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Book of Abstracts

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2010 update on the ROSEBUD project

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The ROSEBUD (Rare Objects SEarch with Bolometers UndergrounD) Collaboration has tested scintillating bolometers of BGO, Al2O3 and LiF in a common experimental set-up in an ultralow background environment at the Canfranc Underground Laboratory. We present the new results of a recent analysis of the data obtained. The BGO heat and light response to different particles has been measured, focusing on its capability for nuclear recoils discrimination against the beta/gamma background. Requirements of BGO as target for a competitive dark matter experiment and comparison of its sensitivity with that of other targets used in direct dark matter searches is discussed. We also have analyzed the simultaneous use of LiF and Al2O3 scintillating bolometers to monitor the neutron flux inside the experimental shielding. New Monte Carlo simulations of the recoils induced in Al2O3 by fast neutrons are presented.

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A light scalar WIMP through the Higgs portal

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If dark matter (DM) simply consists in a scalar particle interacting dominantly with the Higgs boson, the ratio of its annihilation cross section —which is relevant both for the relic abundance and indirect detection— and its spin-independent scattering cross section on nuclei depends only on the DM mass. It is an intriguing result that, fixing the mass and direct detection rate to fit the annual modulation observed by the DAMA experiment, one obtains a relic density in perfect agreement with its observed value. In this talk we update this result and confront the model to the recent CoGeNT data, tentatively interpreting the excess of events in the recoil energy spectrum as being due to DM. CoGeNT, as DAMA, points toward a light DM candidate, with somewhat different (but not necessarily incompatible) masses and cross sections. For the CoGeNT region too, we find an intriguing agreement between the scalar DM relic density and direct detection constraints. We also give the one σ region favoured by the CDMS-II events, that suggest a light DM candidate too, and the limits from Xenon10 2009 data, which, depending on the assumed scintillation efficiency, may exclude both CoGeNT and DAMA. Assuming CoGeNT and/or DAMA to be due to DM leads to definite predictions regarding indirect detection and Higgs search at the LHC.

Parallel session : Dark Matter Candidates 2 / 98

A new vision of the inert doublet model of dark matter

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Dark matter annihilations of into 3 body final states are usually neglected in the computation of the dark matter abundance. It has however been recently shown that those kind of processes can significantly affect its relic density. I will focus on the Inert Doublet Model, which is a minimal extension of the standard Model including a weakly interacting scalar dark matter candidate, the inert Higgs. The latter is directly coupled to the standard Higgs and gauge bosons, while having no direct coupling to quarks or leptons. It represent an archetype for WIMP scalar dark matter, with interesting candidates and phenomenology in the GeV and TeV range. I will present a new vision of the viable parameter space of the model once taking into account annihilations into three-body final states which were not included in the previous analysis. I will show the modifications appearing the predicted relic abundance of the inert Higgs as well as in the prospects for direct and indirect detection.

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An estimate of the Dilaton mass from quarkonium spectra.

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By using a (string inspired) low energy effective field theory with a massive dilaton and a coupling function to gauge fields to model quark confinement, we show that the experimental data of charmonium and bottomonium is fitted when the dilaton mass is given a value about 57 MeV. Our estimate lies in the range proposed by other works which present the dilaton as a dark matter candidate.

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Anisotropies in the diffuse gamma-ray background measured by the Fermi-LAT

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The contribution of unresolved sources to the diffuse gamma-ray background could produce anisotropies in this emission on small angular scales. Recent studies have considered the angular power spectrum and other anisotropy metrics as tools for identifying the contributions to the diffuse emission from unresolved source classes, such as extragalactic and Galactic dark matter as well as various astrophysical gamma-ray source populations. I will present the results of an anisotropy analysis of the diffuse emission measured by the Fermi-LAT.

