon | Luis A. Anchordoqui,

Abstract
'Cosmic radiation is a critical factor for astronauts' safety in the context of evaluating the prospect of future space exploration. The Radiation Assessment Detector (RAD) on board the Curiosity Rover launched by the Mars Scientific Laboratory mission collected valuable data to model the energetic particle radiation environment inside a spacecraft during travel from Earth to Mars, and is currently doing the same on the surface of Mars itself. The Martian Radiation Experiment (MARIE) on board the Mars Odyssey satellite provides estimates of the absorbed radiation dose in the Martian orbit, which are predicted to be similar to the radiation dose on Mars' surface. In combination, these data provide a reliable assessment of the radiation hazards for a manned mission to Mars. Using data from RAD and MARIE we reexamine the risks for a crew on a manned flight to Mars and discuss recent developments in space exploration.'

Collaborations

Keywords and Comments
'cosmic radiation threat to astronauts; mission to Mars', ''

Branch SH | Solar & Heliospheric

Subcategory Outreach and Education

Low Cost Neutron and Muon Detectors for Soil Moisture Monitoring

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 489

Presenter
Patrick Stowell
Author and Co-Author
Patrick Stowell | Paula M. Chadwick | Anthony Brown | Cameron B. Rulten,

Abstract
'Water scarcity is a significant challenge for the world’s population. With the likelihood of extreme droughts increasing each year, technologies to promote sustainable irrigation and improve resilience to water shortage are needed. Continuous monitoring of soil moisture in arid regions is a major problem as existing techniques such as point sensors or satellite mapping can have high associated costs per hectare.\r\n\r\nCosmic Ray Neutron Sensing (CRNS) of soil moisture is a well established technique in the hydrological community. Helium-3 CRNS probes placed above a site can detect cosmic ray neutrons backscattered from the surrounding soil 130-240m away. By monitoring the variation in the total neutrons observed over time (and correcting for cosmic ray intensity) it is possible to estimate the average volumetric soil moisture content for a site. With a large detector footprint, the technique can bridge difference in length scales between point probes and satellite data, however the high cost of Helium-3 is a barrier for adoption outside of the hydrological community.\r\n\r\nWe are currently developing new boron-nitride based cosmic ray detectors as alternatives to expensive Helium-3 detectors. Taking advantage of developments in scintillator composites within the nuclear industry, and low power single photon counting instrumentation, these cost efficient detectors will be specifically optimised for use on smallholder farms. In this talk, I will present the optimisation and testing of these new systems before discussing the use of low cost muon sensors to automatically correct for temporal variations in the incoming cosmic ray intensity.'

Collaborations

Keywords and Comments
'Instrumentation; Neutron; Scintillator; Industrial Application; Soil Monitor;', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Methods

Strongest directly observed Solar Proton Event of 23-Feb-1956: Revised reference for the cosmogenic-isotope method

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 22 Atmospheric effects of CR | SH
Presenter Forum Table

Presenter
Ilya Usoskin
Author and Co-Author
Ilya Usoskin | Sergey Koldobskiy | Gennady Kovaltsov | Eugene Rozanov | Timofei Sukhodolov | Alexander Mishev | Irina Mironova,

Abstract
'Solar extreme solar proton events (SPEs) form important radiation hazards for modern technological society. The strongest directly observed SPE took place on 23-Feb-1956 as an up to 5000 % increase of the count rate of ground-based neutron monitors. It was characterized by a very hard energy spectrum and strong particle fluence. On the other hand, as known from indirect proxies (cosmogenic isotopes), extreme events, 1-2 orders of magnitude stronger, occurred during the past millennia. In order to study past events, a reference scale needs to be made. The SPE of 23-Feb-1956 is often used as such a reference. Thanks to the recent developments in the methodology of SPE analysis, the spectrum of fluence of the reference event have been revisited and re-assessed with higher precision. Here we present the revision of the reference event and estimate the sensitivity of the cosmogenic-isotope method to detect extreme SPEs in the past. It is shown that the modern accuracy of the cosmogenic-isotope method to SPEs is insufficient to detect the reference event but can resolve events 3-4 times stronger. This provides a solid basis for research in the field of extreme events, both for fundamental science, namely solar and stellar physics, and practical applications, such as the risk assessments of severe space-based hazards for a modern technological society.'

Collaborations

Keywords and Comments
'solar energetic particles; solar particle events; neutron monitors', ''

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Branch SH | Solar & Heliospheric

Subcategory Theoretical Methods

Cosmic rays modulation in heliosphere models on GPU

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 490

Presenter
Michal Solanik
Author and Co-Author
Michal Solanik | Pavol Bobík | Ján Genči,

Abstract
'Parker's transport equation stochastic solution for simulation cosmic rays distribution in the heliosphere is demanding on computing resources. Simulations can last days, weeks, or even months with certain input parameters. We implemented 1D Forward-in-time and Backward-in-time models for GPU with successful acceleration ranged from ~7x to 86x. This acceleration was gained with not a negligible reduction of accuracy, especially with changing the entire simulation from double-precision float-point format to floating-point format. This led to a certain deviation that we called pulsations that showed in results with input time step less than 2.0 s. In this paper, \r\nwe discuss the parallelization process on GPU. We also discuss the comparison of our solution with Dunzlaff et al. and the overall accuracy of results gained from GPU implementation of 1D Forward-in-time and Backward-in-time models.'

Collaborations

Keywords and Comments
'Heliosphere; Cosmic rays; GPU; Parker's transport equation', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Methods

Cosmic-ray interactions with the Sun

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 491

Presenter
Mario Nicola Mazziotta
Author and Co-Author
Mario Nicola Mazziotta,

Abstract
'The solar disk is a bright gamma-ray source in the sky. The interactions of cosmic rays with the solar atmosphere produce secondary particles which can reach the Earth. In this work we present a comprehensive calculation of the yields of secondary particles such as gamma-rays, electrons, positrons, neutrons and neutrinos, performed with the FLUKA code. We also estimate the intensity at the Sun and the fluxes at the Earth of these secondary particles by folding their yields with the intensities of cosmic rays impinging on the solar surface. The results are sensitive to the assumptions on the magnetic field near the Sun and to the cosmic-ray transport in the magnetic field in the inner solar system.'

Collaborations
Ferrmi-LAT,

Keywords and Comments
'Solar disk emission;', ''

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Branch SH | Solar & Heliospheric

Subcategory Theoretical Methods

On the solar poloidal magnetic field as one of the main factors for maximum GCR intensity for the last five sunspot minima

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 492

Presenter
Mikhail Krainev
Author and Co-Author
Mikhail Krainev | Boris Gvozdevsky | Mikhail Kalinin | O.P.M. Aslam | Donald Ngobeni | Marius Potgieter,

Abstract
'The conditions in the heliosphere are considered during the minimum phase of the sunspot cycle when the intensity of galactic cosmic rays (GCRs) attains its maximum at the Earth. These times of maximum GCR intensity are determined for the last five sunspot minima, including the present one. From the quantitative correlation between the heliospheric factors important to the modulation of GCRs in the heliosphere and the index of high-latitude photospheric magnetic field (all determined during times of GCR intensity maxima) the conclusion is made that the poloidal magnetic field of the Sun is one of the main governing factors for these heliospheric characteristics.\r\nFollowing this up, the dependence of GCR proton spectra on the index as mentioned above for the last five sunspot minima 21/22 - 24/25 is calculated and discussed with special attention paid to the comparison of spectra for the current and previous sunspot minima and to the energy at which spectral cross-overs occur when the polarity of the heliospheric magnetic field is changed.'

