15th Patras Workshop on Axions, WIMPs and WISPs

Report of Contributions

https://indico.desy.de/e/patras2019

Contribution ID: **2** Type: **Oral**

Axion production in unstable magnetized plasmas

Axions, the hypothetical particles restoring the charge-parity symmetry in the strong sector of the Standard Model, and one of the most prone candidates for dark matter, are well-known to interact with plasmas. Recently, we have shown that if the plasma dynamically responds to the presence of axions, then a new quasi-particle (the axion plasmon-polariton) can be formed, being at the basis of a new generation of plasma-based detection techniques. In this work, we exploit the axion-plasmon hybridization to actively produce axions in streaming magnetized plasmas. We show that, if we make the plasma unstable via the injection of an energetic electron beam (beam-plasma instability), an appreciable production rate of few axions per minute can be achieved. The produced axions can then be detected by Primakoff decay into photons

Primary author: Dr TERÇAS, Hugo (Instituto Superior Técnico, University of Lisbon)

Presenter: Dr TERÇAS, Hugo (Instituto Superior Técnico, University of Lisbon)

Contribution ID: **3** Type: **Oral**

a Dirac triplet for dark matter

Monday 3 June 2019 09:50 (20 minutes)

I will present an a priori argument, why a Dirac triplet
should be the dark matter of the universe.

Primary author: Prof. VAN DER BIJ, Jochum (Freiburg university)

Presenter: Prof. VAN DER BIJ, Jochum (Freiburg university)

Session Classification: Morning 11

Contribution ID: **4** Type: **Oral**

Axions, Relaxions, and Novel Dark Matter Substructure

Monday 3 June 2019 15:40 (20 minutes)

Light ($m <$ eV) scalar particles, notably axions and relaxions, make interesting dark matter (DM) candidates, not least because they modify substructure within galaxies. Due to high occupation numbers typical of such candidates, it well known that clumps of scalar field known as boson stars can form, supported by a balance of self-gravity against gradient energy. I will briefly review recent work regarding the formation and stability of such configurations, and the consequences for terrestrial experiments looking for transient signals. Then, I will propose that a boson star-like 'halo'can surround the Earth or Sun, supported by these external gravitational sources, enhancing the local DM density and modifying experimental sensitivities. I will discuss current constraints on Earth-based and Solar-based halos from gravitational measurements, as well as current and future detection capabilities for scalar field DM.

Primary author: Dr EBY, Joshua (Weizmann Institute of Science)

Presenter: Dr EBY, Joshua (Weizmann Institute of Science)

Session Classification: Afternoon 11

Contribution ID: **5** Type: **Oral**

Gravitationally trapped axions and quark nugget dark matter model

Monday 3 June 2019 15:20 (20 minutes)

I overview the dark matter model offering a very natural explanation of a number (naively unrelated) problems in cosmology: the observed relation $\Omega_{\rm DM} \sim \Omega_{\rm visible}$, the observed asymmetry between matter and antimatter in the Universe, known as the baryogenesis" problem, the so called "Solar Corona Mystery", thePrimordial Lithium Puzzle" to name just a few. In this framework, both types of matter (dark and visible) have the same QCD origin, form at the same QCD epoch, and both proportional to one and the same dimensional parameter of the system, $\Lambda_{\rm QCD}$, which explains how these, naively distinct, problems could be intimately related, and could be solved simultaneously within the same framework.

The talk is based on two recent papers:

1. "Gravitationally bound axions and how one can discover them", PRD-2019

2."New mechanism producing axions in the AQN model and how the CAST can discover them", PRD-2018

Primary author: Prof. ZHITNITSKY, Ariel (University of British Columbia)

Presenter: Prof. ZHITNITSKY, Ariel (University of British Columbia)

Session Classification: Afternoon 11

Contribution ID: **6** Type: **Oral**

Results and update from the ABRACADABRA search for sub-μeV axion dark matter

Monday 3 June 2019 17:30 (20 minutes)

ABRACADABRA is an experiment that searches for axion dark matter (ADM) in the $10^{-14} - 10^{-6}\mathrm{eV}/c^2$ mass range. In ABRACADABRA, ADM couples to the static magnetic field of a toroidal magnet. This coupling induces a small, oscillating magnetic flux in the center of the torus that can be measured by a pickup loop connected to a SQUID current sensor. Both broadband and resonant readout modes are possible in the ABRACADABRA design. In this talk we review the ABRACADABRA motivation, concept, and plans. We also present the first results from a one month search for axions with a prototype, ABRACADABRA-10cm. We found no evidence for axion dark matter and set 95% C.L. upper limits on the axion-photon coupling between $g_{a\gamma\gamma} < 1.4 \times 10^{-10}\,\mathrm{GeV}^{-1}$ and $g_{a\gamma\gamma} < 3.3 \times 10^{-9}\,\mathrm{GeV}^{-1}$ over the mass range $3.1 \times 10^{-10}\,\mathrm{eV} - 8.3 \times 10^{-9}\,\mathrm{eV}$. These results are competitive with the most stringent astrophysical constraints in this mass range.

Primary author: HENNING, Reyco (University of North Carolina at Chapel Hill)

Presenter: HENNING, Reyco (University of North Carolina at Chapel Hill)

Session Classification: Afternoon 12

Contribution ID: **7** Type: **Oral**

Axion Dark Matter Detection with CMB Polarization

Wednesday 5 June 2019 12:25 (20 minutes)

In this talk, I will detail two ways to search for low-mass axion dark matter using cosmic microwave background (CMB) polarization measurements. These appear, in particular, to be some of the most promising ways to directly detect fuzzy dark matter. Axion dark matter causes rotation of the polarization of light passing through it. This gives rise to two novel phenomena in the CMB. First, the late-time oscillations of the axion field today cause the CMB polarization to oscillate in phase across the entire sky. Second, the early-time oscillations of the axion field wash out the polarization produced at last-scattering, reducing the polarized fraction (TE and EE power spectra) compared to the standard prediction. Since the axion field is oscillating, the common (static) 'cosmic birefringence'search is not appropriate for axion dark matter. These two phenomena can be used to search for axion dark matter at the lighter end of the mass range, with a reach several orders of magnitude beyond current constraints. I will present a limit from the washout effect using existing Planck results, and discuss the significant future discovery potential for CMB detectors searching in particular for the oscillating effect.

Primary author: Dr FEDDERKE, Michael A. (Stanford University, University of California Berkeley, and LBNL)

Co-authors: Prof. GRAHAM, Peter W. (Stanford University); Prof. RAJENDRAN, Surjeet (University of California Berkeley, and Johns Hopkins University)

Presenter: Dr FEDDERKE, Michael A. (Stanford University, University of California Berkeley, and LBNL)

Session Classification: Morning 32

Contribution ID: **8** Type: **Poster**

the Advanced Axion Dark Matter detector

Tuesday 4 June 2019 14:35 (5 minutes)

An upgrade to the Axion Dark Matter eXperiment (ADMX) will extend its high sensitivity search for QCD axions up to axion masses of 40 μeV. Axions are especially significant as dark matter if their mass is of order 2–40 μeV. They would then make up the dark-matter halos of galaxies. These halo axions may be detected by the Sikivie process, by which they decay to photons through the $\mathbf{E} \cdot \mathbf{B_0}$ interaction in a tunable high-Q microwave cavity permeated by a strong external magnetic field B_0. The corresponding resonant frequencies are in the microwave part of the electromagnetic spectrum: 0.5–10 GHz.

At present, ADMX uses near quantum-limited SQUID-based amplifiers and a 200 ℓ volume, 7.6 T magnet. Both cavity and amplifier are operated at ultralow temperatures (below 0.1 K). Generation-2 ADMX has demonstrated the sensitivity to detect even the most weakly-coupled QCD axions, the so-called DFSZ limit. Over the next 2–3 years, ADMX will search the 2–9 μeV range at the DFSZ limit.

As the search moves to higher axion masses, and therefore also to higher photon frequencies, the size of the cavities, typically half of the wavelength in two dimensions and 4–8 times the wavelength in the third, becomes smaller. To maintain B_0^2V, one may employ multiple cavities or very elaborate resonant structures. (The number increases more or less as the cube of the axion mass.) Clever microwave engineering can support the growth in cavity complexity to some extent, but there is a substantial cost of such intricate resonant structures and the supporting bits and pieces.

A proposed alternate approach is to increase the magnetic field substantially and decrease the volume. To the extent that the product B_0^2V is maintained, the cavity configurations used over 0.5–2.2 GHz can continue to be used. Ultrahigh-sensitivity superconducting electronics are also required.

A conservative, two phase process is proposed to build the Advanced Axion Dark Matter detector. For the Phase-1 detector, we specify a 19 T, 15 cm diameter magnet based on Nb\sb3Sn and NbTi technology, temperatures in the 60–80 mK regime, and continued use of the ADMX-style Josephson parametric amplifiers. In Phase 2, we add a high-temperature superconducting insert coil to provide >30~T in a 6.5 cm diameter. The operating temperature of the smaller and higher-resonant-frequency cavity is expected to be below 50 mK. Because the thermal emission from the cavity is negligible at these temperatures, Phase 2 will employ quantum-limited single-photon detectors.

Primary author: Dr TANNER, David (University of Florida)

Presenter: Dr TANNER, David (University of Florida)

Session Classification: Poster 1

Contribution ID: **9** Type: **Oral**

Fifth Force Searches in Galaxies

Tuesday 4 June 2019 17:10 (20 minutes)

Fifth forces generically follow from new dynamical fields, and hence are ubiquitous in extensions to the standard model. Broad classes of Lagrangian exhibit "screening mechanisms" which hide the fifth force in high-density environments such as the Milky Way, while keeping it operative on larger scales. I will describe the search for screened fifth forces on the scale of galaxies and their environments. First, I model the gravitational environments of the local Universe to determine the screening properties of real galaxies and the strength of the fifth-force field over space. I then use this information to forward-model two signals – displacement between stellar and gas mass centroids and warping of stellar disks – and hence constrain fifth-force parameters with a Bayesian likelihood formalism. Taking 11,000 HI detections from the ALFALFA survey and 4,000 images from the Nasa Sloan Atlas I show both signals to give evidence for a Chameleon- or Symmetron-screened fifth force of range ~2 Mpc and strength ~0.02 G_N, but caution that unmodelled systematics such as baryonic physics may impact the inference at this level.

Primary author: Dr DESMOND, Harry (University of Oxford)

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Presenter: Dr DESMOND, Harry (University of Oxford)

Session Classification: Afternoon 21

Contribution ID: **10** Type: **Oral**

Isocurvature bounds on axion-like particle dark matter in the post-inflationary scenario

Thursday 6 June 2019 15:30 (20 minutes)

Based on the work published in arXiv: 1903.06194. In collaboration with M. Feix (Univ. Heidelberg), J. Frank (KIT), R. Reischke (IIT, Haifa), B.M. Schaefer (Univ. Heidelberg), T. Schwetz (KIT).

We assume that dark matter is comprised of axion-like particles (ALPs) generated by the realignment mechanism in the post-inflationary scenario. This leads to isocurvature fluctuations with an amplitude of order one for scales comparable to the horizon at the time when the ALP field starts oscillating. The power spectrum of these fluctuations is flat for small wave numbers, extending to scales relevant for cosmological observables. Denoting the relative isocurvature amplitude at $k_* = 0.05$~Mpc^{-1} by $f_{\rm iso}$, Planck observations of the cosmic microwave background (CMB) yield $f_{\rm iso} < 0.31$ at the 2σ-level. This excludes the hypothesis of post-inflationary ALP dark matter with masses $m_a < 10^{-20}$-10^{-16}~eV, where the range is due to details of the ALP mass-temperature dependence. Future CMB stage IV and 21-cm intensity mapping experiments may improve these limits by 1-2 orders of magnitude in m_a.

Primary author: PARGNER, Andreas (Karlsruhe Insitute of Technology)

Presenter: PARGNER, Andreas (Karlsruhe Insitute of Technology)

Session Classification: Afternoon 41

Contribution ID: **11** Type: **Oral**

Light by Light Scattering as a Probe for Axion Dark Matter

Thursday 6 June 2019 17:40 (20 minutes)

The main goal of this work is to probe axion or axion-like particles (ALPs) in light-by-light forward scattering process. We consider the polarization effects caused by off-shell axions in the photon-photon scattering process. We show that the circular polarization signal generated in light-by-light scattering in the current/future laser experiments can shed more light on different aspects of these mysterious particles. Our results show a large enhancement in the conversion rate between circular and linear polarizations at the domain close to the resonance point of axions. This signal enhancement can be used in order to discriminate between the axion contribution to photon-photon scattering and one originates from the virtual electron-positron pairs in the pure QED framework.

Primary author: Dr SHAKERI, Soroush (Institute for Research in Fundamental Sciences (IPM))

Presenter: Dr SHAKERI, Soroush (Institute for Research in Fundamental Sciences (IPM))

Session Classification: Afternoon 42

Contribution ID: **12** Type: **Oral**

Observable signatures of dark photons from supernovae

Tuesday 4 June 2019 09:35 (20 minutes)

A dark photon is a well-motivated new particle which, as a component of an associated dark sector, could explain dark matter. One strong limit on dark photons arises from excessive cooling of supernovae. We point out that even at couplings where too few dark photons are produced in supernovae to violate the cooling bound, they can be observed directly through their decays. Supernovae produce dark photons which decay to positrons, giving a signal in the 511 keV annihilation line observed by SPI/INTEGRAL. Further, prompt gamma-ray emission by these decaying dark photons gives a signal for gamma-ray telescopes. Existing GRS observations of SN1987a already constrain this, and a future nearby SN could provide a detection. Finally, dark photon decays from extragalactic SN would produce a diffuse flux of gamma rays observable by detectors such as SMM and HEAO-1. Together these observations can probe dark photon couplings several orders of magnitude beyond current constraints for masses of roughly 1 - 100 MeV.

Primary author: Mr DEROCCO, William (Stanford University)

Co-authors: KASEN, Dan (UC Berkeley); MARQUES-TAVARES, Gustavo (University of Maryland); GRAHAM, Peter (Stanford University); RAJENDRAN, Surjeet (UC Berkeley)

Presenter: Mr DEROCCO, William (Stanford University)

Session Classification: Morning 21

Contribution ID: **13** Type: **Oral**

Search for scalar dark energy with the ATLAS detector

Monday 3 June 2019 11:40 (20 minutes)

We present the first constraints from a search for light scalar particles produced in association with $t\bar{t}$ and jet final states using 36 fb^{-1} of data collected at $\sqrt{s} = 13$ TeV with the ATLAS detector. The results are interpreted in the context of an Effective Field Theory model of scalar Dark Energy with conformal and disformal couplings. The results provide the most stringent constraints on the scale of disformal interactions between Dark Energy and Standard Model matter, improving the constraints obtained from cosmological and solar system tests by several orders of magnitude.

