Desy-Zeuthen, Valentine's day 08



Indirect Dark Matter Search

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Status of indirect searches Perspectives

Deutsche Forschungsgemeinscheft DFG

Collaborative Research Centre 676 Particles, Strings and the Early Universe - the Structure of Matter and Space-Time -



Bundesministerium für Bildung und Forschung

Standard model of Big-Bang-Cosmology



...requires physics beyond the standard model

To come up with a dark matter candidate is easy...

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	Result
DM candidate	Ωh^2	Cold	Neutral	BBN	Stars	Self	Direct	γ -rays	Astro	Probed	
SM Neutrinos	×	×	 ✓ 	×	×	X	×	-	-	√	Х
Sterile Neutrinos	~	~	✓	\checkmark	\checkmark	\checkmark	\checkmark	\sim	√!	✓	~
Neutralino	√	\checkmark	✓	✓	\checkmark	\checkmark	√!	-√!	√!	✓	\checkmark
Gravitino	\checkmark	√	√	~	√	\checkmark	√	\sim	√	✓	~
Gravitino (broken R-parity)	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	√	\checkmark
Sneutrino $\tilde{\nu}_L$	~	\checkmark	√	\checkmark	\checkmark	\checkmark	×	_√!	√!	✓	×
Sneutrino $\tilde{\nu}_R$	√	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	√!	-√!-	√!	✓	\checkmark
Axino	✓	 ✓ 	√	✓	√	√	\checkmark	\checkmark	√	 ✓ 	√
SUSY Q-balls	\checkmark	\checkmark	\checkmark	\checkmark	\sim	-	√!	\checkmark	\checkmark	1	~
B^1 UED	\checkmark	\checkmark	✓	\checkmark	\checkmark	\checkmark	-√!	_√!	√!	 ✓ 	\checkmark
First level graviton UED	\checkmark	\checkmark	✓	\checkmark	\checkmark	\checkmark	\checkmark	×	×	 ✓ 	\times^{a}
Axion	 ✓ 	√	√	✓	√	1	√!	\checkmark	√	 ✓ 	√
Heavy photon (Little Higgs)	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	_√!	√!	√	\checkmark
Inert Higgs model	✓	\checkmark	✓	\checkmark	\checkmark	\checkmark	\checkmark	-√!-	-	√	\checkmark
Champs	√	\checkmark	×	✓	×	-	-	—	-	✓	×
Wimpzillas	√	1	✓	✓	✓	1	√	\sim	√	~	~

The challenge is to find and identify it..

Taoso et al. 2007



Adapted from G. Bertone

True surface density of DM, Moore et al. 2005



But annihilation fluxes depend on the density SQUARED



Galactic center region



- Galactic center region: extended sources of nonthermal radio&X-ray emission
- Sgr A* extremely underluminous SMBH (L~10⁻⁷ L_{edd})
- HESS observations in 2003-2005

Spectrum of ridge emission

 Energy spectrum of the diffuse emission resembles the energy spectrum of the Sgr A* source: Common origin?



Position of the Gamma-ray source



Observational results: Galactic center



- Dark matter interpretation not likely
- Origin however: not clear...





Some comments on the spectrum



- Heavy WIMPs annihilation in SUSY models -> internal Bremsstrahlung (Bringmann et al. 2007)
- IB: Spectral hardening, interesting scenario for GLAST and ground based IACTs
- In addition: inverse Compton emission from injected pairs as well as absorption

m_x=446 GeV, correct relic density



Constraints on the halo profile

- The observed surface brightness (after subtracting the ridge emission) is consistent with a point-source
- Limits on halo profile ρ(r)~r^{-α},α>1.2 (95% c.l.) under the assumption that VHE-emission is from DM annihilation



Looking for correlated variability with Chandra

- Sgr A* shows flares 1/24 hrs in X-ray, Near-IR
- Simultaneous observations with Chandra and HESS in 2005 with an X-ray flare!
- Typical X-ray flare: lasts for about an hour, increase by a factor of ~10



VHE sensitivity for flaring activity better than at X-rays No simultaneous activity observed at VHE-> Different origin of VHE and X-ray emission?