Collaborations

Keywords and Comments
'GCR intensity; solar modulation in heliosphere; 3D transport equation; 2D transport equation', ''

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Branch SH | Solar & Heliospheric

Subcategory Theoretical Methods

On the transition from 3D to 2D transport equations for a study of long-term cosmic-ray intensity variations in the heliosphere

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 20 GCR long-term modulation | SH
Presenter Forum Table

Presenter
Mikhail Krainev
Author and Co-Author
Mikhail Kalinin | Boris Gvozdevsky | Mikhail Krainev | O.P.M. Aslam | Donald Ngobeni | Marius Potgieter,

Abstract
'We consider in our study the exact two-dimensional (2D) transport equation (TPE) for galactic cosmic ray (GCR) intensity in the heliosphere, averaged over longitude, and derived by averaging the full three-dimensional (3D) steady-state TPE over longitude. As we showed before, this exact 2D TPE is equal to that with the averaged 3D TPE coefficients but with the “source-term” Q2D due to 3D modulation effects. In particular, Q2D is equal to the longitude convolution of the longitudinal variances of the coefficients as used in the 3D TPE and as applicable to the modulation of GCR intensity. In our previous work we also suggested an expression (Qˇ_2D) for Q2D when estimated without solving the 3D TPE for the simplest case of the only characteristic, heliospheric feature depending on helio-longitude is the polarity of the solar magnetic field. \r\nThis study is focused on calculating the term Q̃_2D equal to the same longitude convolution as Q2D when solving numerically the steady-state 3D TPE for the above mentioned simplest case. For cases of close similarity between Q̃_2D and Qˇ_2D, we come to the conclusion that the 2D approach with Qˇ_2D can be used with confidence in the study of the long-term modulation of GCRs instead of using the complex way of solving the full 3D TPE for this simplest case. However, if the calculated (Q̃_2D) and estimated (Qˇ_2D) terms are found to be different, the application of the complex way seems inevitable.\r\nThis work is supported in part by RU-SA NRF-RFBR grant No. 19-52-60003 SA-t.'

Collaborations

Keywords and Comments
'', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Methods

New insights from cross-correlation studies between Solar activity and Cosmic-ray fluxes

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 493

Presenter
Nicola Tomassetti
Author and Co-Author
Nicola Tomassetti | Bruna Bertucci | Emanuele Fiandrini,

Abstract
"The observed variablity of the cosmic-ray intensity in the interplanetary space is driven by the evolution of the Sun's magnetic activity over its 11-year quasiperiodical cycle. Investigating the relationship between solar activity indices and cosmic-ray intensity measurements is then essential for understanding the fundamental processes of particle transport in the heliosphere. In this work, we present global characterization the solar modulation of cosmic rays over the solar activity cycle and for different energies of the cosmic particles. We present our cross-correlation studies using data from space experiments, neutron monitors and solar observatories collected over several solar cycles."

Collaborations

Keywords and Comments
", "

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Branch SH | Solar & Heliospheric

Subcategory Theoretical Methods

Statistical error for cosmic rays modulation evaluation by 1D and 2D models

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 494

Presenter
Viacheslav Mykhailenko
Author and Co-Author
Viacheslav Mykhailenko | Pavol Bobík,

Abstract
"The propagation of cosmic rays through the heliosphere is solved for more than half a century by stochastic methods based on Ito's lemma. This work presents the estimation of statistical error of solution of Foker – Plank equation by 1D forward stochastic differential equations method. \r\n\r\nThe error dependence on simulation statistics and energy is presented for different combinations of input parameters. The 1% precision criterium in intensities and 1% criterium in standard deviation are defined as a function of solar wind velocity and diffusion coefficient value. The implications for 1D backward and 2D models are also discussed."

Collaborations

Keywords and Comments
'Cosmic rays; Fokker - Planck equation; heliosphere; SDE method.', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Methods

Statistical analysis of Sunspot Area and their Heliospheric Effect for the Period 1986-2016

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 495

Presenter
Prithvi Raj Singh
Author and Co-Author
S.L. Agrawal | C. M. Tiwari | Abhay Kumar Singh | Prithvi Raj Singh,

Abstract
'Sunspot area varies over the Sun’s disk and is to be heliospheric behavior during the descending phase of solar cycle 22 to 24. Galactic Cosmic rays encounter an outward-moving solar wind with cyclic magnetic-field fluctuation and turbulence. This causes convection and diffusion in the heliosphere. We have observed that the galactic cosmic rays recoveries are much faster than the solar parameter (sunspot area) with negative time lag during the descending phase of solar cycles 22 and 24. Statistical analysis of absolute asymmetry (A) of sunspot area is carried out for quasi-biennial (QBO) period is ~1.95years with high amplitude during 2001. The significant Rieger-type periods (~124 to ~175 days) of the absolute asymmetry (A) of the sunspot area have been investigated using Morlet Wavelet Techniques (MWT) for combined solar cycles 22-24.'

Collaborations

Keywords and Comments
'Solar activity; Sunspot Area of Northern and Southern hemisphere of the Sun; Galactic Cosmic rays', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Methods

A simulation study of galactic proton modulation from solar minimum to maximum conditions

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 20 GCR long-term modulation | SH
Presenter Forum Table

Presenter
Dzivhuluwani Ndiitwani
Author and Co-Author
Dzivhuluwani Ndiitwani, Donald Ngobeni | O.P.M Aslam | Driaan Bisschoff | Marius Potgieter | Mirko Boezio | Riccardo Munini

Abstract
'The observation of various cosmic ray particles at the Earth had been done with the PAMELA space detector for almost 10 years, from June 2006 to January 2016. The AMS-02 space experiment provides similar cosmic ray data. The purpose of this work is to utilize the available state-of-the-art numerical modulation model for the transport of cosmic rays in the heliosphere to compute the modulation of galactic protons from minimum to maximum solar activity. These modeling results, which simulate realistic heliospheric conditions, are compared to proton observations from PAMELA taken between 2006 and 2014 and to similar AMS-02 observations after 2011. It will be shown how differently modulation mechanisms influence the time-evolution of the proton spectra when modulation conditions change from minimum to maximum.'

Collaborations
PAMELA,

Keywords and Comments
'"Heliosphere; Modulation; Pamela"', "

Branch SH | Solar & Heliospheric

Subcategory Theoretical Methods

SOLAR MODULATION OF GALACTIC-COSMIC RAY ANTIPROTONS

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 20 GCR long-term modulation | SH
Presenter Forum Table

Presenter
Riccardo Munini
Author and Co-Author
Riccardo Munini | Mirko Boezio | Donald Ngobeni | Driaan Bisschoff | Marius Potgieter | O.P.M Aslam | Nadir Marcelli,

Abstract
'In recent years, several new measurements of the antiproton component of the cosmic radiation have become available. These measurements have improved significantly the existing statistics, extending the explored energy region from few tens of MeV up to hundreds of GeV. These measurements are particularly relevant to understand the propagation of cosmic rays in the Galaxy and in the investigation of the nature of Dark Matter. However, an unambiguous interpretation of the experimental data requires a proper reconstruction of the very Local Interstellar Spectrum (LIS) of cosmic-ray antiprotons. Since these measurements are performed deep inside the heliosphere, solar modulation as a highly time and space dependent process which follows the 11-year solar activity cycle, has to be taken into account appropriately. In this work, using a 3D state-of-art solar modulation model, a new LIS for cosmic-ray antiprotons and its related uncertainties are presented. This LIS is derived to match, when modulated, the data sets from AMS02, PAMELA and BESS.'