Primary author: ARGYROPOULOS, Spyridon (Iowa)

Presenter: ARGYROPOULOS, Spyridon (Iowa)

Session Classification: Morning 12

Contribution ID: **14** Type: **Oral**

Effects of Dark Matter in atomic and nuclear phenomena

Monday 3 June 2019 10:10 (20 minutes)

We investigate effects of axion (pseudoscalar), dilaton (scalar), dark photon (vector) and dark Z (pseudovector) which may be observed in atomic, molecular and solid state experiments.

Interaction with dark matter may lead to the variation of the size of the solid state resonators which may be observed using laser interferometry and resonance frequencies measurements [1].

Dark matter may affect Big Bang Nucleosynthesis and explain the Li abundance puzzle [2].

We investigated possibilities to detect linear effects in the axion interaction constants using interference between axion and photon atomic capture amplitudes and coherent axion-photon transformations in the forward scattering on atoms [3-5]. Similar effects have been calculated for the dark photon and photon.

Possible effect of finite photon mass due to magnetic interaction in plazma on galaxy rotation curve have been studied [6]. Slowly varying vector potential A of a low-mass photon field provides negative pressure P=-E/3 in the electromagnetic stress tensor (E is the magnetic field energy density), imitates gravitational pull and may contribute to the observed distribution of the rotational velocities in the Galaxy. Similar effects have been considered for other cosmic phenomena.

We have calculated [7] and measured [8] parity violating effects of low-mass Z'boson (dark boson) and effects of exchange by axion and other hypothetical particles in atoms, molecules and solids [9-17].

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Primary author: Prof. FLAMBAUM, Victor (University of New South Wales)

Presenter: Prof. FLAMBAUM, Victor (University of New South Wales)

Session Classification: Morning 11

Contribution ID: **15** Type: **Oral**

Gravitational Atoms

Tuesday 4 June 2019 11:25 (20 minutes)

Particles in a yet unexplored dark sector with sufficiently large mass and small gauge coupling may form purely gravitational atoms (quantum gravitational bound states) with a rich phenomenology. Near-Planckian atoms decay to gravitons immediately after being produced in the very early universe, creating a nearly monochromatic, isotropic and highly energetic gravitational wave signal. If Einstein gravity is valid all the way up to the Planck scale, and the gravitational waves are redshifted from the earliest moments after inflation until today using the standard ΛCDM scenario, the minimum frequency attainable in this scenario is 10^{13} Hz, three orders of magnitude above the expected cutoff from primordial gravitational waves. Modified Einstein gravity or non-standard cosmological evolution is needed to bring the frequency below that threshold. Gravitational atoms naturally arise in the minimal PIDM scenario consisting of a GUT-scale scalar particle with only gravitational interactions.

Primary authors: Mr PALESSANDRO, Andrea (CP3-Origins); Prof. SLOTH, Martin S. (CP3-Origins); Dr NIELSEN, Niklas G. (CP3-Origins)

Presenter: Mr PALESSANDRO, Andrea (CP3-Origins)

Session Classification: Morning 22

Contribution ID: **16** Type: **Oral**

Searching for weakly interacting particles with the FASER Experiment

Wednesday 5 June 2019 11:45 (20 minutes)

FASER, the ForwArd Search ExpeRiment, is a newly approved experiment at the LHC, dedicated to searching for light, extremely weakly-interacting particles during the LHC Run 3. Such particles may be produced in the LHC's high-energy collisions in large numbers in the far-forward region and then travel long distances through concrete and rock without interacting. They may then decay to visible particles in FASER, which is placed 480 m downstream of the ATLAS interaction point. In this talk, we present the basic concept, the status and the physics reach of FASER. In particular, we discuss the discovery prospects for axion-like particles (ALPs) that couple to the standard model through the axion-photon-photon interaction.

Primary author: Prof. SCHOTT, Matthias (Uni Mainz)

Co-author: FASER COLLABORATION, - (-)

Presenter: Prof. SCHOTT, Matthias (Uni Mainz)

Session Classification: Morning 32

Contribution ID: **17** Type: **Oral**

MADMAX: detection of axion dark matter

Tuesday 4 June 2019 12:05 (20 minutes)

The Axion is the hypothetical low-mass boson predicted by the Peccei-Quinn mechanism solving the strong CP problem. It is naturally also a cold dark matter candidate, thus it could simultaneously solve two major problems of nature. Up to recently, there was no existing experimental effort aiming to detect QCD axions in the mass range around 100 ueV, preferred by models in which the Peccei-Quinn symmetry was restored after inflation.
The MADMAX project is designed to be sensitive for QCD dark matter axions with masses 40ueV –400 ueV. The experimental design is based on the idea of enhanced axion photon conversion in a system with movable dielectric discs.
The MADMAX experiment will be located at DESY in Hamburg and enters now its prototyping phase. The design, realization and time scale of the experiment will be discussed. Proof of concept will be presented indicating the path towards the first physics run.

Primary author: Prof. GARUTTI, Erika (University of Hamburg)

Presenter: Prof. GARUTTI, Erika (University of Hamburg)

Session Classification: Morning 22

Contribution ID: **18** Type: **Oral**

Dark Matter Searches with the COSINE-100 Experiment

Thursday 6 June 2019 11:05 (20 minutes)

COSINE-100 is a direct dark matter detection experiment using ~106 kg of low-background NaI(Tl) detectors submerged in a veto counter consisting of 2 tons of liquid scintillator to test the DAMA/LIBRA' s claim of dark matter observation. The physics run of the experiment began in September 2016 with an average background rate of 3.5 counts/keV/kg/day in the energy region between 2–6 keVee. We observed no excess of events above COSINE-100's background model, allowing us to rule out the spin-independent WIMP interpretation of the DAMA signal using the first 59.5 days of data from COSINE-100. Additionally, we search for a dark matter-induced annual modulation and observe best fit values of modulation amplitude and phase of 0.0092±0.0067 counts/keV/kg/day and 127.2±45.9 days, respectively, using the first 1.7 years of the data. In this talk, I will present status of the COSINE-100 experiment and prospects for future experiments.

Primary author: Mr ADHIKARI, Govinda (Sejong University)

Presenter: Mr ADHIKARI, Govinda (Sejong University)

Session Classification: Morning 42

Contribution ID: **19** Type: **Oral**

The XENON Dark Matter Project at Gran Sasso National Laboratory

Thursday 6 June 2019 09:35 (20 minutes)

The XENON project aims at directly detecting dark matter particles through their interaction in a liquid xenon target. The XENON1T detector, a dual phase Time Projection Chamber with 2 t active mass, has operated at Gran Sasso National Laboratory (Italy) from 2016 to 2018. It collected 1 tonne-year exposure with the lowest electronic recoil background ever achieved by a dark matter detector. The analysis of these data allowed to set the most stringent limit to date on spin-independent WIMP-nucleon cross section for masses greater than 6 GeV. Many other analysis on the same dataset are ongoing, including the search for spin-dependent WIMP-nucleon interactions, WIMP-pion coupling, axion-like particles, super WIMPs and dark photons, WIMP search with Migdal effect, S2-only analysis. A ^{37}Ar calibration campaign was performed at the end of XENON1T scientific runs, to measure the response of the detector to these monochromatic low energy electronic recoils.
The upgrade of XENON1T is ongoing to get to the new generation detector, XENONnT. It will have an active mass of 5.9 t (total xenon mass 8 t), and it will be commissioned by the end of 2019. Thanks to its larger mass (about 4 times larger fiducial volume) and factor 10 background reduction with respect to its forerunner, XENONnT is expected to reach a sensitivity to spin-independent WIMP-nucleon cross section which is about one order of magnitude better than the current best limit with a 20 tonne-year exposure.

Primary author: Dr MOLINARIO, Andrea (Gran Sasso Science Institute)

Presenter: Dr MOLINARIO, Andrea (Gran Sasso Science Institute)

Session Classification: Morning 41

Contribution ID: **20** Type: **Poster**

CAST-CAPP Detector Project

Tuesday 4 June 2019 14:30 (5 minutes)

CAST-CAPP detector project is searching for dark matter axions, in the range of 21 to 25μeV, using tunable rectangular microwave cavities installed in the 43mm twin-bore, 9T, CAST dipole magnet. In December 2018, one of the four identical cavities was operated at constant frequency of ~5.40 GHz and obtained 135 hours of preliminary data with ~25 MHz bandwidth. Data processing and analysis procedure is being developed and latest results indicate a limit on the axion to photon coupling constant on the order of 10^-13 GeV^-1. In this talk, in addition to the details of first run, we will also present some of the hardware improvements, during current phase-2 commissioning, which will enable the examination of up to 500 MHz frequency range using all 4 phase matched cavities with piezo-tuners.

Primary authors: Mr OZBOZDUMAN, Kaan (Bogazici University & CERN); Mr MAROUDAS, Marios (University of Patras)

Presenters: Mr OZBOZDUMAN, Kaan (Bogazici University & CERN); Mr MAROUDAS, Marios (University of Patras)

Session Classification: Poster 1

Contribution ID: **21** Type: **Oral**

Status and prospects of the DarkSide project

Tuesday 4 June 2019 09:55 (20 minutes)

DarkSide utilizes the 39Ar-depleted argon as target and the dual-phase Time Projection Chambers technology to search for WIMP signal. In this talk, I will review the recent results of the DarkSide-50 experiment, currently running at LNGS with 50-kg fiducial mass. I will also present the status of the DarkSide-20k experiment with 20-tonne fiducial mass. Plans for a further step towards a 300-tonne detector will be presented as well.

Primary author: Dr XIAO, Xiang (UCLA)

Presenter: Dr XIAO, Xiang (UCLA)

Session Classification: Morning 21

Contribution ID: **22** Type: **Oral**

Solar Axion Searches with the International Axion Observatory (IAXO) and BabyIAXO

Monday 3 June 2019 15:00 (20 minutes)

More than 80 years after the postulation of dark matter, its nature remains one of the fundamental questions in cosmology waiting to be answered. Axions have taken the spotlight in recent years and are currently one of the leading candidates for the hypothetical, non-baryonic dark matter expected to account for about 25% of the energy density of the Universe. Especially in the light of the Large Hadron Collider at CERN as well as other dedicated dark matter experiments slowly closing in on weakly-interacting massive particle (WIMP) searches, axions and axion-like particles (ALPs) provide a viable alternative approach to solving the dark matter problem. The fact that makes them especially appealing is that they were initially introduced to solve a long-standing problem in quantum chromodynamics and the Standard Model of particle physics, so they do not present an ad-hoc solution to dark matter alone.

Helioscopes are one of three major types of axion experiments and search for axions produced in the core of the Sun via the Primakoff effect. The International Axion Observatory (IAXO) is a next generation axion helioscope aiming at a sensitivity to the axion-photon coupling of 1 - 1.5 orders of magnitude beyond the current most sensitive axion helioscope which is the CERN Axion Solar Telescope (CAST). IAXO will be able to challenge the stringent bounds from supernova SN1987A and furthermore test the axion interpretation of anomalous white-dwarf cooling. Beyond standard axions, this new experiment will also be able to search for a large variety of ALPs and other novel excitations at the low-energy frontier of elementary particle physics. BabyIAXO is proposed as a first stage towards IAXO and aims at extending the sensitivity to axion-photon couplings down to a few 10^{-11} GeV^{-1}. Thus the experiment will deliver significant physics results while demonstrating the feasibility of the full-scale IAXO experiment by validating all subcomponents (magnet, optics, detectors, infrastructure). Here we introduce IAXO and BabyIAXO, report on the current status of both experiments and outline the expected science reach.

This work was performed in part under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

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Presenter: Dr VOGEL, Julia (LLNL)

Session Classification: Afternoon 11

Contribution ID: **23** Type: **Oral**

Production of dark matter axions from global strings

Wednesday 5 June 2019 11:25 (20 minutes)

In light of recent developments of experimental approaches on the search for axion dark matter, it is important to clarify what is the typical theoretical prediction for its mass. The prediction for the axion dark matter mass can be obtained by estimating the relic axion abundance, which is given as a function of the Peccei-Quinn scale. However, the estimation of the axion abundance suffers from huge uncertainty due to the poor understanding of the contribution of axions produced by the decay of global strings. Fortunately, recent numerical approaches enable us to investigate more details on the shape of the spectrum of axions radiated from strings, which gives some clues to resolve the long-standing uncertainty. In this contribution, we review the issue of the production mechanism of dark matter axions and present new results of large scale numerical simulations on the cosmological evolution of global strings. By extrapolating the numerical results, we also discuss the implication for the value of the axion dark matter mass.

Primary authors: VAQUERO, Alejandro (University Of Utah); REDONDO, Javier (Universidad de Zaragoza/MPP); SAIKAWA, Ken'ichi (Max Planck Institute for Physics)

Presenter: SAIKAWA, Ken'ichi (Max Planck Institute for Physics)

Session Classification: Morning 32

Contribution ID: **24** Type: **Poster**

Gravitational waves from Standard Model*Axion*Seesaw*Higgs portal inflation

Tuesday 4 June 2019 14:15 (5 minutes)

Standard Model-Axion-Seesaw-Higgs portal inflation (SMASH) is a minimal extension of the Standard Model that provides a solution to five problems of particle physics and cosmology (inflation, baryon asymmetry, neutrino masses, strong CP problem, and dark matter) in one stroke. An important prediction of this model is the existence of a significant amount of primordial gravitational waves (GWs) that are originated from tensor fluctuations during inflation, and such GW signatures can be probed both indirectly by upcoming cosmic microwave background polarization experiments and directly by future space-born GW interferometers. In this contribution, we point out that the SMASH model indeed gives a non-trivial and unique prediction for the nature of the second order Peccei-Quinn phase transition, which is imprinted on the spectrum of primordial GWs in a frequency range relevant to future high-sensitivity GW experiments. After presenting the analysis on the spectrum of GWs in the SMASH model, we discuss the possibility to probe it in the future GW direct detection experiments.