Further results and work on the Galactic center

- Limiting case: Conventional gamma-ray source with Dark-matter contamination (Ripken et al. 2007)->Limits
- More HESS-data (2006-2008) in the pipeline
- Checking for variability correlated with stellar orbits ("pair-production eclipse")

Sgr Dwarf Galaxy





- Nearby satellite of our Galaxy (d=24 kpc)
- Suffers tidal disruption (but core remains)
- No "conventional" source of VHE g-rays expected
- HESS observations: 11 hrs (Aharonian et al. 2007)

No signal from Sgr dwarf

 Upper limits on <σv> depending on mass distribution in Sgr dwarf



Aharonian et al. 2007

Ongoing work - new searches

- Intermediate Black Hole: Enhanced Gamma-ray emission from spikes (Bertone et al. 2005)
- Explore off-plane halo-emission
- Small scale anisotropy of cosmological annihilation (Ando et al. 2005)





Neutralino Capture in the Sun





Neutralino Capture in the Earth



Look for neutrinos from the center of the Earth.

Sun

Earth









AMANDA as low energy subdetector of IceCube: sensitivity to low-mass WIMPs

IceCube threshold 100 GeV

IceCube with Amanda 30 GeV

Amanda without IceCube 50 GeV



I c e C u b e

Replacing AMANDA in 2010/11: DeepCore

- 6 strings each with 40-60
 PMs, spaced by 7-10 m
- better veto from top
- Can look South
- located in best ice



- uses IceCube technology
- considerably better performance at low energy







Trial Assembly



The High Energy Frontier



Optimistic view...



The New York Times

Late Edition

New York: Today, showers, thunder-storms, then brighter, high 83. Tonight, muggy, low 76. Tomorrow, mostly sunny, hot and humid, high 93. Weather map is on Page Abs.

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\$1.25

Dark Matter is Supersymmetric

The LHC paves the road for Indirect Dark Matter detection





The final proof that the Universe used to be a supersymmetric place was obtained in a unique combination of Particle and Astroparticle experiments: CERN's ATLAS and CTA experiments detected signatures for

Bid to Root Out Lead Trinkets Falters in U.S.

Many Children's Items Are Chinese Imports

By ERIC LIPTON and LOUISE STORY

WASHINGTON, Aug. 5 - Despite a two-year effort to eliminate the threat of poisonous lead in inexpensive children's jewelry, hundreds of thousands of tainted items are still being sold across the United States, the federal government has found.

Inspections by the Consumer Product Safety Commission of 85 pieces of jewelry collected since last fall from retailers and importers determined that 20 percent still posed a potential poisoning hazard. Separate surveys by health officials or lead experts in Ohio, Massachusetts and Maryland found even higher percentages.

The unannounced federal inspections also left no doubt about the primary source of the threat: of the 17.9 million pieces of jewciry items pulled from the market since the start of 2005, 95 percent were made in China.

Numerous hazardous products imported from China - including toxic ingredients put into dog food, tainted toothpaste, faulty tires and toys coated in lead paint - have been recalled. But the problem with the children's jewciry, persisting after two years, reveals just how difficult it may be to resolve such problems.

Federal officials said that they had made progress in curtailing the lead threat in children's jewelry, but that they needed more enforcement powers, like the

OBAMA SIGNS LAW TO WIDEN REACH FOR WIRETAPPING

RESTRICTIONS ARE EASED

Rules on Eavesdropping Are Altered to Match Program in Use

By JAMES RISEN

WASHINGTON, Aug. 5 President Bush signed into law on Sunday legislation that broadly expanded the government's authority to cavesdrop on the international telephone calls and e-mail messages of American citizens without warrants.

Congressional aides and others familiar with the details of the law said that its impact went far beyond the small fixes that administration officials had said were needed to gather information about foreign terrorists. They said seemingly subtle changes in legislative language would sharply alter the legal limits on the government's ability to monitor millions of phone calls and e-mail messages going in and out of the United States.

They also said that the new law for the first time provided a legal framework for much of the surveillance without warrants that was being conducted in secret by the National Security Agency and outside the Foreign Intelligence Surveillance Act, the 1978 law that is supposed to regulate the way the government can listen to the private communications of American citizens.

"This more or less legalizes the N.S.A. program," said Kate Martin director of the Center for Na-