Collaborations

Keywords and Comments
", "

Branch SH | Solar & Heliospheric

Subcategory Theoretical Methods

Data driven analysis of Galactic cosmic rays in the heliosphere: diffusion of cosmic protons and nuclei

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 496

Presenter
Nicola Tomassetti
Author and Co-Author
Nicola Tomassetti | Bruna Bertucci | Federico Donnini | Emanuele Fiandrini | Maura Graziani | Behrouz Khiali | Alejandro Reina Conde,

Abstract
'Galactic cosmic rays (GCRs) inside the heliosphere are affected by magnetic turbulence and Solar wind disturbances which result in the so-called solar modulation effect. To investigate this phenomenon, we have performed a data-driven analysis of the temporal dependence of the GCR flux over the solar cycle. With a global statistical inference of GCR data collected in space by AMS-02, PAMELA, and CRIS on monthly basis, we have determined the dependence of the GCR diffusion parameters upon time and rigidity. In this conference, we present our results for GCR protons and nuclei, we discuss their interpretation in terms of basic processes of particle transport and their relations with the dynamics of the heliospheric plasma.'

Collaborations

Keywords and Comments
", "

Branch SH | Solar & Heliospheric

Subcategory Theoretical Methods

Anisotropy of Cosmic Rays and Chaotic Trajectories in the Heliosphere

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 497

Presenter
Vanessa López-Barquero
Author and Co-Author
Vanessa López-Barquero | Paolo Desiati,

Abstract
"As cosmic rays (CRs) propagate in the Galaxy, they can be affected by magnetic structures that temporarily trap them and cause their trajectories to display chaotic behavior, therefore modifying the simple diffusion scenario. When CRs arrive at the Earth, they do so anisotropically. These chaotic effects can be a fundamental contributor to this anisotropy. Accordingly, this requires a comprehensive description of chaos in trapping conditions since it is necessary to assess their repercussions on the CR arrival directions. This study utilizes a new method described in López-Barquero & Desiati(2021) to characterize chaotic trajectories in bound systems. This method is based on the Finite-Time Lyapunov Exponent (FTLE), a quantity that determines the levels of chaos based on the trajectories' divergence rate. The FTLE is useful since it adapts to trapping conditions in magnetic structures or even propagating media changes. \r\nHere, we explore the effects that chaos and trapping can have on the TeV CR anisotropy. Concretely, we apply this method to study the behavior of CRs entering the heliosphere. Specifically, how the distinct heliospheric structures and CR impinging directions from the ISM can affect chaos levels. \r\nThe heliosphere has an intrinsic directionality that affects CRs differently depending on where they enter it. This feature causes preferential directions from which particles tend to be more chaotic than others. This eventually translates into changes in the arrival maps which are not uniformly distributed. Instead, we expect sectors in the map to change separately from others, creating a time-variation that could be detected. Consequently, this result points to the idea that time-variability in the maps is essential to understanding the CR anisotropy's overall processes."

Collaborations

Keywords and Comments
'Anisotropy; heliosphere; chaos; trapping; confinement; magnetic fields; MHD; solar wind; energetic particles; magnetic mirror; propagation;\xa0heliospheric;\xa0chaotic; cosmic rays; maps;', ''

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Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

The altitude profile of the cosmic ray atmospheric cutoff

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 22 Atmospheric effects of CR | SH
Presenter Forum Table

Presenter
Stepan Poluianov
Author and Co-Author
Stepan Poluianov, Alexander Mishev

Abstract
'Neutron monitors are the main ground-based instruments for continuous measurements the cosmic-ray intensity operating over more than five decades. Those instruments are energy-integrating detectors with count rates governed by the atmospheric and geomagnetic cutoffs. The geomagnetic cutoff dominates (up to 17 GV in rigidity) over most of the globe. However, it is negligible in the polar regions, and there, the atmospheric cutoff is important. The atmospheric cutoff depends on the elevation of the instrument above sea level (on the atmospheric depth), and it is estimated as ~1 GV for cosmic-ray protons at sea level. However, the cutoff is not precisely known at higher altitudes. This is specifically important for studies based on high-altitude polar neutron monitors, which count rate is solely defined by the atmospheric cutoff. \r\n\r\nWe present a newly estimated altitude profile of the atmospheric cutoff for cosmic-ray protons, which can be used in analysis of both galactic cosmic rays and solar energetic particles. We computed the profile using two methods. The first one is based on Monte Carlo simulation of the cosmic-ray induced cascade in the atmosphere with the PLANETOCOSMICS code. The second one uses recently computed and verified neutron monitor yield function by Mishev et al., 2020, which considers the efficiency of the instrument. Both methods agree reasonably well, though the yield-function based one provides a more conservative result, as expected. There are two definitions of solar-particle sub-GLE (sub-Ground-Level-Enhancement) events by Raukunen et al. (2018) and Poluianov et al. (2018) based on different principles. Considering the derived in this study atmospheric cutoff at altitudes about 3000 m a.s.l., we conclude: there is no contradiction between the definitions.'

Collaborations

Keywords and Comments
'neutron monitor; atmospheric cutoff; DOMC; DOMB; sub-GLE', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Stellar versus Galactic: The intensity of energetic particles at the evolving Earth and young exoplanets

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 22 Atmospheric effects of CR | SH
Presenter Forum Table

Presenter
Donna Rodgers-Lee
Author and Co-Author
Donna Rodgers-Lee, Aline Vidotto | Andrew Taylor | Paul Rimmer | Turlough Downes

Abstract
"Energetic particles may have contributed to the start of life on Earth and exoplanets. The stellar energetic particle and Galactic cosmic ray fluxes that reached Earth at the time when life is thought to have begun is largely determined by the stellar wind properties. The magnetic field strength and velocity profile of a solar-type star's wind evolve with time. Therefore, the modulation of Galactic cosmic rays will evolve with stellar age. Generally, young solar-type stars are very magnetically active and drive faster stellar winds. \r\n\r\nI will compare the contributions from two distinct populations of energetic particles: stellar energetic particles accelerated by their host stars and Galactic cosmic rays. I will present our recent results simulating the propagation of energetic particles through the astrosphere to the location of Earth as a function of a solar-type star's life. I will focus on the stellar and Galactic cosmic ray fluxes present at the time when life is thought to have begun on Earth (~1 Gyr) and 600Myr which is relevant for the exoplanetary system, HR 2562b orbiting a ~solar-type star. I will show that the Galactic cosmic ray intensities which reached the young Earth would have been greatly reduced in comparison to the present day intensity. At this time, stellar energetic particle fluxes would have been larger than Galactic cosmic rays at low energies. I will show the effect that the Sun being a slow/fast rotator would have had on the energetic particle fluxes reaching the young Earth. Finally, I will discuss the possible chemical signatures that we might expect from energetic particles which may be observable with upcoming missions such as JWST."