Primary authors: RINGWALD, Andreas (DESY); TAMARIT, Carlos (Technische Universität München); SAIKAWA, Ken'ichi (Max Planck Institute for Physics)

Presenter: SAIKAWA, Ken'ichi (Max Planck Institute for Physics)

Session Classification: Poster 1

Contribution ID: **25** Type: **Oral**

Axions from Strings

Tuesday 4 June 2019 17:30 (20 minutes)

If a PQ phase was ever restored after inflation the evolution of the QCD axion field would be dominated by topological defects, such as strings and domain walls. While in this case the relic abundance of axions is in principle completely calculable in terms of the axion mass, in practice no reliable analytic tool is available. I will first review the physics underlying the production and evolution of axionic strings and how they can lead to suitable DM axions. I will then present results from recent field theory simulations and discuss about the implications for axion dark matter.

Ref: 1806.04677

Primary author: GORGHETTO, Marco (SISSA)

Co-authors: HARDY, Edward (Liverpool U.); VILLADORO, Giovanni (ICTP)

Presenter: GORGHETTO, Marco (SISSA)

Session Classification: Afternoon 21

Contribution ID: **26** Type: **Oral**

Exploiting higher-order resonant modes for axion haloscopes

Friday 7 June 2019 09:55 (20 minutes)

The haloscope is one of the most sensitive approaches to the QCD axion physics within the region where the axion is considered as a dark matter candidate. However, the current experimental sensitivities, relying on the lowest fundamental TM010 mode of a cylindrical cavity, is limited to relatively low mass regions. Exploiting higher-order resonant modes would be beneficial because it enables us to extend the search range with no volume loss and higher quality factors. However, this approach has been discarded mainly due to the significantly degraded form factors and difficulty in frequency tuning. We introduce a new concept of tuning mechanism, which both enhances the form factors and yields reasonable frequency tunability, and demonstrate its feasibility for axion search experiments. In addition, convolution of this concept with the multiple-cell cavity design enables us to widen the search range towards even higher frequencies beyond 10 GHz. We present a simulation study to evaluate this conceptual approach for high mass axion search.

Primary author: YOUN, SungWoo (CAPP/IBS)

Presenter: YOUN, SungWoo (CAPP/IBS)

Session Classification: Morning 51

Contribution ID: **27** Type: **Oral**

Axions from supernovae: bounds and discovery opportunities

Monday 3 June 2019 16:30 (20 minutes)

In this talk it will be discussed the physics potential of a Galactic supernovae in probing axions and axion-like particles, starting from the lesson of the SN 1987A to current and planned experiments

Primary author: Dr MIRIZZI, Alessandro (University of Bari)

Presenter: Dr MIRIZZI, Alessandro (University of Bari)

Session Classification: Afternoon 12

Contribution ID: **28** Type: **Oral**

Relic Neutrino Detection with PTOLEMY

Wednesday 5 June 2019 11:05 (20 minutes)

The Universe became transparent to neutrino's approximately 1 second after the Big Bang. These neutrino's are omnipresent with a density of around 300 cm^{-3}. However, they have never been observed since they have cooled down to a temperature of 1.9K, corresponding to an energy of just several 100 μeV. Within the PTOLEMY collaboration we are investigating techniques to observe these neutrino's through their capture on tritium and its subsequent two-body beta decay.

The ultimate goal of PTOLEMY is to construct a target of 100g of tritium lightly bound to a solid state substrate and measuring the endpoint of the decay spectrum with an extreme precision. The electron energy resolution should be of the order of 50meV in order to be able to observe the monochromatic electrons induced by neutrino capture from the three-body decay spectrum of the ordinary decays.
To make the experiment even more challenging, we need to suppress the extreme background from the ordinary tritium decays (around 10^{15} Bq/g tritium) to 100Hz around the endpoint of the spectrum in order not to saturate the cryogenic calorimetry system. We propose a technique to suppress the background by means of a **ExB** drift filter with an appropriate gradient in the **B** field.

To date, our method is the only viable proposal to detect relic neutrinos. If we succeed this would be the 4^{th} piece of direct evidence for the Big Bang.

Primary author: Mr COLIJN, A (Nikhef)

Presenter: Mr COLIJN, A (Nikhef)

Session Classification: Morning 32

Contribution ID: **29** Type: **Oral**

Revisiting the axion emissivity from a supernova and the SN 1987 A

Thursday 6 June 2019 15:50 (20 minutes)

We perform an updated calculation of the SN axion emissivity via nucleon bremmstrhalung. Using state-of-the-art SN simulations we study the impact of the axion emission on the SN neutrino signal and we update the SN 1987A bound.

Primary author: Mr CARENZA, Pierluca (University of Bari)

Co-authors: Dr MIRIZZI, Alessandro (University of Bari); Prof. CO', Giampaolo (Dipartimento di Matematica e Fisica "E. De Giorgi", Università del Salento & Istituto Nazionale di Fisica Nucleare - Sezione di Lecce); Prof. GIANNOTTI, Maurizio (Physical Sciences, Barry University); Dr RAUSCHER, Thomas (Department of Physics, University of Basel & Centre for Astrophysics Research, University of Hertfordshire); Dr FISCHER, Tobias (Institute of Theoretical Physics, University of Wroclaw)

Presenter: Mr CARENZA, Pierluca (University of Bari)

Session Classification: Afternoon 41

Contribution ID: **30** Type: **Oral**

Status of the LZ Dark Matter Experiment

Friday 7 June 2019 09:35 (20 minutes)

LUX-ZEPLIN (LZ) is a second-generation dark matter direct detection experiment currently under construction at the 4850'-level of the Sanford Underground Research Facility (SURF) in Lead, South Dakota, USA. The experiment utilizes a dual-phase time projection chamber (TPC), containing seven active tons of purified liquid xenon, to search for potential signals from weakly interacting massive particles (WIMPs). LZ has been designed to explore much of the parameter space available for WIMP models, with unprecedented sensitivity to WIMP masses between a few GeV and a few TeV. Active assembly work of the experiment at SURF is currently ongoing with expected data taking to begin in 2020. An experiment overview, the timeline and the current detector construction status of LZ will be presented.

Primary author: Dr HORN, Markus (South Dakota Science and Technology Authority)

Presenter: Dr HORN, Markus (South Dakota Science and Technology Authority)

Session Classification: Morning 51

Contribution ID: **31** Type: **Oral**

Recent results from Dark Matter searches with EDELWEISS

Monday 3 June 2019 12:00 (20 minutes)

EDELWEISS is a phased direct Dark Matter search program based on cryogenic high purity Ge mono-crystals. The simultaneous measurement of heat via thermal sensors (NTDs) and ionization allows for discrimination of nuclear and electron recoils. Based on electronic recoils, a search for axions and axion-like particles in the keV mass range can be performed. With an optimized setup of phonon readout, first limits for sub-GeV spin-independent Dark Matter searches with Ge targets were achieved. These searches have been extended to Strongly Interacting Massive Particles (SIMPs) down to 45 MeV by exploiting the Migdal effect. Recent results and prospects for the ongoing DM searches will be presented.

Primary author: Mr SIEBENBORN, Bernhard (Karlsruhe Institute of Technology (KIT))

Presenter: Mr SIEBENBORN, Bernhard (Karlsruhe Institute of Technology (KIT))

Session Classification: Morning 12

Contribution ID: **32** Type: **Oral**

Employing Precision Frequency Metrology for Axion Detection

Tuesday 4 June 2019 11:05 (20 minutes)

Due to its extraordinary precision reaching 10^{-18} level, frequency metrology is one of the most sensitive tools used in many tests of fundamental physics such as detection of violations of the Lorentz Invariance and special relativity, drifts of the fine structure constant, etc. In this presentation, we consider how to adopt these tool for axion searches and demonstrate the key differences with the power detection techniques used by all previous studies.
The proposed approach is based on a photonic cavity supporting two mutually orthogonal modes. We demonstrate how axion modified Maxwell electrodynamics leads to either a beam splitter or parametric interaction between the modes in the axion up- or downconversion cases respectively and how these axion mediated interaction terms could be detected using frequency observation. Prospects of the proposed system are analysed based on the current technological level, and particular measurement schemes are considered. We will discuss the key advantages of the frequency metrology comparing to the traditional power detection methods, such as absence of strong magnetic fields, mode volume independence, power ration improvement, etc. Some preliminary experimental results will be discussed. Finally, a method to boost the sensitivity of such metrological setup using exceptional points in the eigenvalues and eigenvectors of the system will be discussed.

Primary author: Dr GORYACHEV, Maxim (University of Western Australia)

Co-authors: Dr BEN, MacAlister (University of Western Australia); Prof. TOBAR, Michael (University of Western Australia)

Presenter: Dr GORYACHEV, Maxim (University of Western Australia)

Session Classification: Morning 22

Contribution ID: **33** Type: **Poster**

Broadening Frequency Range of a Ferromagnetic Axion Haloscope with Strongly Coupled Cavity-Magnon Polaritons

Tuesday 4 June 2019 14:40 (5 minutes)

Ferromagnetic axion haloscopes search for axion dark matter by exploiting their coupling to electrons. We present a new theoretical framework by which such devices can be understood with a Hamiltonian approach using strongly coupled cavity photons, and magnons from a spherical ferrimagnet. Particular focus is put of the operation of these devices in the dispersive regime, which allows these experiments to search over a broader frequency range with respect to the axion parameter space. An initial experiment is performed with limits set on axion to electron coupling of $g_{aee} > 3.7 \times 10^{-9}$
in the range 33.79μeV<m_a< 33.94μeV with 95% confidence. The potential range of operation of this experiment is calculated, however, to be in bands: 4.1μeV centred around 34.1μeV and 6.6μeV centred around 41.4μeV. Future improvements to the experiment are also discussed.

Primary author: Mr FLOWER, Graeme (University of Western Australia)

Co-authors: Dr BOURHILL, Jeremy (University of Western Australia); Dr GORYACHEV, Maxim (University of Western Australia); Prof. TOBAR, Michael (University of Western Australia)

Presenter: Mr FLOWER, Graeme (University of Western Australia)

Session Classification: Poster 1

Contribution ID: **34** Type: **Oral**

New Structures in Axion Halos on Super-de Broglie Scales

Tuesday 4 June 2019 12:25 (20 minutes)

It was recently shown that axion dark matter, as a highly-correlated Bose fluid, contains extra-classical physics on super-de Broglie and cosmological length scales. The extra-classical physics comes in the form of an exchange-correlation interaction, induced by the constraints of symmetric particle exchange and inter-axion correlations from self-gravitation. Exchange-correlation physics creates opportunities for axion dark matter to form cosmological structures unique from standard cold dark matter. This talk presents our most recent results in studying axion structure formation with exchange-correlation interactions, including N-body simulations of full collapse and virialization of isolated halos. Novel structures induced by exchange-correlation interactions are found to be created in even the most violent collapses. Applications to observation and axion search efforts are also discussed.

Primary author: Dr LENTZ, Erik (University of Goettingen)

Co-authors: Dr ROSENBERG, Leslie (University of Washington); Dr QUINN, Thomas (University of Washington)

Presenter: Dr LENTZ, Erik (University of Goettingen)

Session Classification: Morning 22

Contribution ID: **35** Type: **Oral**

Low-mass Dark Matter Detection with the CRESST-III experiment

Monday 3 June 2019 09:30 (20 minutes)

CRESST (Cryogenic Rare Event Search with Superconducting Thermometers) is a direct dark matter search experiment, located at the Laboratori Nazionali del Gran Sasso (LNGS) in Italy, where an overburden of 1400m of rock (3800m water equivalent) provides an efficient reduction of the cosmic radiation background.
In the CRESST experiment, ~24g scintillating $CaWO_4$ crystals are used as target material for elastic DM-nucleus scattering and operated as cryogenic detectors at ~15mK temperatures. The simultaneous measurement of the phonon signal from each target crystal and the emitted scintillation light in a separate cryogenic light detector provides event-by-event particle identification for background suppression. In 2018, the first run of CRESST-III was successfully completed, achieving an unprecedented low energy threshold for nuclear recoils of 30.1 eV. Such a low threshold provides a significant boost in sensitivity allowing to probe dark matter particle masses as low as $160\mathrm{MeV/c^2}$.
In this contribution the latest results of CRESST-III will be presented accompanied by a brief status update on the ongoing activities of the experiment.

Primary author: Dr MOKINA, Valentyna (HEPHY)

Presenter: Dr MOKINA, Valentyna (HEPHY)

Session Classification: Morning 11

Contribution ID: **36** Type: **Oral**

Collapsing Bose stars as source of repeating fast radio bursts

Friday 7 June 2019 11:45 (20 minutes)

The substructures of light bosonic (axion-like) dark matter may condense into compact Bose stars. Peculiar self-interaction potential of the ALPs introduces attraction between particles and causes collapse of large-mass Bose stars. These processes proceed in an unexpected universal way. First, the central part of Bose star approaches a singular density profile due to self-similar infall of the ALP into the star center. Second, multiparticle relativistic interactions in the dense center stop the collapse and produce an outgoing stream of mildly relativistic ALP. This two-step process is repeated many times separated by random time intervals required to construct the next self-similar collapsing solution. We find that powerful flashes of radio waves may be produced during the collapse due to parametric resonance of photons caused by oscillating axion field of the Bose star. We show that spectrum, energy, duration, repeatability of the flashes produced during Bose star collapse coincide with the properties of repeating fast radio burst FRB 121102.

Primary author: Dr PANIN, Alexander (INR RAS, Moscow)

Co-authors: LEVKOV, Dmitry (INR RAS); Prof. TKACHEV, Igor (INR RAS)

Presenter: Dr PANIN, Alexander (INR RAS, Moscow)

Session Classification: Morning 52

Contribution ID: **37** Type: **Poster**

GridPix detectors from CAST to IAXO

Tuesday 4 June 2019 14:45 (5 minutes)

In the scope of the search for axions and axion like particles (Alps) a detector especially built for low energy X-rays based on the GridPix technology was developed at the University of Bonn. The GridPix is a MicroMegas like readout consisting of a pixelized readout ASIC (Timepix) with a perfectly aligned gas amplification stage, which is photolithographically built on top of the ASIC. Resulting in a very high granularity this detector is capable of detecting single electrons allowing the measurement of low energy X-rays down to the 200 eV range. To convert these the X-rays into electrons a small gas volume is built above the readout sealed with an X-ray entrance window.

This detector was successfully used in two data taking campaigns 2014/15 and after that with major upgrades in 2017/18 at the CAST experiment. The already analysed data from the 2014/15 campaign led to new limits on the chameleon photon coupling, while the recorded data from the second campaign is still under analysation promising even better result.
While the detector used in 2014/15 was rather simple, containing one GridPix and a window made out of 2 µm mylar glued on a copper strong back, the detector for the 2017/18 run was majorly improved for background reduction. First, two active moun vetos have been implemented. Second, the central GridPix was surrounded by 6 veto GridPixes and actively water cooled. Third, the mylar window was exchanged by a 300 nm silicon nitride window leading to a better transmission especially in the energy regime below 3 keV.

