**Indirect Detection**

*Parallel Session 3 (Savvas Koushiappas) WH6W (The Dark Side)*

Donato\footnote{Donato} Fiorenza Università degli Studi di Torino, Indirect dark matter detection

We present the main properties of indirect supersymmetric dark matter detection by means of antimatter in cosmic rays. We discuss the astrophysical properties and uncertainties for the background as well for the signals.

Koglin\footnote{Koglin} Jason Columbia University, Antideuterons as an Indirect Dark Matter Signature: Design and Preparation for a Balloon-born GAPS Experiment

The General Antiparticle Spectrometer (GAPS) exploits low energy antideuterons produced in neutralino-neutralino annihilations as an indirect dark matter (DM) signature that is effectively free from background. When an antiparticle is captured by a targetmaterial, it forms exotic atom in an excited state which quickly decays by emitting X-rays of precisely defined energy and a correlated pion signature from nuclear annihilation. The GAPS method of using this combined X-ray and pion signature to uniquely identify antiparticles has been verified through accelerator testing of a prototype detector. I will describe the design of a balloon-born GAPS experiment that complements existing and planned direct DM searches as well as other indirect techniques, probing a different, and often unique, region of parameter space in a variety of proposed DM models. I will also outline the steps that we are taking to build a GAPS instrument and execute multiple long duration balloon flights.

Pearce\footnote{Pearce} Mark KTH, PAMELA - a satellite experiment searching for dark matter with cosmic ray antiparticles

PAMELA is a satellite-borne experiment designed for precision studies of the charged cosmic radiation, and in particular the antimatter component: antiprotons (80 MeV-190 GeV), positrons (50 MeV-270 GeV). PAMELA is housed on-board the Russian Resurs-DK1 satellite, which was launched on June 15th 2006 in an elliptical (350-600 km altitude) orbit with an inclination of 70 degrees. PAMELA consists of a permanent magnet spectrometer, to provide rigidity and charge sign information; a Time-of-Flight system, for velocity and charge determination; a silicon-tungsten calorimeter, for lepton/hadron discrimination; and a neutron detector. An anticoincidence system is used offline to reject false triggers. The PAMELA experiment will be reviewed with a focus on the indication detection of dark matter through antiparticle signatures. The status of the experiment approximately 1 year after launch will also be discussed.

Gardner\footnote{Gardner} Susan University of Kentucky, On the Possibility of Observing Dark Matter via the Gyromagnetic Faraday Effect

If dark matter consists of cold, neutral particles with a non-zero magnetic moment, then, in the presence of an external magnetic field, a measurable gyromagnetic Faraday effect becomes possible. This enables direct constraints on the nature and distribution of such dark matter through detailed measurements of the polarization and temperature of the cosmic microwave background radiation.

**Direct Detection**

*Parallel Session 3a (Dan Bauer, Chair) 1 North*

Schnee\footnote{Schnee} Richard Case Western Reserve University, Surface Event Screening with Beta Cage

Existing screening facilities are insufficiently sensitive to meet the needs of many dark-matter experiments for low-energy electron emitters and alpha-decaying isotopes. To provide such screening, the BetaCage will be a large-area (1 m$^2$), low background, atmospheric-pressure neon drift chamber with unprecedented sensitivity to low-energy surface contamination. Its sensitivity to beta rates as low as $10^7$ counts keV(-1) cm$^2$(-1) day(-1) will be beyond the level needed for the SuperCDMS one-ton dark matter experiment, and it should have negligible backgrounds for alphas. It also has potential use in radioactive trace analysis such as carbon or tritium dating, with $3$H/$1$H sensitivity of $10^6$(-19) and $14$C/$12$C sensitivity of $10^6$(-16). A prototype detector, 50x50x25 cm, is under construction. Details of the design studies, detector operation, and prototype status will be described.

Collar\footnote{Collar} Juan, University Chicago, modified-electrode HPGe applications to light WIMP detection

Recent progress in HPGe detector manufacture and low-noise front end electronics points at the possibility of fabricating large mass, ultra-low threshold germanium detectors with optimal energy resolution and enhanced PSD characteristics. The applications to neutrino and astroparticle physics are numerous. Coincidentally, a shift in interest from the MSSM to the NMSSM seems to be taking place among phenomenologists, stemming from the most recent experimental constraints on the Higgs mass. The NMSSM naturally generates neutralinos in the 1-10 GeV mass region, with accelerator bounds already restricting lower masses. We will examine the prospects for detection of WIMPs in this mass window, normally beyond reach of direct search experiments, with this new type of device. The characterization of a first prototype and a description of ongoing R&D will be presented.