Collaborations

Keywords and Comments
", "

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Sensitivity estimation of LHAASO-WCDA for observing GLE events

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 498

Presenter
yunfeng zhang
Author and Co-Author
yunfeng zhang, Yonglin Feng | Huanyu Jia

Abstract
'Ground Level Enhancement (GLE) events of solar cosmic ray refer to the sudden, sharp and short-lived enhancement of ground level energetic particles generated from solar flare. The study of GLE events has been playing an important role in the study of solar activity and basic physics of cosmic rays. The Large High Altitude Air Shower Observatory (LHAASO), a multi-component instrument, is located at high altitude (4410 m a.s.l.) in Daocheng, Sichuan province, P.R. China, with the one of the main aims to observe GLE events. The sensitivity of LHAASO-WCDA to observe GLE events has been estimated in this paper. The minimum flux needed for LHAASO-WCDA to observe GLE event has been calculated by using the energy spectrum of 13 GLE events during 22 solar cycles. The result shows that LHAASO-WCDA can observe GLE events with the energy exceeds 50, 100, 200 or 500 GeV.'

Collaborations

Keywords and Comments
'sensitivity; GLE; LHAASO-WCDA', ''

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Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Using magnetic ray-tracing to reproduce the Sun's cosmic-ray shadow as seen by IceCube

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 499

Presenter
Jens Kleimann
Author and Co-Author
Jens Kleimann | Frederik Tenholt | Niklas Döpper | Mike Kroll | Julia Becker Tjus | Horst Fichtner | Paolo Desiati,

Abstract
'The cosmic-ray Sun shadow is caused by high-energy charged cosmic rays (CRs) being blocked and deflected by the Sun and its magnetic field, thereby modulating the resulting shadow in both size and shape. Recent Sun shadow observations by ground-based particle observatories have established a novel and potentially fruitful link between solar physics and high-energy particle astrophysics. Most notably, the shadow's size and depth was recently shown to correlate with the 11-year solar cycle.\r\nThis talk addresses the observational situation, the general setup and implementation of our group's Sun shadow simulations, test cases, and actual simulations of increasing complexity. Based on extrapolations from magnetograms, we create artificial shadow images by numerically computing trajectories of charged CRs in the coronal magnetic field for the energy range of 5-316 TeV and for various mass numbers and typically measured CR spectra, and analyze these images in comparison to data from the IceCube neutrino observatory. We confirm the observationally established correlation between the magnitude of the shadowing effect and both the mean sunspot number and the polarity of the magnetic field during the solar cycle. Contrary to previous findings, a non-monotonous dependence on energy during solar minimum is identified and modeled using a simplified (dipolar) configuration for the coronal magnetic field.'

Collaborations

Keywords and Comments
'particle tracing; imaging; solar corona; magnetic field', ''

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Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Transparency of magnetosphere for cosmic rays in last two millennia

Time 15 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 22 Atmospheric effects of CR | SH
Presenter Forum Table

Presenter
Daniel Gecášek
Author and Co-Author
Daniel Gecášek, Pavol Bobík | Genči Ján

Abstract
'We present a simulation of magnetosphere transparency for cosmic rays in the last two millennia. Simulations were done in the COR system, in a module for cosmic rays trajectory evaluation in different models of geomagnetic fields for period 0 to 1900 CE. The COR system available at cor.crmodels.org is also briefly presented. The global and local trends for cut-off rigidities evolution in the last two millennia are analyzed. Consequences for radiocarbon dating are discussed.'

Collaborations

Keywords and Comments
"cosmic rays; Earth's magnetic field; radiocarbon dating", ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Cosmic Rays from the Termination Shock to the Heliopause: the Role of the Heliospheric Current Sheet

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 500

Presenter
Jozsef Kota
Author and Co-Author
Jozsef Kota,

Abstract
"The large-scale heliospheric current sheet (HCS), dividing the two hemispheres of the opposite magnetic polarities is a dominant large-scale feature of the Heliosphere and is known to play a crucial role in the modulation of anomalous and galactic cosmic rays (ACRs and GCRs).. \r\nThe present work investigates how the HCS may affect the acceleration of ACRs at the solar wind termination shock (TS) and the transport of ACR and GCRs throughthe Inner Heliosheath (IHS). A 2D 'hoop model' model is employed, which can capture the most essential effects of the wavy HCS. We also discuss how do ACRs leave and GCRs enter the Heliosphere."

Collaborations

Keywords and Comments
"'Anomalous Cosmic rays; Particle acceleration; drift; termination shock; Heliopause"', "

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Combined heliospheric modulation of galactic protons and helium nuclei from solar minimum to maximum activity related to observations by PAMELA.

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 20 GCR long-term modulation | SH
Presenter Forum Table

Presenter
Donald Ngobeni
Author and Co-Author
Donald Ngobeni, O.P.M Aslam | Driaan Bisschoff | Chris Ndiitwani | Marius Potgieter | Mirko Boezio | Nadir Marcelli | Riccardo Munini | Vladimir Mikhailov

Abstract
'The global features of the modulation of galactic cosmic ray protons and helium nuclei are studied in the heliosphere from solar minimum to maximum activity with a comprehensive, three-dimensional, drift model and compared to proton and helium observations measured by PAMELA from 2006 to 2014. Combined with accurate very local interstellar spectra (VLIS) for protons and helium nuclei, this provides the opportunity to study in detail how differently the proton to helium ratio, over a wide range of rigidities, behaves towards increasing solar activity. In particular, the effects at the Earth of the difference in their VLIS's, mass-to-charge ratio (A/Z) and those caused by the main modulation mechanisms will be illustrated from solar minimum to maximum activity.'

Collaborations

Keywords and Comments
'Cosmic rays · Heliosphere · Solar modulation ·\r\nSolar activity · Galactic proton · Galactic helium', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Numerical modeling of the solar modulation of helium isotopes in the inner heliosphere

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 501

Presenter
Donald Ngobeni
Author and Co-Author
Donald Ngobeni, O.P.M. Aslam | Driaan Bisschoff | Innocentia Ramokgaba | Chris Ndiitwani | Marius Potgieter

Abstract
'The observation of cosmic ray Helium isotopes (Helium-3 and Helium-4) at the Earth had been done with the PAMELA and AMS-02 space detectors, from July 2006 to December 2007 and May 2011 to November 2017, respectively. These available observations span time frames that include the solar magnetic field reversal epoch. In this work, a comprehensive, three-dimensional numerical modulation model for the transport of cosmic rays in the heliosphere is utilized to compute the modulation of galactic Helium isotopes from minimum to maximum solar activity. The computed ratio of Helium-3 to Helium-4 is compared with the observed ratio from PAMELA and AMS-02 taken between 2006 and 2017. It will be shown how the rigidity and time dependence of this ratio depends on the level of solar activity and what the underlying physics is for this behaviour'

Collaborations

Keywords and Comments
'Cosmic rays · Heliosphere · Solar modulation ·\r\nSolar activity · Galactic helium isotopes', ''

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Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Turbulent Reduction of Drifts for Solar Energetic Particles