This started the development of the IAXO detector with the goal to achieve even lower backgrounds. For this the selection of special radiopure materials is required as well as a veto system for offline suppression of background events is necessary. Also the successor of the Timepix, Timepix3 will be introduced leading to a nearly dead time free data taking and the ability of a 3D-event reconstruction.

Primary author: Mr SCHIFFER, Tobias (Universität Bonn)

Co-authors: KAMINSKI, Jochen (University of Bonn); DESCH, Klaus (University of Bonn); GRUBER, Markus (Universität Bonn); Mr SEBASTIAN, Schmidt (Physikalisches Institut der Universität Bonn)

Presenter: Mr SCHIFFER, Tobias (Universität Bonn)

Session Classification: Poster 1

Contribution ID: **38** Type: **Poster**

CAST: Mechanical tuning of RADES microwave cavities

Tuesday 4 June 2019 15:25 (5 minutes)

Many experiments all over the world search for Axions in different mass ranges. The Relic Axion Detector Experimental Setup (RADES) uses microwave filters as detectors which are in theory able to scan a mass range of 10 to 100 μeV. A typical RADES filter consists of N sub-cavities coupled by rectangular irises. They are installed at CAST in a bore of a powerful decommissioned LHC 9 T magnet. Currently, all RADES prototypes work at a fixed frequency. In order to scan through the mass ranges the cavities need to be tunable. Different approaches exist to generate tuning of the resonant frequency of a cavity.
This poster will focus on the mechanical tuning by changing the width of a 5 sub-cavities filter with inductive irises and a vertical cut up to 2.5 mm. Results of the tuning range of this method at warm, Q values and resonant frequencies of the vertical cut cavity between 7 K and 300 K in closed (f = 8.4 GHz) and open (1.25 mm; f = 8.1 GHz) position will be presented. Moreover, first ideas of a mechanical tuning mechanism at cryogenic temperatures and in a multi-tesla magnetic field will be shown.

Primary author: GOLM, Jessica (CERN)

Co-authors: Mr GARCÍA BARCELÓ, Jose María (Universidad Politécnica de Cartagena); ARGUEDAS CUENDIS, Sergio (CERN)

Presenter: GOLM, Jessica (CERN)

Session Classification: Poster 1

Contribution ID: **39** Type: **Oral**

Galactic axions search with a superconducting resonant cavity

Tuesday 4 June 2019 12:45 (20 minutes)

To account for the dark matter content in our Universe, post-inflationary scenarios predict for the QCD axion a mass in the range $(10 - 10^3)$ μeV. Searches with haloscope experiments in this mass range require the monitoring of resonant cavity modes with frequency above 5 GHz, where several experimental limitations occur due to linear amplifiers, small volumes, and low quality factors of Cu resonant cavities. In this talk we deal with the last issue, presenting the latest result of the QUAX$-a\gamma$ Collaboration for the search for galactic axions using a haloscope based on a 36 cm^3 NbTi superconducting cavity. The cavity worked at T = 4K in a 2T magnetic field and exhibited a quality factor $Q_0 = 4.5 \times 10^5$ for the TM010 mode at 9 GHz. With such values of Q the axion signal is signicantly increased with respect to copper cavity haloscopes. Operating this setup we set the limit $g_{a\gamma\gamma} < 1.03 \times 10^{12}\text{GeV}^{-1}$ on the axion photon coupling for a mass of about 37 μeV. A comprehensive study of the NbTi cavity at different magnetic fields, temperatures, and frequencies is also presented.

Primary author: Dr GATTI, Claudio (INFN)

Presenter: Dr GATTI, Claudio (INFN)

Session Classification: Morning 22

Contribution ID: **40** Type: **Oral**

R&D toward next-generation LXe experiments

Tuesday 4 June 2019 11:45 (20 minutes)

As noble liquid time projection chambers grow in size, it becomes more difficult to maintain sufficiently large drift field and efficient prompt light collection, both of which are important for dark matter detector performance. I will report on first results from two new systems (XeBrA and IBEX) at Lawrence Berkeley National Laboratory, designed for investigations of high voltage and light collection. The Xenon Breakdown Apparatus (XeBrA) is a 5-liter cryogenic chamber built to characterize high voltage behavior of liquid xenon and enabling detailed, reproducible studies of dielectric breakdown and the onset of electroluminescence. IBEX is an apparatus used to measure the angular distribution of light reflected off of polytetrafluoroethylene (PTFE) samples submerged in liquid xenon, in order to investigate microphysical models of reflection in this context.

Primary author: Dr KRAVITZ, Scott (Lawrence Berkeley National Lab)

Presenter: Dr KRAVITZ, Scott (Lawrence Berkeley National Lab)

Session Classification: Morning 22

Contribution ID: **41** Type: **Oral**

New Results from the ADMX G2 Axion Dark Matter Search

Thursday 6 June 2019 15:10 (20 minutes)

We present the results from the second year of operations of the ADMX G2 Axion Dark Matter search. ADMX has continued its search for axions to higher masses, with sensitivity to an axion model with DFSZ coupling where axions make up the bulk of the local dark matter density. ADMX is also sensitive to KSVZ axions that make up even a small fraction of dark matter. In addition to this year's search results, we will discuss our significantly increased our scan speed, our blind synthetic axion signal injection system, and make projections for future axion mass coverage.

Primary author: Prof. RYBKA, Gray (University of Washington)

Presenter: Prof. RYBKA, Gray (University of Washington)

Session Classification: Afternoon 41

Contribution ID: **42** Type: **Poster**

The CAST/RADES project progress: electrical tuning ideas and a new 30 sub-cavities axion detector design

Tuesday 4 June 2019 15:10 (5 minutes)

Progress on the possibilities for implementing frequency tuning and increasing the volume of RADES (*Relic Axion Detector Exploratory Setup*) axion search cavities are described. The cavities works at X-Band and consist of inter-coupled sub-cavities. A first 5 cavity prototype split into two halves has been manufactured and provides a tuning range of 700 MHz by varying the distance of the two halves. Alternatively, tuning with ferroelectric materials varying the dielectric permittivity is being investigated and simulated. In order to increase cavity volume, and thus sensitivity, a new 30 sub-cavities detector design provides a higher volume keeping the previous RADES frequency range, of ~8.4 GHz. The 30 cell cavity considerably increases the sensitivity of the sensor as compared to the previous experiment. A description of the theoretical framework and the simulations of the electromagnetic properties of the system will be presented.

Primary author: Mr GARCÍA BARCELÓ, Jose María (Universidad Politécnica de Cartagena)

Co-authors: GOLM, Jessica (CERN); ARGUEDAS CUENDIS, Sergio (CERN)

Presenter: Mr GARCÍA BARCELÓ, Jose María (Universidad Politécnica de Cartagena)

Session Classification: Poster 1

Contribution ID: **43** Type: **Oral**

DARWIN : The ultimate low-background astroparticle physics observatory

Wednesday 5 June 2019 09:55 (20 minutes)

The DARWIN experiment is a proposed next-generation dual-phase time projection chamber which will operate 50 tonnes of xenon. With such a large target, its low-energy threshold and ultra low background level, it will be sensible enough to explore the entire experimentally accessible parameter space for WIMPs above a mass of 5 GeV/c2, as well as to search for axions and axion-like particles. It will be capable to measure low energy solar neutrinos flux with a high precision, observe the coherent neutrino-nucleus interaction and detect galactic supernovae. Finally it has great potential to discover neutrinoless double beta decay of 136Xe. We present here the ongoing R&D activities and the sensitivity for the different physics channels.

Primary author: Dr SCOTTO LAVINA, Luca (CNRS / LPNHE Laboratory)

Presenter: Dr SCOTTO LAVINA, Luca (CNRS / LPNHE Laboratory)

Session Classification: Morning 31

Contribution ID: **44** Type: **Poster**

Towards the development of the ferromagnetic haloscope: status report of QUAX

Tuesday 4 June 2019 14:50 (5 minutes)

The search of dark matter in the form of Axions, extremely light and weakly interacting particles, can be performed with detectors called haloscopes. These setups usually test the coupling of Axions with photons, but recently ferromagnetic haloscopes have been proposed to probe the interaction of Axions with the electrons of a magnetic material [1].
The QUAX experiment aims at implementing this idea. The first setup was operated at cryogenic temperatures and the results were presented in [2] for a limited range of the Axion mass. The apparatus demonstrates the possibility of using electron spin resonance in a microwave cavity at $4\,\mathrm{K}$ to measure Axion-induced excesses of magnetization in a sizable quantity of material.
However, such prototype is still far from the sensitivity needed for a QCD-Axion search, and more developments are necessary in terms of measurement precision and maximization of the signal.
The most recent improvements in this direction will be presented. These include the implementation of an apparatus at mK temperatures featuring a Josephson Parametric Amplifier, of a superconducting cavity operating in a high magnetic field, and of drastically increased material volume.
Eventually, the potential bandwidth of such haloscopes is under study through a tool which ultimately could also be used to get an absolute calibration of the setup.

[1] "Searching for galactic axions through magnetized media: The QUAX proposal", R. Barbieri *et al.* Phys. Dark Univ. 15: 135 (2017) https://doi.org/10.1016/j.dark.2017.01.003.

[2] "Operation of a ferromagnetic axion haloscope at $m_a = 58\,\mu\mathrm{eV}$", N. Crescini *et al.* Eur. Phys. J. C 78: 703 (2018) https://doi.org/10.1140/epjc/s10052-018-6163-8.

Primary author: Mr CRESCINI, Nicolò (University of Padua - INFN-LNL)

Co-authors: Prof. CARUGNO, Giovanni (University of Padua - INFN-LNL); Dr RUOSO, Giuseppe (INFN-LNL)

Presenter: Mr CRESCINI, Nicolò (University of Padua - INFN-LNL)

Session Classification: Poster 1

Contribution ID: **45** Type: **Oral**

Searching for axion dark matter with tuneable plasma haloscopes

Tuesday 4 June 2019 10:15 (20 minutes)

We propose a new strategy to search for dark matter axions using tunable cryogenic plasmas. Unlike current experiments, which repair the mismatch between axion and photon masses via breaking translational invariance (cavity and dielectric haloscopes), a plasma haloscope enables resonant conversion by matching the axion mass to a plasma frequency. A key advantage is that the plasma frequency is unrelated to the physical size of the device, allowing large conversion volumes. We identify wire metamaterials as a promising candidate plasma, wherein the plasma frequency can be tuned by varying the interwire spacing. For realistic experimental sizes we estimate competitive sensitivity for axion masses $35 - 400\,\mu$eV.

Primary authors: Dr MILLAR, Alexander (Stockholm University); Mr VITAGLIANO, Edoardo (Max Planck Institute for Physics); Prof. WILCZEK, Frank (MIT); Dr PANCALDI, Matteo (Stockholm University); Dr LAWSON, Matthew (Stockholm University)

Presenter: Dr MILLAR, Alexander (Stockholm University)

Session Classification: Morning 21

Contribution ID: **46** Type: **Oral**

Searches for hidden particles with NA64

Thursday 6 June 2019 11:25 (20 minutes)

NA64 is a fixed target experiment at the CERN SPS aiming at a sensitive search for hidden sectors. In this talk, we will present our latest results on the search for a new sub-GeV vector gauge boson (A′) mediated dark matter (χ) production. The A′, called dark photon, could be generated in the reaction e−Z⟶e−ZA′ of 100 GeV electrons dumped against an active target which is followed by the prompt invisible decay A′⟶χχ. The experimental signature of this process would be a clean event with an isolated electron and large missing energy in the detector. This allows us to set new limits on the ɣ−A′ mixing strength and constrain the new parameter space for the most interesting light dark matter models.
Results on the search for the visible A' -> e+e− decays, as well as X⟶ e+e− decay of a new 17 MeV X boson, which could explain a recently observed anomaly in the 8Be transitions will be also discussed.

Primary author: Mr DEPERO, Emilio (ETH Zurich)

Presenter: Mr DEPERO, Emilio (ETH Zurich)

Session Classification: Morning 42

Contribution ID: **47** Type: **Oral**

Implications of Gaia for direct dark matter detection

Monday 3 June 2019 17:10 (20 minutes)

The recent releases of data from the Gaia satellite are transformational for galactic astronomy. The unprecetented accuracy with which stellar positions and velocities can be determined with Gaia means we are getting a fresh understanding of the structure, composition and history of the Milky Way's halo. The new data shows that the Milky Way underwent several major merger events which shaped the kinematic structure of the halo in surprising ways. These events will have important consequences for experiments searching for dark matter on Earth. In some cases, like direct searches for WIMPs, Gaia allows us to update the standard halo assumptions used in modelling expected signals. In other cases, notably axion haloscopes, the relics of our Milky Way's past may be much more readily observable.

Primary author: Dr O'HARE, Ciaran (Universidad de Zaragoza)

Presenter: Dr O'HARE, Ciaran (Universidad de Zaragoza)

Session Classification: Afternoon 12

Contribution ID: **48** Type: **Oral**

Axion Haloscope Experiments at the University of Western Australia

Monday 3 June 2019 16:50 (20 minutes)

At UWA we have funded axion detection programs for several mass ranges. The research program includes:

1) The Oscillating Resonant Group AxioN (ORGAN) experiment [1], to search the mass range 0.06 to 0.21 mev using a 14 Tesla magnet, dilution fridge, novel microwave cavity designs [2] and readout systems based on cross correlation to combine more than one cavity [3].

2) Ferromagnetic Axion Haloscope with Strongly Coupled Cavity-Magnon Polaritons to broaden the bandwidth of such experiments [4].

3) New experiments which interfere two highly stabilized photon modes and search for frequency or phase perturbations in these modes caused by galactic halo axions [5].

4) New low mass broad band and resonant schemes based on lumped LC elements for very low-mass ALPS [6,7], which promise enhanced sensitivity below a micro-eV.

After a general overview of the work at UWA, an update of the ORGAN experiment will be given. The magnet and dilution fridge will be delivered this year along with a laboratory upgrade, with the experiment expected to begin in 2020.