Winn\footnote{Winn}, David, Fairfield University, High Gain Nanomachined Semiconductor Detectors for Dark Matter Searches

Semiconductor materials (Ge, Si, GaAs, SiC, diamond) can be nanomachined to form low radioactivity high gain detectors for direct ionization or scintillation light signals, using either geometrically field shaped impact ionization or oxide secondary emission. Examples in Si are shown, with direct applications to Ge. These materials can be cooled to use transition edge thermometry in conjunction with the ionization detection.
Neutrino coherent scattering cross sections can be as large as $10^{-39}$ cm$^2$, while current dark matter experiments have sensitivities to WIMP coherent scattering cross sections five orders of magnitude smaller. With large target masses and few KeV recoil energy detection thresholds, neutral current coherent scattering of solar neutrinos becomes an unavoidable background in dark matter searches.

In this talk I will outline the Axion Dark Matter eXperiment (ADMX) at Lawrence Livermore National Laboratory (LLNL). The experiment consists of a microwave cavity permeated by strong static axial magnetic field. As first described by Pierre Sikivie in 1983 dark matter axions passing through this cavity will resonantly scatter off the virtual photons from the magnetic field into real microwave photons that can be detected by a sensitive receiver. Here I will describe the details of the detector, the current results and the progress that’s been made in its upgrade to SQUID amplifiers.

Measurements of light yield, charge yield and nuclear recoil discrimination in a variety of noble gases/mixtures including neon, argon and xenon at pressures up to 100 bar will be presented.

We revisit the calculation of the relic density of the lightest Kaluza-Klein particle (LKP) in the model of Universal Extra Dimensions (UED). We extend the calculation of hep-ph/0206071 to include coannihilation processes with all level one KK particles with a most general KK particle spectrum, without any simplifying assumptions. In particular, we do not assume a completely degenerate KK spectrum and instead retain the dependence on each individual KK mass.
As an application of our results, we calculate the Kaluza-Klein relic density in the Minimal UED model, turning on coannihilations with all level one KK particles. We then go beyond the minimal model and discuss the size of the coannihilation effects separately for each class of level 1 KK particles and direct detection limit on KK dark matter.

**Shah, Nausheen**

University of Chicago, Gravitons and Dark Matter in Universal Extra Dimensions

Models of Universal Extra Dimensions (UED) at the TeV scale lead to the presence of Kaluza Klein (KK) excitations of the ordinary fermions and bosons of the Standard Model that may be observed at hadron and lepton colliders. A conserved discrete symmetry, KK-parity, ensures the stability of the lightest KK particle (LKP), which, if neutral, becomes a good dark matter particle. It has been recently shown that for a certain range of masses of the LKP a relic density consistent with the experimentally observed one may be obtained. These works, however, ignore the impact of KK graviton production at early times. Whether the $G^1$ is the LKP or not, the $G^n$ tower thus produced can decay to the LKP, and depending on the reheating temperature, may lead to a modification of the relic density. In this article, we show that this effect may lead to a relevant modification of the range of KK masses consistent with the observed relic density. Additionally, if evidence

**Ruchayskiy, Oleg**

EPFL (Swiss Polytechnic Institute), Searching for sterile neutrino dark matter

Extension of the Standard Model by the 3 right-handed neutrino allows to explain a number of phenomena in particle physics, astrophysics and cosmology. In particular, the lightest right-handed (sterile) netrino is a viable dark matter candidate. I will review the properties of this DM candidate and discuss the existing restrictions for its parameters, as well as prospects for its future search.

**Ma, Ernest**

University of California, Riverside, Common Origin of Neutrino Mass and Dark Matter

Dark matter is not made up of neutrinos, but the former’s existence may be necessary for the latter to acquire mass through radiative corrections. This idea is verifiable at the LHC.

**Su, Shufang**

University of Arizona, Dark Matter in the Left-Right Twin Higgs Models

We analyzed the dark matter relic density of the dark matter candidate in the left-right Twin Higgs models. We also studied the direct and indirect detection potential at the current and future dark matter detection experiments.

**Dolle, Ethan**

University of Arizona, Dark Matter in the Left-Right Twin Higgs Model