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 19 SEP Acceleration and Propagation | SH
Presenter Forum Table

Presenter
Jabus van den Berg
Author and Co-Author
Jabus van den Berg | Eugene Engelbrecht | Du Toit Strauss | Nicolas Wijsen,

Abstract
'Particle drifts perpendicular to the background magnetic field are proposed by some authors as an explanation for the very efficient perpendicular transport of solar energetic particles (SEPs). This process, however, competes with perpendicular diffusion caused by magnetic turbulence, which will also disrupt the drift patterns and reduce the efficiency of drift effects. The latter phenomenon is well known in cosmic ray studies, but not yet considered in SEP models. Additionally, SEP models which do not include drifts, especially for electrons, use turbulent drift reduction as a justification of this omission, without critically evaluating or testing this assumption. We present the first theoretical step for a theory of drift suppression in SEP transport. This is done by deriving the turbulence-dependent drift reduction function with a pitch-angle dependence, as applicable for anisotropic particle distributions, and by investigating to what extent drifts will be reduced in the inner heliosphere for realistic turbulence conditions and different pitch-angle dependencies of the perpendicular diffusion coefficient.'

Collaborations

Keywords and Comments
'solar energetic particles; drifts; diffusion; turbulence', ''

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Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Anomalous Transport and Acceleration of Energetic Particles

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 19 SEP Acceleration and Propagation | SH
Presenter Forum Table

Presenter
Frederic Effenberger
Author and Co-Author
Frederic Effenberger | Du Toit Strauss | Horst Fichtner | Dominik Walter,

Abstract
'The theoretical description of energetic particle transport near interplanetary shocks in the inner and outer Heliosphere and in other astrophysical contexts usually follows a diffusive paradigm. By means of scattering of particles at magnetic irregularities upstream and downstream of the shock, particles can be moved back and forth across the shock discontinuity and gain energy, forming power-law energy spectra. In recent years, it has become clearer that this scattering does not necessarily adhere to a Gaussian diffusive picture, i.e. it can be an anomalous transport process, possibly caused by inhomogeneous structures in the plasma turbulence, such as small-scale flux tubes. This anomalous transport is, as a first approximation, often characterized by a non-linear behavior of the mean-square displacement of particles. Here we discuss the theory and implications of this assumption in the context of interplanetary shocks. In particular, we will address how this behaviour can be modeled with non-Gaussian probability distributions together with a stochastic differential equation scheme.'

Collaborations

Keywords and Comments
'energetic particles; anomalous diffusion; cosmic rays; solar eruptions', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

TeV Cosmic Rays at the Sun: A Diffusive Approach

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 502

Presenter
Jozsef Kota
Author and Co-Author
Jozsef Kota | Federico Fraschetti | Joe Giacalone,

Abstract
'TeV and multi TeV cosmic rays (CRs) cross the heliosphere in almost straight lines and are deflected only in the close vicinity of the Sun. Particles hitting the Sun create a cosmic-ray shadow (Amenomori et al. 2013, PRL, 111A, 1101) and can also create high-energy gamma rays seen by Fermi LAT (Linden et al. 2019, PRL 121, 1103). In this work we make an attempt to relate the solar cycle variation of the total area of the cosmic-ray shadow to the flux of gamma rays produced.. Both of these are proportional to the fraction of CRs hitting the Sun. While the Tibet collaboration developed a sophisticated CR back-tracing trajectory simulation, the first theoretical work on the production of gamma rays (Steckel, Stanev, and Gaisser 1991, Ap.J. 382, 652) applied a simple diffusion equation to predict the GCR flux at the bottom of the corona. These early predictions are in striking contrast with the Fermi/LAT observations, vastly underestimating the high-energy gamma-flux .\r\n\r\nWe revisit the diffusive analysis adopting an alternative equation that retains the full pitch-angle distribution of cosmic rays and remains applicable at high CR rigidities. Preliminary results will be presented and some implication for the expected gamma flux will be discussed.'

Collaborations

Keywords and Comments
'TeV Cosmic Rays; Sun; particle propagation; gamma rays', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Implications of Solar Magnetograms for the Drifts of Cosmic Rays

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 503

Presenter
Horst Fichtner
Author and Co-Author
Horst Fichtner | Andreas Kopp,

Abstract
'While gradient and curvature drifts are well-established elements of\r\nthe propagation of cosmic rays in the heliospheric magnetic field,\r\ntheir perturbation by the solar activity-induced large-scale\r\ndistortions of dipole-like field configurations even during solar\r\nminima and by magnetic turbulence is an open problem. Various\r\nempirical or phenomenological approaches have been suggested to\r\nquantify these effects so that they can be straightforwardly\r\nincorporated in modulation models covering the 22-year periodicity\r\n(including the sign) of solar activity. These approaches, however,\r\neither lack clear physics-based parametrizations (e.g., in terms of\r\nthe tilt-angle of the heliospheric current sheet) or have been shown\r\nto be incompatible with measurements (like a dependence on the\r\nnormalized turbulence level $\\delta B/B$). We propose here a new\r\napproach to the treatment of drifts over an entire solar cycle\r\nincluding maximum periods, which is based on solar magnetograms. This\r\nnot only provides a physics-based approach to the reduction of drifts\r\nduring solar activity maxima but also a treatment that is fully\r\nconsistent with those MHD models of the solar wind and the embedded\r\nheliospheric magnetic field that exploit solar magnetograms as inner\r\nboundary conditions.'

Collaborations

Keywords and Comments
'cosmic rays: drifts; Sun: magnetograms', ''

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Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

A study of variations of galactic cosmic ray intensity based on a hybrid data-processing method

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 504

Presenter
Zhenning Shen
Author and Co-Author
Zhenning Shen, Qin Gang

Abstract
'The low energy cosmic-ray (CR) fluxes measured by space-borne instruments are \r\ngenerally considered to consist of the gradually changing galactic cosmic rays \r\n(GCRs) and the short-lived solar energetic particles (SEPs). The SEP events cause the sharp and ephemeral increases in the time profile of CR observations with higher occurrence rate in solar maximum. It is necessary to eliminate such \r\nspikes and obtain the pure GCR component while studying the modulation of GCRs \r\nboth in short and long time scales. A hybrid data processing method based on \r\nspike detection and time series analysis techniques is developed to remove\r\nthe spikes and decompose the GCR data observed by the Interplanetary Monitoring \r\nPlatform 8 (IMP 8) into the long-term variation trend and the 27-day variation components. With the hybrid data processing method, the 11-year \r\nand 27-day variations in the intensity of low energy GCR can be studied \r\nsystematically. Using the fitted trend component, the time lag in solar modulation of low energy GCRs is studied, and the results show that the time lag is both epoch and energy dependent. The obtained 27-day variation component is anti-correlated with the changes in solar wind velocity even during solar maximum. Implementing the running Fourier series fit procedure, the 27-day \r\nvariation amplitude of proton flux is computed. It is found that the yearly averaged values show clearly 11- and 22-year variation cycles. In addition, \r\nthe energy spectrum of the 27-day variation amplitude is softer in $A<0$ solar minimum than that in $A>0$ solar minimum.'