Following this a detailed look at our low-mass Haloscope experiments using lumped LC components will be presented. In particular a reformulation of axion modified electrodynamics is presented, which is shown to be of similar form to odd-parity Lorentz invariance violating background fields in the photon sector of the Standard Model Extension. When a DC B-field is applied an oscillating background polarization is induced at a frequency equivalent to the axion mass. In contrast, when a large DC E-field is applied, an oscillating background magnetization is induced at a frequency equivalent to the axion mass. We then go on to show that these terms are equivalent to impressed source terms, analogous to the way that voltage and current sources are impressed into Maxwell's equations in circuit and antenna theory [8]. The impressed source terms represent the conversion of external energy into electromagnetic energy due to the inverse Primakoff effect converting energy from axions under a DC magnetic field into photons. It is shown that the impressed electrical DC current that drives the solenoidal magnetic DC field of an electromagnet, induces an impressed effective magnetic current (or voltage source) parallel to the DC electrical current, oscillating at the Compton frequency of the axion. The effective magnetic current drives a voltage source through an electric vector potential and also defines the boundary condition of the oscillating axion induced polarization (or impressed axion induced electric field) inside and outside the electromagnet. This impressed electric field, like in any voltage source, represents an extra force per unit charge supplied to the system, which also adds to the Lorentz force and allows low-mass experiments based on lumped elements to achieve a greater sensitivity than what is currently thought to be.

[1] BT McAllister, G Flower, EN Ivanov, M Goryachev, J Bourhill, ME Tobar, The ORGAN experiment: An axion haloscope above 15 GHz, Physics of the Dark Universe, vol. 18, pp. 67–72, 2017.

[2] BT McAllister, G Flower, LE Tobar, ME Tobar, Tunable Super-Mode Dielectric Resonators for Axion Haloscopes, Phys. Rev. Applied, vol. 9, 014028, 2018.

[3] BT McAllister, S Parker, EN Ivanov, ME Tobar, Cross-correlation Signal Processing for Axion and WISP Dark Matter Searches, IEEE Trans. on UFFC, vol. 66, no. 1, 2019.

[4] Broadening Frequency Range of a Ferromagnetic Axion Haloscope with Strongly Coupled Cavity-Magnon Polaritons. (To be presented by G. Flower at PATRAS 2019)

[5] M Goryachev, BT McAllister, ME Tobar, arXiv:1806.07141 [physics.ins-det] (To be presented by M. Goryachev at PATRAS 2019)

[6] ME Tobar, BT McAllister, M Goryachev, arXiv:1809.01654 [hep-ph]

[7] ME Tobar, BT McAllister, M Goryachev, arXiv:1803.07755 [physics.ins-det]

[8] ME Tobar, BT McAllister, M Goryachev, arXiv:1904.05774 [physics.class-ph]

Primary author: Prof. TOBAR, Michael (University of Western Australia)

Co-authors: Mr MCALLISTER, Ben (University of Western Australia); Dr GORYACHEV, Maxim (University of Western Australia)

Presenter: Prof. TOBAR, Michael (University of Western Australia)

Session Classification: Afternoon 12

Contribution ID: **49** Type: **Poster**

Radiopure electronics for the Micromegas detector for IAXO

Tuesday 4 June 2019 15:05 (5 minutes)

New radiopure electronics for the Micromegas detector to be used in the future BabyIAXO helioscope is proposed based on the FEC-Feminos and AGET ASIC from Saclay due to their long tragectory of collaboration and proven functionaly as in CAST experiment. The modular readout will be divided in two stages. The first part of the electronics is composed of 4 Front End Cards (FEC) with one AGET chip and spark filters. It is intended to be placed as near as possible to the detector inside the shielding, so, it should be as radiopure as possible by selecting the components and reducing their number. The second part of the readout will be performed by the Back End Card (BEC) which will include the ADC and an FPGA to control the system. In order to define the effect of the electronics placement and components, simulation studies are carried away that replicate the design and estimate the energy deposit in the detector from Monte Carlo emission events. In parallel, radiopurity characterization measurements on all components have been started in Canfranc.

Primary authors: Mr COGOLLOS, Cristian (ICCUB (Institut de Ciències del Cosmos - Universitat de Barcelona)); Dr PICATOSTE, Eduardo (Institut de Ciències del Cosmos de la Universitat de Barcelona)

Co-authors: Dr GASCON, David (Institut de Ciències del Cosmos de la Universitat de Barcelona); MAURICIO, Joan (Institut de Ciències del Cosmos de la Universitat de Barcelona); MIRALDA, Jordi (Institut de Ciències del Cosmos de la Universitat de Barcelona)

Presenter: Mr COGOLLOS, Cristian (ICCUB (Institut de Ciències del Cosmos - Universitat de Barcelona))

Session Classification: Poster 1

Contribution ID: **51** Type: **Oral**

Searches for exotic decays with NA62

Wednesday 5 June 2019 12:05 (20 minutes)

The features of the NA62 experiment at the CERN SPS –high-intensity setup, trigger-system flexibility, high-frequency tracking of beam particles, redundant particle identification, and ultra-high-efficiency photon vetoes –make NA62 particularly suitable to search for long-lived, weakly-coupled particles within Beyond the Standard Model physics, using kaon and pion decays as well as operating the experiment in dump mode.
The latest results and the NA62 sensitivity for production and decay searches of Dark Photons, Heavy Neutral Lepton and Axion-Like Particles will be presented, together with prospects for future data taking at the NA62 experiment.

Primary authors: Dr CENCI, Patrizia (INFN Perugia); Dr VOLPE, Roberta (UCLouvain (Belgium))

Presenter: Dr VOLPE, Roberta (UCLouvain (Belgium))

Session Classification: Morning 32

Contribution ID: **52** Type: **Oral**

Cryogenic Electronics for Axion Searches

Monday 3 June 2019 14:40 (20 minutes)

This talk will give an overview of the cryogenic detector, particularly cold electronics for the most sensitive experiment to probe the QCD axion to date, Axion Dark Matter eXperiment, (ADMX). The detector technology includes a dilution refrigerator operated at 90mK and quantum-noise-limited amplifiers which contribute minimally to the system noise temperature thereby increasing the experimental sensitivity to the QCD axion. Using these technologies, ADMX has demonstrated recent success in reaching the so-called (DFSZ) sensitivity covering axion mass ranges from 2.66 to 3.31 μeV which no other axion experiment has achieved to this date. These results have crucial implications for the future direction of ongoing dark matter searches.

Primary author: Dr KHATIWADA, Rakshya (Fermilab)

Presenter: Dr KHATIWADA, Rakshya (Fermilab)

Session Classification: Afternoon 11

Contribution ID: **53** Type: **Oral**

The search for an Axion Dark Matter Signature using Radio Telescopes

Monday 3 June 2019 12:40 (20 minutes)

Next generation telescopes such as the Square Kilometre Array (SKA) present an exciting opportunity for radio astronomy to contribute to the search for dark matter. Using the theory initially set out by Sikivie 1983 we investigate axion conversion in the magnetic fields that pervade spiral galaxies, galaxy clusters and around dense objects such as neutron stars. I will present the strength of the expected axion signature for a range of sources, the sensitivity of this signal to the structure of the magnetic field, the different challenges presented by resonant and non-resonant conversion, and the shape of the associated spectral profiles. We find that the observation of non-resonant axion conversion in particular presents a significant challenge, principally due to the large discrepancy between the scale of astrophysical magnetic fields and that required for axion conversion, but that the observation of nearby neutron stars may offer an opportunity to rule out new regions of parameters space.

Primary author: Ms KELLEY, Katharine (ICRAR-UWA)

Presenter: Ms KELLEY, Katharine (ICRAR-UWA)

Session Classification: Morning 12

Contribution ID: **55** Type: **Oral**

Axion dark matter search at CAST using haloscopes

Thursday 6 June 2019 12:25 (20 minutes)

The CERN axion solar telescope (CAST) is well known for its searches of axions coming from the sun using different types of X-ray detectors. However, in recent years the CAST Collaboration has shifted its focus from solar axions to relic axions with two conceptually new detectors:
The Relic Axions Detector Exploratory Setup (RADES) which is based on a microwave filters and tunable microwave resonant cavities (CAPP-CAST). Both setups take advantage of the 9 Tesla field, produced by the CAST magnet and are installed parasitically to the solar axion search setup.

The RADES detector geometry consists of 5 or 6 copper plated stainless steel sub-cavities joined by rectangular irises resonating at approximately 8.4 GHz, while the CAPP-CAST detector consists of 4 identical tunable rectangular cavities resonating at 5.2 - 5.5GHz. In this presentation the advantages of these type of cavity geometries to resonate at frequencies above 5 GHz and at the same time grow in volume are going to be discussed. Furthermore, the measurements of the electromagnetic properties of both setups are going to be presented. Finally, the preliminary results of the data taken during 2018 with both detectors are going to be shown. The results show the potential of this type of filter to reach QCD axion sensitivity when exploiting the 9 meter long bore of the CAST dipole magnet.

Primary author: ARGUEDAS CUENDIS, Sergio (CERN)

Presenter: ARGUEDAS CUENDIS, Sergio (CERN)

Session Classification: Morning 42

Contribution ID: **56** Type: **Oral**

QCD Axions off the beaten tracks

Friday 7 June 2019 11:05 (20 minutes)

Benchmarks in the axion parameter space (couplings to photons, electrons and nucleons versus axion mass, and the viable mass range for axion DM) are provided by the well-known KSVZ and DFSZ axion models. However, recent years have witnessed a burst of theoretical ideas that produced a large landscape of QCD axion models, for which the relation between mass and couplings can differ sizeably from the usual KSVZ/DFSZ predictions, and others for which axion-DM can be found at mass-values much larger or smaller than usually though. A selection of some representative scenarios will be reviewed in this talk.

Primary author: Dr NARDI, Enrico (Istituto Nazionale di Fisica Nucleare)

Presenter: Dr NARDI, Enrico (Istituto Nazionale di Fisica Nucleare)

Session Classification: Morning 52

Contribution ID: **57** Type: **Oral**

WISP solutions to the solar abundance problem: general requirements and an example

Thursday 6 June 2019 10:15 (20 minutes)

We consider the poorly studied before non-diffusive energy transport solutions to the solar abundance problem. We find the luminous flux change inside the Sun required to reconcile the Standard solar model with helioseismology. An example of a WISP extension of the Standard model is suggested which can alleviate the discrepancies.

Primary author: Mr SOKOLOV, Anton (INR RAS)

Presenter: Mr SOKOLOV, Anton (INR RAS)

Session Classification: Morning 41

Contribution ID: **58** Type: **Oral**

Axion Dark Matter Search with Interferometric Gravitational Wave Detectors

Wednesday 5 June 2019 12:45 (20 minutes)

Axion dark matter differentiates the phase velocities of the circular-polarized photons. In this work, we present a scheme to measure its phase difference by using a linear optical cavity. We applied this scheme to the Fabry-Perot arm of gravitational wave detectors such as aLIGO, CE, and DECIGO. We found that their potential sensitivities to the axion-photon coupling constant, g_{aγ}, can reach beyond the current limit of CAST with several orders of magnitude, at a wide axion mass range 10^{-16}eV < m < 10^{-9} eV. Our sensitivity can be achieved without loosing any sensitivity to gravitational waves. This work is based on our recent paper [arXiv: 1903.02017].

Primary author: Mr NAGANO, Koji (ICRR, University of Tokyo)

Co-authors: Dr OBATA, IPPEI (ICRR, University of Tokyo); Dr FUJITA, Tomohiro (Kyoto University); Prof. MICHIMURA, Yuta (University of Tokyo)

Presenter: Dr OBATA, IPPEI (ICRR, University of Tokyo)

Session Classification: Morning 32

Contribution ID: **59** Type: **Poster**

Proof-of-principle booster setup for the MADMAX dielectric haloscope

Tuesday 4 June 2019 15:00 (5 minutes)

The MADMAX experiment is aimed to directly detect dark matter axions with masses between $40\,\mu$eV and $400\,\mu$eV by using their conversion to photons at boundaries between materials of different dielectric constants under a strong magnetic field. Combining many such surfaces, this conversion can be significantly enhanced using constructive interference and resonances. We present a first proof-of-principle realization of such a booster system consisting of a copper mirror and up to 5 sapphire disks. The electromagnetic response of the system is investigated by reflectivity measurements. The mechanical accuracy, calibration process of unwanted reflections and the repeatability of the results using basic optimization algorithms to place the disks are investigated. Possible systematics from 3D effects such as tilts are discussed. We find that for the presented cases the electromagnetic response predicted by previous one-dimensional theoretical calculations is sufficiently realized with our setup.

Primary author: Mr KNIRCK, Stefan (Max-Planck-Institute for Physics)

Presenter: Mr KNIRCK, Stefan (Max-Planck-Institute for Physics)

Session Classification: Poster 1

Contribution ID: **60** Type: **Oral**

The writing of the KLASH Conceptual Design Report

Monday 3 June 2019 18:10 (20 minutes)

The KLASH (KLoe magnet for Axion SearcH) experiment has been proposed to search for galactic axions with mass between 0.2 and 1 μeV using a large volume resonant cavity (22 m^3), cooled down to 4.5 K and immersed in a 0.6 T magnetic field generated inside the superconducting magnet of the KLOE experiment located at the National Laboratory of Frascati of INFN. In September 2018 INFN approved one-year study for writing the Conceptual Design Report. In this talk we will show the recent results on the KLASH sensitivity based on the full electromagnetic simulation of the resonant cavity. We will discuss the choice for the cryostat and cavity cryogenic and mechanical design, in particular for the tuning system, and the readout system based on a microstrip SQUID amplifier. Moreover we will discuss recent advances in motivating an axion in this relatively low mass region.

Primary author: Dr LIGI, Carlo (INFN - LNF)

Presenter: Dr LIGI, Carlo (INFN - LNF)

Session Classification: Afternoon 12

Contribution ID: **61** Type: **Oral**

Ultra-wide frequency tuning with dielectric meta-material for higher mass axion search

Thursday 6 June 2019 17:00 (20 minutes)

We, Center for Axion and Precision Physics research (CAPP), introduce a noble method of frequency tuning for the higher mass axion searching cavity using dielectric meta-material. When the dielectric slits are arranged periodically, they become a dielectric meta-material that has an effective dielectric constant which is proportional to the ratio of the period to the gap, that is, we can precisely control the electric permittivity of the structure. We have simulated the microwave frequency resonance mode of the rectangular cavity where the dielectric slits are periodically placed, using finite-difference-time-domain (FDTD) method and found that the anisotropic dielectric characteristics along the direction of dielectric slit alignment are consistent with the analytic prediction. We also found that dielectric constants are constantly related to the period and slit gap when the dielectric slits are arranged with an azimuthal period in a cylindrical cavity. By arranging such dielectric meta-material in a cylindrical cavity and by adjusting its spacing, we have the resonant frequencies of TM0n0 modes tuned with respect to effective electric permittivity and the position of DMM. When the cavity diameter is 90mm, we could obtain tuning range of 4GHz $\sim$ 5.5GHz at TM020 mode, 5.2GHz $\sim$ 7.5GHz and 6.9GHz $\sim$ 8.4GHz at TM030 mode with different size of dielectric while form factor is maintained above 0.3.