Collaborations

Keywords and Comments
'', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Electron acceleration parallel and perpendicular to overshoot magnetic field in quasi-perpendicular collisionless shock

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 19 SEP Acceleration and Propagation | SH
Presenter Forum Table

Presenter
Fumiko Otsuka
Author and Co-Author
Fumiko Otsuka | Mitsuo Oka | Shuichi Matsukiyo,

Abstract
'Energetic, non-thermal electrons are commonly observed both upstream and immediately downstream from the Earth's quasi-perpendicular bow shock (Gosling, 1989). Upstream the energetic electrons are generally field-aligned beams, whereas downstream the flux of them is generally most intense in the direction perpendicular to the magnetic field. However, the acceleration mechanism of these electrons remains unclear. Here, we show a new type of electron acceleration process at an overshoot downstream of a quasi-perpendicular collisionless shock, by performing a one-dimensional particle-in-cell (PIC) simulation. The shock parameters are as follows. The Alfven Mach number is 7.1, upstream plasma beta is 0.3, the shock angle is 70 degrees. The ion to electron mass ratio is 625, the ratio of electron plasma to cyclotron frequency is 10. \r\n\r\nKinetic energies of non-thermal electrons, averaged several gyrations, were divided into those of the guiding center motions parallel and perpendicular to the ambient field and that of the rotations of the guiding center. We then found the following electron acceleration process. Incoming electron is trapped in a thin structure of the time-varying, compressed overshoot magnetic field during a shock reformation process. Simultaneously, it gains a kinetic energy perpendicular to the magnetic field via betatron acceleration, followed by an additional energy increase along the field. The energy conversion from the perpendicular to parallel directions occurs due to a rapid decrease of the overshoot magnetic field; eventually, it is released upstream as a field-aligned beam. The result will be related to in-situ observations of the Earth's bow shock.'

Collaborations

Keywords and Comments
"electron acceleration; quasi-perpendicular shock; particle-in-cell simulation; earth's bow shock", ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

The 23 July 2012 SEP event numerical simulation with multi-spacecraft observation data

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 23 Solar Events observed on/near Earth | SH
Presenter Forum Table

Presenter
Shiyang Qi
Author and Co-Author
Shiyang Qi | Gang Qin,

Abstract
'23 July 2012, multiple-spacecraft, namely STEREO-A, STEREO-B, and ACE, observed an extremely powerful, superfast interplanetary coronal mass ejection (ICME) together with the ICME-driven shock and associated solar energetic particles (SEPs). We analyze the relationship between the propagation of the shock and the SEP flux with the Parker spiral magnetic field model. Moreover, we simulate the SEP event by numerically solving the three-dimensional focused transport equation of SEPs considering the shock as the moving source of energetic particles. We use the same diffusion model format for the simulations of protons and electrons but with different parameters for simplicity. The simulation results can qualitatively explain the important features of the SEP flux observed by the multiple spacecraft simultaneously. Additionally, the numerical results for both energetic protons and electrons approximately agree with multi-spacecraft observations.'

Collaborations

Keywords and Comments
", "

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Suprathermal Electron Acceleration by an ICME-driven Quasi-perpendicular Shock on 2000 Feb 11

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 506

Presenter
Fanjing Kong
Author and Co-Author
Gang Qin | Fanjing Kong,

Abstract
'Using test-particle simulations we study the acceleration of suprathermal electrons at an ICME-driven quasi-perpendicular shock on 2000 Feb 11 observed by Wind spacecraft. The downstream electron distribution in several energy channels from ~0.3 to ~40 keV are obtained assuming an initial distribution based on the observed upstream electron intensities. It is shown that in each energy channel the ratio of downstream to upstream intensities peaks at about 90° pitch angle, and in each pitch angle direction the downstream electron energy spectral index is much larger than the theoretical index of diffusive shock acceleration. In addition, assuming the dominance of shock drift acceleration mechanism and the conservation of the phase space density before and after the acceleration, we find that the estimated drift length is proportional to the electron energy but the drift time is almost energy independent. Furthermore, we construct a theoretical model based on SDA to describe the energy dependence of drift length and drift time. These results indicate the importance of SDA in the acceleration of electrons by quasi-perpendicular shocks, consistent with Yang et al. conclusion.'

Collaborations

Keywords and Comments
'acceleration of particles; shock waves; turbulence', ''

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Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Time Evolution of Parallel Shock Accelerated Particle Spectrum Bend-over Energy

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 19 SEP Acceleration and Propagation | SH
Presenter Forum Table

Presenter
Gang Qin
Author and Co-Author
Gang Qin | Fanjing Kong,

Abstract
'Shock acceleration is an important mechanism to accelerate energetic particles. Using test-particle simulations we investigate the time evolution of the accelerated particle energy spectrum in the downstream of a parallel shock with magnetic turbulence. From simulation results we obtain power-law energy spectra with a bend-over energy. It is shown that the bend-over energy increases with time. With the particle mean acceleration time and mean momentum change during each cycle of the shock crossing from the diffusive shock acceleration model, a time-dependent differential equation for the maximum energy of particles accelerated at the shock can be approximately obtained, we assume the model can be used to describe the time evolution of the bend-over energy. It is found that the bend-over energy from simulations agrees well with the theoretical model with the nonlinear diffusion theory.'

Collaborations

Keywords and Comments
'acceleration of particles; shock waves; turbulence', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Effects of the Magnetic Cloud and Sheath on the Solar Energetic Particles and Forbush Decrease associated with the Ground-level Enhancement Event of 2000 July 14

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 21 Short-term modulation | SH
Presenter Forum Table

Presenter
S.-S. Wu
Author and Co-Author
S.-S. Wu | Gang Qin,

Abstract
'Solar energetic particles (SEPs) and Forbush decreases (Fds) in galactic cosmic ray (GCR) intensity are two important phenomena accompanied by interplanetary coronal mass ejections (ICMEs). A fast and strong magnetic cloud (MC) was behind the ICME-driven shock associated with the ground-level enhancement event on 2000 July 14. Observations show that both SEPs and GCRs had a rapid two-step decrease near the sheath and MC arrivals at 1 au. We therefore study the effect of sheath and MC on the SEPs and Fd by numerically solving the focused transport equation. In the simulation model, the MC and sheath are modeled as thick spherical caps behind the ICME shock with enhanced magnetic field. The magnetic turbulence levels in the MC and sheath are set to be lower and higher than that in the ambient solar wind, respectively. The simulated SEP intensity-time profiles fit the observations well in energies ranging from $\\sim$1 to $\\sim$100 MeV, and the simulated GCR intensity reproduces the main characteristics of the Fd, such as the pre-increase precursor, amplitude, total recovery time. It is found that the two-step decreases are reproduced at the sheath and MC arrivals and both the magnetic field and magnetic turbulence in the sheath-MC structure are important for the formation of the two-step decreases. It is suggested that the sheath produced most of the decrese while the MC contributed to the formation of the second step decrease for both the SEPs and Fd, and the MC also prolonged the recovery time of the Fd.'

Collaborations

Keywords and Comments
'Solar energetic particle; Forbush decrease; galactic cosmic ray; coronal mass ejection; coronal mass ejection shock; space weather', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Observations and numerical simulations of impulsive SEP events with Ulysses and ACE observations

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 19 SEP Acceleration and Propagation | SH
Presenter Forum Table

Presenter
L.-L. Lian
Author and Co-Author
L.-L. Lian | Gang Qin | Yang Wang | S.-W. Cui,

Abstract
'We study the latitudinal extent of the impulsive solar energetic particle (SEP) events of 2000 June 10 and 2001 December 26 using energetic electron observations from the *ACE* and *Ulysses*. We investigate the effects of particle source and transport on the profiles. We get the best fit parameters for simulations by comparing simulations with the two spacecraft observations. We show that perpendicular diffusion and adiabatic cooling can significantly affect the propagation of particles. In addition, it is found that the start and peak times of particle injections are between the onset and peak times of flare for the two events. Furthermore, we have theoretical models for the peak intensity of the particle source and the time interval from the onset of flares to the peak time of the particle source. We show that the theories agree well with the best fit parameters.'

Collaborations

Keywords and Comments
'Solar energetic particles; acceleration of particles; turbulence; flare', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Study of momentum diffusion with the effect of adiabatic focusing

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 507

Presenter
junfang wang
Author and Co-Author
junfang wang | Gang Qin,

Abstract
'Momentum diffusion of the energetic charged particles is an important mechanism of the\r\ntransport process in astrophysics, physics of the fusion devices, and laboratory plasmas. \r\nIn the light of observations, for the investigation of energetic particle\r\ntransport through magnetized plasma, one usually assumes the\r\nmagnetic field configuration as the superposition of the background\r\nmagnetic field B_0 and the turbulent component $\\delta B$. \r\nThe fact that large-scale magnetic field is nonuniform in space\r\ngives rise to the so called adiabatic focusing effect\r\nof the energetic particles. \r\nPrevious authors found that the along-field focuing \r\ncan lead to the convective term in momentum space. \r\nHere, we explore the momentum diffusion depending on the adiabatic focusing \r\neffect along the background magnetic field. \r\nBy employing the iteration method, \r\nwe derive the momentum diffusion coefficient $A(\\xi)=A_0+\\mathcal{M}_4(\\xi)$ \r\nwith the uniform field momentum diffusion coefficient A_0 and \r\nthe modifying term $\\mathcal{M}_4(\\xi)=M_1(\\xi)+M_2(\\xi)+M_3(\\xi)+M_4(\\xi)$ \r\nby retaining up to the fourth order of the focusing parameter $\\xi$. \r\nThereafter, we evaluate the modifying term $\\mathcal{M}_4(\\xi)$\r\nto find that it is not equal to zero for most of the cases, so that we obtain \r\na new second order acceleration mechanism of energetic charged particles.\r\nAfter evaluating the modifying term, \r\nwe find that it is determined by \r\nthe sign of the focusing characteristic length \r\nand the cross helicity of turbulent magnetic field.'

Collaborations

Keywords and Comments
'Interplanetary turbulence ; Magnetic fields; Solar energetic\r\nparticles', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Numerical Study the Corotating Interaction Region's effect on cosmic proton and helium

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 21 Short-term modulation | SH
Presenter Forum Table

Presenter
xi luo
Author and Co-Author
xi luo, Marius Potgieter | Fang Shen | Weiwei Xu

Abstract
'A Corotating Interaction Region (CIR) is formed when the fast solar wind catches the slow solar wind. It is known that the intensity of Galactic Cosmic Ray (GCR) is modulated by the CIR. Usually, the GCR intensity is suppressed inside the CIR. However, previous studies were mainly confined to GCR protons. In this study, we have utilized a hybrid GCR transport model, which incorporates the Magnetohydrodynamic (MHD) simulated solar wind plasma background with CIR structure. Additionally, adopting appropriate mass, charge and Local Interstellar Spectra, the hybrid transport model is applied to both GCR proton and helium. It is found that (1) both proton and helium is modulated by the CIR so that their intensity is depressed; (2)however, the modulation level of proton and helium is different, and interestingly, the ratio of the proton and helium flux also varies with longitude.'

Collaborations

Keywords and Comments
'Corotating Interaction Region; Solar Modulation', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Study Galactic Cosmic Ray Modulation with AMS-02 observation

Time 14 July 2021 | 12:00 - 13:30 | Berlin Time
Session Discussion: 20 GCR long-term modulation | SH
Presenter Forum Table

Presenter
xiaojian song
Author and Co-Author
xiaojian song | xi luo | weiwei xu,

Abstract
'The accurate measurements of the galactic cosmic ray (GCR) fluxes as function of time and energy by the Alpha Magnetic Spectrometer (AMS) give us unique information to search dark matter, to study the dynamics of solar modulation, to constraint the parameters in modulation model, to improve the precision of radiation dose prediction in the ongoing deep space exploration.\r\nThe transport of low rigidity GCRs (<30GV) in the heliosphere is described by the Parker equation. This equation is solved by stochastic differential equation approach in numerical model. The input parameters in the model (solar wind speed, tilt angle, magnetic intensity and polarity) are obtained by the observation near the Earth. The time varying parameters (diffusion coefficient, drift coefficient) is usually tuned manually. This method only gives result what looks good, but cannot gives the uncertainty of parameters.\r\nIn this study, the Markov chain Monte Carlo (MCMC) technique is used to determine the time varying posterior probability distribution of parameters related to the GCR transport equation. In Bayesian statistics, MCMC is a class of samplers in which we can simulate draws that are slightly dependent and are approximately from a posterior distribution. The Metropolis-Hastings algorithm is used to implement the MCMC sampler. Compared to the traditional method where the likelihood function is evaluated on the grid of points in parameter space, the MCMC sampler is low resource consumption as it is insensitive to the dimensionality of the parameter space.'

Collaborations

Keywords and Comments
'galactic cosmic rays; solar modulation', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Simulating the transport of high energy solar protons during historic GLE events

Time 15 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 23 Solar Events observed on/near Earth | SH
Presenter Forum Table

Presenter
Charlotte Waterfall
Author and Co-Author
Charlotte Waterfall, Silvia Dalla

Abstract
'3D test particle simulations of historic GLE events are performed to investigate the propagation and distribution of solar protons within the heliosphere. Multiple past GLEs are considered that possess a variety of properties of the associated solar events, e.g. a range of source flare longitudes and coronal mass ejection velocities. The test particle model, which includes drift effects, is also used to explore the influence a heliospheric current sheet (HCS) has on the propagation of protons. For example, historic GLEs with a source location close to and far from the HCS, as well as poorly and well-connected events are considered. The modelling is performed for high energy (300-1200 MeV) protons to represent the energetic conditions under which these GLEs occur. The derived intensity profiles at 1AU are compared to observations from HEPAD onboard GOES, as well as STEREO (at lower energies and locations away from Earth) and neutron monitor data.'