Primary author: Dr KWON, Ohjoon (Institute for basic science)

Co-authors: Dr CHUNG, Woohyun (Institute for Basic Science); Prof. SEMERTZIDIS, Yannis (Institute for basic science)

Presenter: Dr KWON, Ohjoon (Institute for basic science)

Session Classification: Afternoon 42

Contribution ID: **62** Type: **Oral**

CAPP's first axion dark matter data and R&D projects

Monday 3 June 2019 17:50 (20 minutes)

A couple of years after the first installation of dilution refrigerators, IBS/CAPP has launched a pilot axion cavity experiment, CAPP-PACE, equipped with an 8 T superconducting magnet with 12 cm inner bore to search for microwave axions with a mass around 10 μeV. The experiment utilized a high Q-factor cavity with a piezoelectric frequency tuning system. The total system noise temperature was measured to be between 1 and 1.5 K. The axion dark matter physics data were taken during 2018, scanning frequencies about 250 MHz and then 1 MHz with 10*KSVZ and KSVZ sensitivity, respectively. Now the main focus of our research at this stage is on developing quantum noise-limited amplifiers and superconducting cavities. We present the results from the CAPP's first physics data in the axion mass range around 10 μeV and the progress of R&D projects.

Primary author: Dr CHUNG, Woohyun (IBS/CAPP)

Co-authors: Mr KUTLU, Caglar (KAIST/IBS/CAPP); Mr AHN, Danho (Institute for Basic Science, Center for Axion and Precision Physics Research); Prof. KIM, Jihn (Kyunghee U.); Mr KIM, Jinsu (KAIST/IBS/CAPP); Dr KWON, Ohjoon (Institute for basic science); Prof. SEMERTZIDIS, Yannis (IBS/CAPP)

Presenter: Dr CHUNG, Woohyun (IBS/CAPP)

Session Classification: Afternoon 12

Contribution ID: **63** Type: **Oral**

Superconducting YBCO microwave cavity in a high magnetic field for axion dark matter search

Monday 3 June 2019 10:30 (20 minutes)

Maintaining high Q-factor of the superconducting cavity in a strong magnetic field at gigahertz frequencies is a crucial component in a highly sensitive axion detection system and at the same time, a largely unexplored and challenging task. The natural choice of material for the superconducting cavity to be placed in a high magnetic field is a high-temperature superconductor (HTS) with a high critical field (>100 T) and a high depinning frequency (>10GHz). The deposition, however, of a high-quality, grain-aligned HTS film on a three-dimensional surface is technically difficult. IBS/CAPP has fabricated a polygon-shaped resonant cavity with commercial YBCO tapes covering the entire inner wall and measured the Q-factor at 4 K at 6.9 GHz as a function of an external DC magnetic field. We present the microwave measurement of the YBCO cavity (TM010 mode) which shows that the Q factor of the cavity do not degrade until 8 Tesla. This result indicates the possibility of realizing a high Q-factor superconducting cavity in a high magnetic field for axion search.

Primary author: Mr AHN, Danho (Institute for Basic Science, Center for Axion and Precision Physics Research, KAIST)

Co-authors: Prof. YOUM, Dojun (KAIST); Mr LEE, Doyu (KAIST); Dr LEE, Jhinhwan (IBS CALDES); Dr KWON, Ohjoon (Institute for basic science); YOUN, SungWoo (CAPP/IBS); Dr JANG, Wonjun (IBS/QNS); Dr CHUNG, Woohyun (IBS/CAPP); Prof. SEMERTZIDIS, Yannis (IBS/CAPP)

Presenter: Mr AHN, Danho (Institute for Basic Science, Center for Axion and Precision Physics Research, KAIST)

Session Classification: Morning 11

Contribution ID: **64** Type: **Poster**

3D effects in dielectric haloscopes and dish antennas

Tuesday 4 June 2019 15:30 (5 minutes)

The presence of axions modifies the Maxwell equations. This is exploited by many axion direct detection search experiments. Feasibility studies and optimizations of the experiment require computing the E-fields in 3D. Using finite element methods (FEM) in full 3D this is computationally very expensive and time consuming.
We present two techniques to compute the 3D E-field solutions for open systems, such as dielectric haloscopes and dish antennas. Our two approaches elude the bottlenecks of a pure 3D FEM solution. The first approach reduces the problem to two dimensions by using the radial symmetry even in the case when external fields break this symmetry. The second approach is based on a scalar diffraction theory which is applied recursively to construct the emitted E-field.

The simplified 3D simulation techniques are used to perform feasibility studies of the MADMAX prototype experiment. The power emitted by the dielectric haloscope is studied and compared to 1D calculations. We find that diffraction effects can reduce the emitted power, especially for a large photon wavelength / small axion mass. The beam shape in 3D is found to be in good approximation Gaussian allowing a good coupling to a Gaussian antenna. From the beam shapes and a comparison of the two methods we see that near field effects are not dominant in dielectric haloscopes. We also study the influence of tilts and B-field inhomogeneities.
Finally we also look at velocity effects in dish antennas and dielectric haloscopes.
In conclusion we have not found any potential show stoppers for the realisation of dielectric haloscopes in the studied cases.

Primary author: SCHUETTE-ENGEL, Jan (Uni Hamburg)

Co-author: Mr KNIRCK, Stefan (MPP)

Presenter: SCHUETTE-ENGEL, Jan (Uni Hamburg)

Session Classification: Poster 1

Contribution ID: **65** Type: **Poster**

The 1m Prototype for the ʻAny Light Particle Searchʼ (ALPS) experiment

Tuesday 4 June 2019 15:20 (5 minutes)

The Any Light Particle Search (ALPS II) is a Light-Shining-Through-a-Wall experiment which will use optical cavities to enhance the oscillation of photons into Axion-like particles (ALPs) and vice-versa. We set up a 1-m-prototype table-top experiment to test and develop subsystems for the finale ALPS II experiment. We will give an overview of this experiment and its current status.

Primary author: Mr KARAN, Kanioar (Max-Planck-Institut für Gravitationsphysik / Leibniz Universität Hannover)

Co-authors: Dr WILLKE, Benno (Leibniz Universität Hannover); Mr SCHMELZER, Dennis (AEI Hannover); Dr WEI, Li-Wei (AEI Hannover)

Presenter: Mr KARAN, Kanioar (Max-Planck-Institut für Gravitationsphysik / Leibniz Universität Hannover)

Session Classification: Poster 1

Contribution ID: **66** Type: **Oral**

Axion superradiance in rotating neutron stars

Friday 7 June 2019 12:45 (20 minutes)

It is a well-known fact that compact gravitating objects admit bound state configurations for massive bosonic fields. We describe a new class of superradiant instabilities of axion bound states in neutron star magnetospheres. The instability arises from the mixing of axion and photon modes in the magnetic field of the neutron star which extract energy from the rotating magnetosphere. Unlike for black holes, where the dissipation required for superradiance is provided by an absorbative horizon, the non-hermitian dynamics in this mechanism come from the resistivity in the stellar magnetosphere arising from a finite bulk conductivity. The axion field mixes with photon modes which superradiantly scatter off the magnetosphere, extracting rotational energy which is then deposited back into the axion sector leading to an instability. We derive the superradiant eigenfrequencies for the axion-photon system using quantum mechanical perturbation theory on the axion boundstate, drawing an analogy with atomic selection rules. We then compare the characteristic time scale of the instability to the spin-down measurements of pulsars which limit the allowed rate of angular momentum extraction from neutron stars.

Primary author: Dr DAY, Francesca (University of Cambridge)

Presenter: Dr DAY, Francesca (University of Cambridge)

Session Classification: Morning 52

Contribution ID: **67** Type: **Oral**

Production and detection of an axion dark matter echo

Friday 7 June 2019 11:25 (20 minutes)

Electromagnetic radiation with angular frequency equal to half the axion mass stimulates the decay of cold dark matter axions and produces an echo, i.e. faint electromagnetic radiation traveling in the opposite direction. We propose to search for axion dark matter by sending out to space a powerful beam of microwave radiation and listening for its echo. We find that this is a promising approach to axion detection in the 2×10^(-7) to 3×10^(-4) eV mass range.

Primary authors: ARZA, Ariel (University of Florida); Prof. SIKIVIE, Pierre (University of Florida)

Presenter: ARZA, Ariel (University of Florida)

Session Classification: Morning 52

Contribution ID: **68** Type: **Oral**

Single Photon Counter at 14 and 26 GHz for searching Galactic Axions within the QUAX and ORGAN projects

Thursday 6 June 2019 17:20 (20 minutes)

Axions appear in extensions of the Standard Model of particle physics and may be the solution of the Dark Matter in our Universe. Several new experiments are foreseen in the next decade searching them in a wide range of the parameter space. In the mass region from few to several tens of microelectronvolt, detector sensitivity will be limited by the Standard Quantum Limit of linear amplifiers and a new class of single microwave-photon detectors is needed.
We have developed a single photon counter (SPC) at 14 GHz, based on the voltage switching of a Josephson junction coupled to a coplanar waveguide for QUAX project. By measuring the switching voltage, we can register single photons at 14 GHz with the rate less than 1 photon per 3000 sec.
We fabricated Al-AlOx-Al Josephson junctions for single photon detecting. Switching rate was measured at different temperatures and for different positions of bias current relatively to critical current. First measurements have shown an optimistic situation with a lifetime over 1000 sec at 100mK, limited by external interferences. After using additional filters, we were able to increase the time of false triggering of the detector prototype on Al SIS to 5000-6000 sec.
We have made RF tests by measuring switching probability in dependence on attenuation of the signal for different values of a bias current relatively to the critical current. These curves show that the detection probability decreases with the decrease of the power with different exponent rates proportional to one, two and three. This behavior demonstrate the single-photon, two-photon and three-photon detection mechanisms.
We are starting development of SPC based on Al-Al Josephson junction for 26 GHz receiving system of the ORGAN project.
In general, we can develop SPC based on Al-Al Josephson junction for the range of frequencies from 3 to 50 GHz.

The work was supported by Russian Science Foundation (project 16-19-10468).

[1] L.Kuzmin, A.Sobolev, C.Gatti, D.Gioacchino, N.Crescini, A.Gordeeva, E.Il'ichev, Single Photon Counter based on a Josephson Junction at 14 GHz for searching Galactic Axions, IEEE TAS, Vol.8, pp.1-5(2018).

Primary author: Prof. KUZMIN, Leonid (Chalmers University of Technology, Gothenburg, Sweden)

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Presenter: Prof. KUZMIN, Leonid (Chalmers University of Technology, Gothenburg, Sweden)

Session Classification: Afternoon 42

Contribution ID: **69** Type: **Oral**

Duration of classicality in degenerate quantum scalar fields

Thursday 6 June 2019 12:45 (20 minutes)

We develop a formalism to help calculate in quantum field theory the departures from the description of a system by classical field equations. We apply the formalism to a homogeneous classical field with attractive contact interactions, to a homogeneous self-gravitating classical field in critical expansion and to an inhomogeneous classical field with repulsive contact interactions.
We show that, in a full quantum description, parametric resonance causes quanta to jump in pairs out of the classical condensate into all modes with wave vector within an instability window.
We calculate, in each case, the time scale over which the classical condensate is depleted and after which a classical description is invalid.

Primary author: Dr TODARELLO, Elisa (KIT)

Co-authors: Dr ARZA, Ariel (University of Florida); Prof. SIKIVIE, Pierre (University of Florida); CHAKRABARTY, Sankha S. (University of Florida); Dr ENOMOTO, Seishi (High Energy Accelerator Research Organization (KEK)); HAN, Yaqi (University of Florida)

Presenter: Dr TODARELLO, Elisa (KIT)

Session Classification: Morning 42

Contribution ID: **70** Type: **Oral**

Hunting Chameleons with the CAST Experiment at CERN

Monday 3 June 2019 12:20 (20 minutes)

Dark energy poses one of the most intriguing mysteries of our time and so far no experimental efforts could validate any of the existing theories. In 2003 the chameleon, a neutral spinless scalar particle, had been postulated as possible candidate. This particle couples to photons and can be produced in the Sun by the Primakoff effect. The CERN Axion Solar Telescope (CAST) aims to detect these solar chameleons by two different methods. First, their coupling to photons is utilized by exploiting the inverse Primakoff effect in a strong magnetic field. Chameleons convert to X-ray photons, which then are detected by the GridPix detector, a combination of a Timepix ASIC and a Micromegas set-up. The second method takes advantage of the screening mechanism of the chameleons based on their coupling to matter. Depending on the ambient matter density the effective mass of the chameleon changes and under certain conditions the particle gets reflected off a material surface. By using an optomechanical force sensor the KWISP detector aims to measure the pressure exerted by the chameleons reflecting off a thin membrane. In this talk both detection methods used at CAST will be presented.

Primary author: Mr BAIER, Justin (Albert-Ludwigs-Universität Freiburg)

Presenter: Mr BAIER, Justin (Albert-Ludwigs-Universität Freiburg)

Session Classification: Morning 12

Contribution ID: **71** Type: **Poster**

Tuning Axion Haloscopes with Non-Linear Dielectric Materials

Tuesday 4 June 2019 14:55 (5 minutes)

Axion haloscopes based on the resonant cavity technique require large and larger arrays of cavities to maintain signal power as frequency increases. For large numbers of cavities, tuning the cavity resonant frequency with mechanical actuators becomes difficult, especially at temperatures below 100 mK. We propose the use of non-linear dielectric crystals such as Strontium Titanate to tune large cavity arrays without the need for large numbers of mechanical actuators. We will show simulation and prototype testing results.

Primary author: SONNENSCHEIN, Andrew (Fermilab)

Presenter: SONNENSCHEIN, Andrew (Fermilab)

Session Classification: Poster 1

Contribution ID: **72** Type: **Oral**

Axion-like Dark Matter Constraints from Cosmic Birefringence

Thursday 6 June 2019 18:20 (20 minutes)

Axion-like particles (ALPs) are leading dark matter candidates originally motivated by the strong CP problem and also arise in theories of string compactifications. I will present a sensitive probe for ALPs or ultra-light dark matter - the birefringence in the cosmic microwave background (CMB). Birefringence arises from the oscillating ALPs' effective refractive index and is also relevant for laboratory axion searches. Constraints on the axion-photon coupling derived from birefringence of CMB polarization lead to orders of magnitude improvement over prior constraints, with further prospects for upcoming cosmological birefringence observations. These limits, in hitherto unconstrained regions of the coupling vs. ALP mass parameter-space, are independent of assumed magnetic fields and relatively robust to ALP dark matter fraction.

Primary author: Dr TRIVEDI, Pranjal (University of Hamburg)

Co-author: Prof. SIGL, Guenter (University of Hamburg)

Presenter: Dr TRIVEDI, Pranjal (University of Hamburg)

Session Classification: Afternoon 42

Contribution ID: **73** Type: **Poster**

Heterodyne detection in the ALPS II experiment

Tuesday 4 June 2019 15:35 (5 minutes)

The Any Light Particle Search (ALPS) II is an experiment designed to search for weakly interacting sub-eV particles that couple to photons in the presence of a magnetic field. In order to detect the extremely weak photon fields associated with the existence of such hypothetical particles, the detector employed needs to be sensitive to power levels equivalent to a few photons per week. The ALPS group at the University of Florida has developed a detection method based on heterodyne interferometry that takes advantage of the coherent nature of the expected signal field. We use optical techniques similar to those found in modern day gravitational wave experiments to precisely track the phase of the signal over measurement times of several weeks with a precision better than 0.1 cycles.
We will report on the design and tests of the heterodyne optical setup and its associated shot-noise-limited detector.

Primary authors: Dr HALLAL, Ayman (University of Florida); Dr TANNER, David (University of Florida); Dr MESSINEO, Giuseppe (University of Florida); Dr MUELLER, Guido (University of Florida)

Presenter: Dr TANNER, David (University of Florida)

Session Classification: Poster 1

Contribution ID: **74** Type: **Oral**

Color centers as detectors for low mass dark matter

Thursday 6 June 2019 11:45 (20 minutes)

With direct searches getting closer and closer to the neutrino floor, the classical WIMP remains as elusive as ever. The low hanging WIMP fruit will eventually be exhausted as the remaining parameter space is excluded. The need for expanding our sensitivity to lower masses is evident. I will present a novel technique for direct detection by measuring defects in crystals with high sensitivity. These defects can be induced by the eV scale nuclear recoils expected from interaction with low mass dark matter. I will then report on the progress made so far in testing the viability of such a detector.

Primary author: Mr MOSBACHER, Yossi (The Weizamnn Institute of Science)

Presenter: Mr MOSBACHER, Yossi (The Weizamnn Institute of Science)

Session Classification: Morning 42

Contribution ID: **75** Type: **Poster**

Discovering Axions by Studies of the Breit-Wheeler Process

Tuesday 4 June 2019 14:25 (5 minutes)

A recent experiment on the Gemini laser facility at the Rutherford Appleton Laboratory collided intense beams of high-energy photons (~500 MeV) with a dense X-ray eld (~1.5 keV) to investigate the final QED process involving photons which has not been directly observed, the Breit-Wheeler process. The BW process has been well studied in QED so we are exploring how to use the results of these experiments to investigate how processes involving particles beyond the Standard Model, e.g. the axion, affect the expected results. We have calculated the cross sections of two axion-involved processes using effective field theory and will discuss how the effective mass value of the axion, the coupling parameters, and the signicance of the cross sections compare with the BW process. We can use these results to predict departures from the expected BW pair-production rate in the experiment and aim to use these and the experimental analysis to exclude some of the axion models.

Primary author: Ms WU, Wei (Imperial College London)

Presenter: Ms WU, Wei (Imperial College London)

Session Classification: Poster 1

Contribution ID: **76** Type: **Poster**

Searches for weakly coupling sub-eV Dark Matter at ELI-NP

Tuesday 4 June 2019 15:15 (5 minutes)

Search for sub-eV Dark Matter candidates at E4 (RA5-DM) looking for frequency shifted photons via four-wave mixing in the vacuum caused by stimulated decay of resonantly produced DM when two color lasers are combined and focused into the vacuum at ELI-NP facility

Primary author: Dr ROSU, Madalin-Mihai (Extreme Light Infrastructure - Nuclear Physics)

Presenter: Dr ROSU, Madalin-Mihai (Extreme Light Infrastructure - Nuclear Physics)

Session Classification: Poster 1

Contribution ID: **77** Type: **Oral**

Heavy axions

Thursday 6 June 2019 16:40 (20 minutes)

I will review recent attempts to build heavy axion models which solve the strong CP problem while enlarging the parameter space well beyond that of invisible axion models. Next, I will present a recent model of heavy axions: the first axion model solving the strong CP problem with colour unification and massless fermions. The axion scale may be not far from the TeV region which translates to observable signals at colliders.

Based on: Eur.Phys.J. C78 (2018) no.11, 972 (1805.06465) in collaboration with M.K. Gaillard, M.B. Gavela, R. Houtz and R. del Rey.

Primary author: Mr QUILEZ, Pablo (Universidad Autónoma de Madrid and IFT UAM/CSIC)

Presenter: Mr QUILEZ, Pablo (Universidad Autónoma de Madrid and IFT UAM/CSIC)

Session Classification: Afternoon 42

Contribution ID: **78** Type: **Oral**

Metallic Magnetic Calorimeters for Dark Matter searches

Thursday 6 June 2019 14:50 (20 minutes)

In the last decade low temperature metallic magnetic calorimeters have shown to be suitable for a large number of applications thanks to their excellent energy resolution, reliable energy calibration and extremely low intrinsic background. Recently the interest to use these detectors in experiments designed for understanding the nature of Dark Matter have led to the development of new detector systems.
We discuss the use of metallic magnetic calorimeters at the IAXO helioscope. The expected energy resolution below 10 eV FWHM will open the possibility for investigating a possible contribution of axion-electron coupling to the solar axion spectrum.
Metallic magnetic calorimeter can also be used for the readout of large crystals for the search of light mass WIMPs interaction. We present two different detector systems: one for the detection of light and heat generated in scintillating crystals following particle interaction and a second one for the detection of very small energy releases in semiconductor thanks to the Neganov-Trofimov-Luke amplification.

Primary author: Dr GASTALDO, Loredana (Kirchhoff-Institut für Physik, Universität Heidelberg)

Presenter: Dr GASTALDO, Loredana (Kirchhoff-Institut für Physik, Universität Heidelberg)

Session Classification: Afternoon 41

Contribution ID: **79** Type: **Oral**

The Axion Echo method and the Big Flow

Wednesday 5 June 2019 10:15 (20 minutes)

Electromagnetic radiation with angular frequency half the axion mass stimulates the decay of dark matter axions and produces an echo, i.e. faint electromagnetic radiation traveling in the opposite direction. Thus one may search for axion dark matter by sending out to space a powerful beam of electromagnetic radiation and listening for its echo. The method is particularly attractive if the Earth is bathed in a cold axion flow of known direction. The Caustic Ring Model of the Milky Way halo predicts such a cold flow with high local density, called the Big Flow. The direction of the Big Flow is determined from triangular features in the IRAS and GAIA maps of the Milky Way with a precision of order 0.5 degree of arc.

Primary author: Prof. SIKIVIE, Pierre (University of Florida)

Presenter: Prof. SIKIVIE, Pierre (University of Florida)

Session Classification: Morning 31

Contribution ID: **80** Type: **Oral**

Status and update on the BRASS project

Friday 7 June 2019 12:05 (20 minutes)

The BRASS (Broad-band Radiometric Axion SearcheS) experiment uses a magnetized conversion surface to search for dark matter axions. The pioneering experiment BRASS-6 will use a 6 sqm parabolic dish and an array of permanent magnets arranged in a flat conversion surface together with an M band receiver. The experiment is currently under construction in radio-shielded laboratory space at the University of Hamburg. We will report on the details of the setup, calibration procedures, and expected performance.

Primary author: Dr NGUYEN, Le Hoang (UNiversity of Hamburg)

Presenter: Dr NGUYEN, Le Hoang (UNiversity of Hamburg)

Session Classification: Morning 52

Contribution ID: **81** Type: **Oral**

Direct directional Dark Matter searches

Friday 7 June 2019 10:15 (20 minutes)

We are going to discuss the physics reach and the experimental challenges of directional WIMP-like Dark Matter searches, illustrating the concept of the CYGNUS-TPC international collaboration and how the CYGNO effort fits into it. We are going to present the latest R&D results in the field and discuss future short and long term developments of such techniques, also in the context of solar Neutrinos measurements.

Primary author: Dr BARACCHINI, Elisabetta (Gran Sasso Science Institute)

Presenter: Dr BARACCHINI, Elisabetta (Gran Sasso Science Institute)

Session Classification: Morning 51

Contribution ID: **82** Type: **not specified**

The Status of WIMP Dark Matter Detection

Wednesday 5 June 2019 09:00 (35 minutes)

The identification of the nature of the dark matter in the universe that constitutes 85% of its matter content is amongst the highest priorities in science. Discovery would elucidate both the missing mass problem and open Beyond the Standard Model physics. Direct searches seek evidence of galactic dark matter particles, such as WIMPs, scattering in terrestrial targets in low-background experiments operated deep underground. I shall present the status of the field and future prospects for direct searches for dark matter.

Primary author: Dr GHAG, Chamkaur (UCL)

Presenter: Dr GHAG, Chamkaur (UCL)

Session Classification: Morning 31

Contribution ID: **83** Type: **Oral**

Searching for signatures of fundamental physics on gamma-ray propagation with Fermi-LAT observations

Tuesday 4 June 2019 17:50 (20 minutes)

The possible interaction of axionlike particles (ALPs) with photons would leave distinctive features in observations of gamma-ray sources. Such features include apparent oscillations in energy spectra, a reduction of the opacity of the Universe to gamma rays, as well as the possibility of a gamma-ray burst from core-collapse supernovae. In this talk I will review the latest results obtained with the Fermi Large Area Telescope and present new analyses for the gamma-ray opacity and the search for gamma-ray bursts from extragalactic supernovae. It will be shown that current and future gamma-ray observations have the sensitivity to probe ALP dark matter for ALP masses below 1e-6 eV.

Primary author: MEYER, Manuel (Stanford University)

Presenter: MEYER, Manuel (Stanford University)

Session Classification: Afternoon 21

Contribution ID: **84** Type: **Oral**

The Cosmic Axion Spin Precession Experiment - Progress and Results

Tuesday 4 June 2019 18:10 (20 minutes)

The nature of dark matter, the invisible substance making up over 4/5 of the matter in the Universe, is one of the most fundamental mysteries of modern physics.
Ultralight bosons such as axions, axion-like particles or dark photons could make up most of the dark matter.
Couplings between such bosons and nuclear spins may enable their direct detection via nuclear magnetic resonance (NMR) spectroscopy: as nuclear spins move through the galactic dark-matter halo, they couple to dark-matter particles and behave as if they were in an oscillating magnetic field, generating a dark-matter-driven NMR signal.

Here we present preliminary CASPEr results obtained via ultralow-field NMR spectroscopy and report progress of the experiment probing the so called axion-wind coupling in the mass range from 1 peV to 10 neV currently under construction in Mainz.

Primary author: Dr WICKENBROCK, Arne (Johannes Gutenberg-Universität)

Presenter: Dr WICKENBROCK, Arne (Johannes Gutenberg-Universität)

Session Classification: Afternoon 21

Contribution ID: **85** Type: **Oral**

Electric Dipole Measurements at Storage Rings

Monday 3 June 2019 11:20 (20 minutes)

Plans for the measurement of charged hadron electric dipole moments (EDMs) at storage rings will be presented. These experiments will also allow for searches of oscillating EDMs connected with axion or axion-like particles. Results of a first test run will be discussed.

Primary author: Prof. PRETZ, Jörg (RWTH Aachen, III. Physikalisches Institut B)

Presenter: Prof. PRETZ, Jörg (RWTH Aachen, III. Physikalisches Institut B)

Session Classification: Morning 12

Contribution ID: **86** Type: **Poster**

ALPS-II cavity control with a surrogate field: model and experiment

Tuesday 4 June 2019 14:20 (5 minutes)

Any Light Particle Search (ALPS) is a series of laboratory light-shining-through-a-wall experiments seeking light-weight sub-eV dark matter candidates including the well-motivated axion-like-particles (ALPs). To extend the experiment sensitivity into scientifically interesting parameter space in terms of ALP-photon coupling, in addition to using long dipole magnets from HERA, ALPS-II anticipates aggressive resonant optical gain, for which a dichroic control concept has been developed to be in line with the transition edge sensor for photon counting. The dichroic control concept is based on two laser wavelengths with a quasi-harmonic frequency relation, and one of the main challenges is to ensure a constant frequency offset between these two laser fields that are in simultaneous resonance with the dichroic optical cavity in ALPS-II throughout science data-taking. We will elaborate on such dichroic control concept, derive specific requirements for ALPS-II based on realistic modelling, and present the results from our prototyping experiment.

Primary author: Dr WEI, Li-Wei (AEI Hannover)

Co-authors: Dr SPECTOR, Aaron (DESY); Dr WILLKE, Benno (Leibniz Universität Hannover); Mr SCHMELZER, Dennis (AEI Hannover); TAYLOR, Ethan James (University of Wyoming); HOLLIS, Hal (University of Florida); POLD, Jan Hendrik (AEI Hannover); Mr KARAN, Kanioar (Max-Planck-Institut für Gravitationsphysik / Leibniz Universität Hannover)

Presenter: Dr WEI, Li-Wei (AEI Hannover)

Session Classification: Poster 1

Contribution ID: **87** Type: **not specified**

Die Verborgene Seite des Universums - auf der Suche nach Dunkler Materie

Tuesday 4 June 2019 19:30 (1 hour)

Das Universum ist nur zu einem kleinen Teil direkt sichtbar. Ein grosser Teil besteht aus Materie, die weder im Sichtbaren, noch im UV-, Gamma-, Infrarot- oder Mikrowellenbereich strahlt. Aus Messungen der Rotationskurven von Galaxien, der Masse von Galaxienhaufen, der Verteilung der grossräumigen Strukturen, des kosmischen Mikrowellenhintergrundes und der Expansionsrate des Universum wissen wir, dass die sichtbare Materie, aus der Galaxien, Sonnen, Planeten und Menschen bestehen, etwa 4% des Gesamtinhaltes des Universum bildet. Der Rest ist “dunkel”, und kann bisher nur indirekt, also über die Gravitationswechselwirkung enthüllt werden. Die dunkle Materie kann aus massereichen, noch unbekannten Teilchen bestehen, die in einer frühen Phase des Universums entstanden sind. Weltweit wird mit immer empfindlicheren Detektoren fieberhaft nach ihnen gesucht. Das Ziel ist, diese Teilchen über die elastische Streuung an Atomkernen eines terrestrischen Detektors, und über ihre Umwandlung in bekannten Teilchen in der Sonne, im galaktischen Zentrum und im Halo der Milchstrasse nachzuweisen.