Collaborations

Keywords and Comments
'', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Characteristics of the N-component of the heliospheric magnetic field observed by IMP and ACE over 46 years

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 508

Presenter
Renier Burger
Author and Co-Author
Renier Burger, Amore Nel | Nicholas Engelbrecht

Abstract
'Ab initio modulation models use a turbulence spectrum as input, and changes in this spectrum over multiple solar magnetic cycles can have significant effects on the calculated level of modulation. In this project, turbulence quantities are calculated for 27-day intervals and then binned and presented in 378-day intervals, using IMP and ACE magnetic field data from late 1973 to the last solar minimum in late 2020. For the N-component of the magnetic field, we find that the average spectral index of the inertial range is 1.69$\\pm$0.06 and that of the energy range 1.03$\\pm$0.22. The breakpoint between the energy- and the inertial range is at a timescale of around 68 min but with a large spread; this quantity is believed to be solar-cycle dependent but difficult to resolve accurately. The spectral levels of both the energy- and the inertial range show a clear solar-cycle dependence for ACE data, but this dependence is much less obvious for IMP data before 1998. The lowest yearly-averaged magnetic field magnitude and the lowest magnetic variance since 1974 occur in the interval that includes the 2020 solar minimum, 4.16 nT and 4.4 nT^2 respectively; both quantities are lower than the corresponding 2009 solar minimum values. The ratio of the square root of the average variance to the average magnetic field magnitude, $\\delta$B/B, is remarkably constant at 0.52$\\pm$0.03 over the 46-year period.'

Collaborations

Keywords and Comments
'IMP spacecraft; ACE spacecraft; heliospheric magnetic field; turbulence; spectral index; spectral level; magnetic variance', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Imbalance acceleration/escape of energetic particles at interplanetary shocks: effect on spectral steepening

Time 12 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 19 SEP Acceleration and Propagation | SH
Presenter Forum Table

Presenter
Federico Fraschetti
Author and Co-Author
Federico Fraschetti,

Abstract
'Growing multispacecraft networks are broadening the opportunity of measuring energy spectra of energetic particles at interplanetary shocks over three decades or more in energy at the same distance (different from 1 AU) from the Sun. Energetic particles spectra at interplanetary shocks often exhibit a non-power law shape, even within two energy decades. We have introduced a 1D transport equation accounting for particle acceleration and escape, both allowed at all particle energies. The diffusion is contributed by self-generated turbulence close to the shock and by pre-existing turbulence far upstream. The upstream particle intensity profile steepens within one diffusion length from the shock as compared with diffusive shock acceleration rollover. The spectrum, controlled by macroscopic parameters such as shock compression, speed, far upstream diffusion coefficient and escape time at the shock, can be reduced to a log-parabola, that has been shown to describe the escape in a probabilistic approach. In the case of upstream uniform diffusion coefficient, the customarily used power law/exponential cut off solution is retrieved.'

Collaborations

Keywords and Comments
'Particle acceleration; particle escape; interplanetary shocks', ''

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Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Access of cosmic rays to an ICME from external field lines

Time 14 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: 21 Short-term modulation | SH
Presenter Forum Table

Presenter
Timo Laitinen
Author and Co-Author
Timo Laitinen | Silvia Dalla,

Abstract
'Interplanetary coronal mass ejections (ICMEs) cause decreases, so-called Forbush decreases, in the cosmic ray (CR) intensities. FDs are seen as up to 25% decreases in neutron monitor counts at Earth, lasting up to over a week. An ICME is thought to cause a FD through two mechanisms: by enhancing diffusion in the ICME shock wave sheath; and by preventing the CRs from penetrating the magnetic fluxrope embedded in the ICME. CR propagation during a FD is usually modelled as enhanced diffusion either within the whole ICME or within the embedded fluxrope. However, a question that is so far unanswered is how the CRs can reach the isolated fluxrope fieldlines from the open, external interplanetary fieldlines. We study the propagation of CRs from external field into a fluxrope by employing full-orbit particle simulations with scattering. The interface between the internal and external field lines is modelled analytically. We find that the CRs can access the fluxrope rapidly through x-point region, where the external magnetic field partially cancels the magnetic field of the fluxrope. The access is rapid compared to diffusive radial propagation of CRs within the rope. We find that CR propagation within the fluxrope can be modelled using diffusion models, without need to separately model the access to the isolated field lines, provided that the bounds of the diffusion area are taken as that of the isolated fieldlines instead of the region with smoothly rotating magnetic field. Thus, to evaluate the role of a fluxrope in FDs, the extent of the region where the rope magnetic fields are not connected to the external field must be analysed.'

Collaborations

Keywords and Comments
'Forbush Decrease; ICME;simulations', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

TIME-DEPENDENT PROPAGATION TIMES AND ENERGY LOSSES OF PROTONS IN THE HELIOSPHERE: A SOLAR MODULATION MODELLING IN LIGHT OF NEW COSMIC-RAY DATA FROM OBSERVATIONS

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 509

Presenter
Behrouz Khiali
Author and Co-Author
Behrouz Khiali | Nicola Tomassetti | Emanuele Fiandrini | Bruna Bertucci,

Abstract
'After entering the Galactic cosmic rays (CRs) into the heliosphere, their intensities decrease during their propagation toward the Earth. This effect is subjected to a variety of physical processes through their propagation which referred to as CR solar modulation. The key ingredients in the study of this phenomenon are the knowledge of the local interstellar spectrum (LIS) of Galactic cosmic rays and the understanding of how the solar modulation affects the LIS inside the heliosphere. For this purpose, here we present an improved data-driven description of the solar modulation phenomenon, that is, the temporal evolution of the CR flux inside the heliosphere caused by the 11-year variability cycle of the Sun's magnetic activity. The model was applied to the Galactic proton flux measured by Voyager 1, AMS-02, and PAMELA missions which provide valuable information, allowing us to shed light on the shape of the LIS and the details of the solar modulation for the time period from mid- 2006 to mid-2017. The new results for the temporal dependence of the key model parameters, their relationship with solar activity proxies, the implications for the CR transport in magnetic turbulence, and the new insights on our understanding of the solar modulation effect are presented. The study of the time variation of GCR spectra observed at Earth can shed light on the underlying physical processes, specifically diffusion and particle drifts.'

Collaborations

Keywords and Comments
'Cosmic-rays ; solar modulation ; heliosphere', ''

Branch SH | Solar & Heliospheric

Subcategory Theoretical Results

Comparison of the energy spectra between pileup shock and converging shock

Time 16 July 2021 | 18:00 - 19:30 | Berlin Time
Session Discussion: Presenter Forum 1 - Evening | All Categories - Continued in Presenter Forum 2 with identical contributions and allocations
Presenter Forum Table 510

Presenter
Xin Wang
Author and Co-Author
Xin Wang | Xueshang Feng | Yihua Yan | Mingde Ding,

Abstract
'We present a few possibilities for forming an extended energy spectrum and producing a varied slope in different double-shock models. In our previous work, the converging double-shock model would provide more kinetic energy injecting into the particles acceleration. The high efficient injection rate excited by amplified magnetic turbulence from the converged region make the extended energy spectrum be possible. In our present work, the pileup-shock model provide a opportunity of the re-accelerated processes of the particles on the merged shock precursor region. With the expended precursor region, more and more particles can participate into the pileup-shock system, the ‘concave’ slope of the energy spectrum would be produced due to the enhancement magnetic turbulence between the merged pileup-shock. We have proved that the converging double-shock model taken a negative effect on the accelerated particles and produce an energy ‘break’ slope. And we investigate that a positive effect on particle acceleration in pileup twin-shock scenario can produce a ‘concave’ slope on the energy spectrum.'

Collaborations

Keywords and Comments
'GLE; acceleration of particles--methods:numerical--shock waves--solar wind--Sun:coronal mass ejections(CMEs)', ''