Primary author: Prof. BAUDIS, Laura (Universität Zürich)

Presenter: Prof. BAUDIS, Laura (Universität Zürich)

Session Classification: Öffentlicher Abendvortrag

Contribution ID: **88** Type: **not specified**

Axions in and out of the Swampland

Thursday 6 June 2019 09:00 (35 minutes)

A series of conjectures have been recently proposed to distinguish effective field theories that can be consistently coupled to quantum gravity from those which cannot. The latter do not arise as low energy limits of string
compactifications and are said to live in the Swampland. In this talk, I will review the formulation and status of some of the Swampland conjectures, in particular the Weak Gravity Conjecture, and their applications to the heonomenology of axions, e.g. in models of inflation and dark matter.

Primary author: SOLER, Pablo (ITP Heidelberg)

Presenter: SOLER, Pablo (ITP Heidelberg)

Session Classification: Morning 41

Contribution ID: **89** Type: **Oral**

The ALPS II experiment at DESY

Thursday 6 June 2019 12:05 (20 minutes)

The Any Light Particle Search II (ALPS II) experiment at DESY will look for axion-like particles (ALPs) with low masses ($m < 10^{-4}$ eV). ALPS II is a purely laboratory-based experiment, where ALPs could be produced and detected employing the light-shining-through-wall (LSW) technique using infrared photons with a wavelength of 1064 nm. ALPS II utilizes the concept of resonant enhancement on the production and regeneration side to improve the sensitivity of traditional LSW-experiments. Construction is planned to finish end of 2020. The talk will present the current status of ALPS II.

Primary author: JANUSCHEK, Friederike (DESY)

Presenter: JANUSCHEK, Friederike (DESY)

Session Classification: Morning 42

Contribution ID: **90** Type: **Oral**

Testing dark energy models with atom interferometry

Wednesday 5 June 2019 09:35 (20 minutes)

The accelerated expansion of the universe motivates a wide class of scalar field theories that modify gravity on large scales. In regions where the weak field limit of General Relativity has been confirmed by experiment, such theories need a screening mechanism to suppress the new force. I will describe how theories with screening mechanisms can be tested in the laboratory, in particular with atom-interferometry experiments.
I will describe the results of a recent experiment in which we measured the acceleration of an atom toward a macroscopic test mass inside a high vacuum chamber, where the new force is unscreened in some theories. Our measurement shows that the attraction between atoms and the test mass does not differ appreciably from Newtonian gravity. This result places stringent limits on the free parameters in chameleon and symmetron theories of modified gravity.

Primary author: Dr BURRAGE, Clare (Dr.)

Presenter: Dr BURRAGE, Clare (Dr.)

Session Classification: Morning 31

Contribution ID: **91** Type: **Poster**

Gravitational imprints of monodromic axions

Tuesday 4 June 2019 15:40 (5 minutes)

Axion-like particles (ALP) are promising candidates for dark matter, if produced via the misalignment mechanism. In the presence of a monodromy the discrete shift symmetry of ALPs is explicitly broken. This can lead to a rapid growth of fluctuations during the early stages of vacuum realignment, even if the field is initially homogeneous. We describe the production of stochastic gravitational waves from this process. We also discuss the role of the fluctuations on structure formation and explain how the small scale of the fluctuations prevents their collapse into bound objects such as miniclusters.

Primary author: Mr CHATRCHYAN, Aleksandr (Heidelberg University, Institute for theoretical physics)

Co-authors: Prof. JAECKEL, Joerg (Institute for Theoretical Physics, Heidelberg University); Prof. BERGES, Jürgen (Institute for Thoeretical Physics, Heidelberg University)

Presenter: Mr CHATRCHYAN, Aleksandr (Heidelberg University, Institute for theoretical physics)

Session Classification: Poster 1

Contribution ID: **92** Type: **not specified**

Welcome

Monday 3 June 2019 14:30 (10 minutes)

Introductory Remarks

Primary authors: Prof. FISCHER, Horst (ALU Freiburg, Physikalisches Institut); Prof. SCHUMANN, Marc (Univertity of Freiburg)

Presenters: Prof. FISCHER, Horst (ALU Freiburg, Physikalisches Institut); Prof. SCHUMANN, Marc (Univertity of Freiburg)

Session Classification: Afternoon 11

Contribution ID: **93** Type: **not specified**

Conclusions and Farewell

Friday 7 June 2019 13:05 (10 minutes)

Primary authors: Prof. FISCHER, Horst (ALU Freiburg, Physikalisches Institut); Prof. SCHUMANN, Marc (Univertity of Freiburg)

Presenters: Prof. FISCHER, Horst (ALU Freiburg, Physikalisches Institut); Prof. SCHUMANN, Marc (Univertity of Freiburg)

Session Classification: Close-out

Contribution ID: **94** Type: **not specified**

Dark Matter in the Milky Way and the Local Group: how much and where?

Friday 7 June 2019 09:00 (35 minutes)

Recent estimates on the mass of the Milky Way, the Andromeda galaxy, and their satellite systems have given considerably smaller total masses than has been anticipated some 15 years ago. This trend was impressively confirmed by the first results of the Gaia mission. I give an overview of the various mass estimates, discuss possible shortcomings of the employed methods, and draw implications for the dark mass in the solar neighborhood and in the Galactic disk.

Primary author: Prof. STEINMETZ, Matthias (Leibniz Institute for Astrophysics Potsdam)

Presenter: Prof. STEINMETZ, Matthias (Leibniz Institute for Astrophysics Potsdam)

Session Classification: Morning 51

Contribution ID: **96** Type: **Oral**

qBOUNCE, and an acoustic Ramsey-type Gravity Resonance Spectrometer

Thursday 6 June 2019 14:30 (20 minutes)

This talk focuses on the control and understanding of a gravitationally interacting elementary quantum system using the techniques of resonance spectroscopy. It offers a new way of looking at gravitation at short distances based on quantum interference. The ultra-cold neutron reflects from a mirror in well-defined quantum states in the gravity potential of the earth allowing the application of gravity resonance spectroscopy (GRS). GRS relies on frequency measurements, which provide a spectacular sensitivity.
An acoustic Ramsey setup, currently under development, will set new standards in precision for the experiment qBOUNCE in many respects.
I also present a novel search strategy using GRS to differentiate between Einstein's cosmological constant and dark energy theories. This example show that questions of particle physics and cosmology at highest energies can be pursued at the other extreme of the energy scale, using neutrons at the lowest energies down to the pico-eV range.

Primary author: ABELE, Hartmut (TU Wien)

Presenter: ABELE, Hartmut (TU Wien)

Session Classification: Afternoon 41

Contribution ID: **97** Type: **not specified**

Feebly interacting particles: experimental prospects at accelerator-based experiments.

Tuesday 4 June 2019 09:00 (35 minutes)

Light and feebly interacting particles (axions/ALPs, HNLs, Dark Photons, Dark Scalars) represent an alternative paradigm to the current lore of New Physics at the TeV scale and are getting an increasing attention within the accelerator-based communities.
I will review the experimental prospects for their searches
at beam dump, fixed-target and collider-based experiments.

Primary author: LANFRANCHI, Gaia (INFN)

Presenter: LANFRANCHI, Gaia (INFN)

Session Classification: Morning 21

Contribution ID: **99** Type: **Oral**

Status of the Muon g-2 experiment at Fermilab

Thursday 6 June 2019 09:55 (20 minutes)

The Muon g-2 Experiment (E989) at Fermilab has been designed to measure the muon anomalous magnetic moment with a precision of 140 part-per-billion (ppb), reducing by four times today's 540 ppb uncertainty, which is dominated by the BNL E821 collaboration final result. Data-taking has begun in February 2018 and the collaboration aims at producing a preliminary result in 2019, based on a statistical sample that is already larger than the E821 sample. E989 measures the spin precession frequency of 3.1 GeV positive muons circulating in a 15 m diameter storage ring with an especially uniform magnetic field, with a design goal of 100 ppb for the statistical uncertainty and 70
ppm for the systematic one. The average magnetic field is measured with NMR probes with a goal total uncertainty of 70 ppb, entirely systematic. These two measurements, combined with several other much more precisely known Physics constants, will determine the muon anomaly with a precision of 140 ppb.

Primary author: LUSIANI, Alberto (Scuola Normale Superiore and INFN, sezione di Pisa)

Presenter: LUSIANI, Alberto (Scuola Normale Superiore and INFN, sezione di Pisa)

Session Classification: Morning 41

Contribution ID: **100** Type: **Poster**

A Search for Solar Axions via the Resonant Absorption by Atomic Nuclei

Tuesday 4 June 2019 15:45 (5 minutes)

The modern theoretical models of "invisible" axion describe its interaction with ordinary matter in terms of effective coupling with nucleons (g_{AN}), electrons (g_{Ae}) and photons ($g_{A\gamma}$).

Axion coupling to atomic nuclei (g_{AN}) makes it possible for axions to be resonantly emitted or absorbed during the nuclear transitions of magnetic-type.

Particular isotopes possess the low-energy nuclear excited states ($\sim$ 1~keV), thus making it possible to test the solar axion flux.
The resonant absorption of axions within the target material will lead to population of that excited state, whose following de-excitation will lead to the excess amount of X-ray with the corresponding energy.

A series of low-background experiments were performed with solid state (^{7}Li, ^{57}Fe, ^{169}Tm) resulted in setting and following gradual improvement of the upper limits on the axion coupling constants and $g_{A\gamma}$, g_{Ae} and $g_{A\gamma}$.
It soon became evident that in order to improve sensitivity of experiment one has to significantly increase the target mass, but in that case a self-absorption of the X-rays by the target bulk cancels out the intended advantages.
This challenge could be solved by introducing the target material inside the active volume of the detector.

The following step involved proportional gas chamber, filled with ^{83}Kr gas located at the underground facility at Baksan Neutrino Observatory.

At the moment a principally new approach is being developed that involves the creation of cryogenic bolometer setup with Tm-containing crystal at its core.

Primary authors: Prof. DERBIN, Alexander (Petersburg Nuclear Physics Institute NRC KI); Mr UNZHAKOV, Evgeniy (Petersburg Nuclear Physics Institute); Dr DRACHNEV, Ilia (PNPI NRC KI)

Presenter: Mr UNZHAKOV, Evgeniy (Petersburg Nuclear Physics Institute)

Session Classification: Poster 1

Contribution ID: **101** Type: **Poster**

Search for hidden-photon dark-matter with FUNK

Tuesday 4 June 2019 15:50 (5 minutes)

The FUNK (Finding $U(1)$s of Novel Kind) experiment was built to search direct evidences for hidden-photon (HP) dark-matter. We use a $15\,\mathrm{m}^2$ spherical metallic mirror as a HP-to-photon converter via Maxwellian-like transition. Signals are expected to come together as single photon events at the radius point where we mounted a low-noise photomultiplier.
We scanned the whole optical range of frequencies with extension in far-UV and looked for HP with masses between 2 and 8 eV.
In our preliminary results, we found no events excess but provide the up-to-date strongest limit for HP direct searches in this region.

[1] D. Veberič, *et al.*, PoS (ICRC2017) 880

Primary author: Mr ANDRIANAVALOMAHEFA, Arnaud (Karlsruhe Institute of Technology)

Presenter: Mr ANDRIANAVALOMAHEFA, Arnaud (Karlsruhe Institute of Technology)

Session Classification: Poster 1

Contribution ID: **102** Type: **Oral**

Observation of two-neutrino double electron capture in Xe-124 with XENON1T

Friday 7 June 2019 12:25 (20 minutes)

Two-neutrino double electron capture (2νECEC) is a second-order weak-interaction process with a predicted half-life that surpasses the age of the Universe by many orders of magnitude. Here we report the direct observation of 2νECEC in Xe-124 with the XENON1T dark-matter detector. The significance of the signal is 4.4 standard deviations and the corresponding half-life of 1.8×10^{22} years is the longest measured directly so far.

Primary author: Dr LINDEMANN, Sebastian (Universität Freiburg)

Presenter: Dr LINDEMANN, Sebastian (Universität Freiburg)

Session Classification: Morning 52

Contribution ID: **103** Type: **Oral**

VMB@CERN

Thursday 6 June 2019 18:00 (20 minutes)

Vacuum magnetic birefringence is a non-linear electrodynamic effect predicted as a consequence of the formulation of the Euler-Kockel-Heisenberg effective Lagrangian, first proposed in 1935, which takes into account electron-positron fluctuations. A direct laboratory observation of vacuum magnetic birefringence is still lacking today due to its value: Δn = 4x10e-24 @ B = 1T.
Key ingredients of a polarimeter for detecting such a small birefringence are a long optical path within an intense magnetic field and a time-dependent effect. To lengthen the optical path a Fabry-Perot cavity is generally used. Interestingly, there is a difficulty in reaching the predicted shot noise limit of such polarimeters: the cavity mirrors generate a birefringence-dominated noise whose ellipticity is amplified by the cavity itself limiting the maximum finesse capable of increasing the SNR.
The VMB@CERN collaboration proposes an experiment which overcomes this difficulty by using an LHC superconducting magnet together with a novel polarization modulation scheme for the polarimeter.

Primary author: KUNC, Stepan (Technical University of Liberec)

Co-authors: Dr ELLJI, A. (3School of Physics and Astronomy, Cardiff University); Dr DELLA VALLE, F. (2INFN, Sez. di Trieste and Dip. di Fisica, Università di Trieste); Dr RUOSO, G. (3INFN, Lab. Naz. di Legnaro, viale dell'Università); Prof. ZAVATTINI, G. (Università di Ferrara and INFN); Dr SULC, M. (Technical University of Liberec); Dr PUGNAT, P. (11LNCMI, EMFL, CNRS & Université Grenoble Alpes)

Presenter: KUNC, Stepan (Technical University of Liberec)

Session Classification: Afternoon 42