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Annihilation vs. Decay: Constraining Dark Matter Properties from a Gamma-Ray Detection in Dwarf Galaxies

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Most proposed dark matter candidates are stable and are produced thermally in the early Universe. However, there is also the possibility of unstable dark matter, produced thermally or otherwise. We propose a strategy to distinguish between dark matter annihilation and/or decay in the case that a clear signal is detected in gamma-ray observations of Milky Way dwarf galaxies with gamma-ray experiments. The sole measurement of the energy spectrum of an indirect signal would render the discrimination between these cases impossible. We show that by examining the dependence of the intensity and energy spectrum on the angular distribution of the emission, the origin could be identified as decay, annihilation, or both. In addition, once the type of signal is established, we show how these measurements could help to extract information about the dark matter properties, including mass, annihilation cross section, lifetime, dominant annihilation and decay channels, and the presence of substructure.

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Background Rejection in DRIFT

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The DRIFT dark matter detector is a 1 m^3 scale TPC with direction sensitivity to WIMP recoils operating in the Boulby Mine in England. Our primary background are from low-energy nuclear recoil events due to radon progeny plated out on the detector's wire central cathode. Here we describe a dramatic background reduction resulting from the installation of a new thin-film central cathode. We also describe a new technique which promises to fully fiducialize the chamber, potentially eliminating this source of background entirely.

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Background radiation in direct dark matter experiments

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Key improvements in the sensitivity of direct dark matter search experiments can only be achieved if the radiation causing background events in detectors is well understood and proper measures are taken to suppress it.
The background radiation arising from radioactivity and cosmic-ray muons is discussed in this paper in connection with the sensitivity of large-scale experiments to direct dark matter searches. Different shielding designs are considered to attenuate gamma-rays and neutrons coming from radioactivity in rock and lab walls. Purity of materials used in detector construction is analysed and the background event rates due to the presence of radioactive isotopes in detector components are presented. Event rates in dark matter detectors caused by muon-induced neutrons with and without active veto systems are discussed providing requirements for a depth of an underground laboratory and the efficiency of the veto system.

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Background rejection and sensitivity for new generation Ge detectors experiments

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Germanium detectors have been used in several experiments searching for Rare Events due to their good features (detection efficiency, energy resolution or robustness). New generation detectors, like broad energy detectors or segmented ones, could improve the sensitivity of this kind of experiments since different background rejection techniques could be developed without losing detection efficiency.

Within these techniques, analysis of the pulse shapes in a segmented detector, in the segment where the energy deposit happens and in the adjacent ones (the so-called net and induced signals respectively), seems to be one of the most powerful ones. Applying to 76Ge double beta decay region of interest (2.0-2.1 MeV), a set of routines for pulse generation and analysis has allowed to estimate that the background could be reduced by a factor 25, keeping a detection efficiency for neutrinoless double beta decay events of 76.3% using 2kg detectors.

A summary of the development of pulse generation and analysis routines (both for net and induced signals) will be given, showing the rejection factors and detection efficiency values obtained for the different configurations considered.

Plenary session : Structure Formation & N-body Simulation / 153

Baryons in structure formation simulations

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Plenary session : Dark Matter Candidates 2 / 164

Bayesian constraints on supersymmetric neutralino dark matter

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Plenary session : Dark Matter Candidates 1 / 190

Bose-Einstein Condensation of Dark Matter Axions

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It was found recently that dark matter axions thermalize and form a Bose-Einstein condensate (BEC). This provides an opportunity to distinguish axions from other forms of dark matter on observational grounds. I'll show that if the dark matter is axions, tidal torque theory predicts a specific structure for the phase space distribution of the halos of isolated disk galaxies, such as the Milky Way. This phase space structure is precisely that of the caustic ring model, for which observational support has been found earlier. The other dark matter candidates predict a different phase space structure for galactic halos. These findings imply that the dark matter is axions.

Plenary session : Dark Matter Direct Searches 3 / 195

CRESST-II

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The CRESST experiment is a Dark Matter search using calcium tungstate cryogenic detectors. Background discrimination is achieved by the simultaneous detection of scintillation light and phonons. Results of the last year of data taking are presented.

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Calibration of noble liquid dark matter detectors

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Knowledge of the energy scales for nuclear recoil-induced signals is crucial for determining the sensitivity of any WIMP detector. I will present a number of experiments recently performed at Yale University to measure the nuclear recoil scintillation and ionization yields in liquid xenon, as well as the nuclear recoil scintillation yields in liquid argon and liquid neon. I will also describe recent successful development work on the doping of metastable krypton atoms into all three of these liquids, so as to calibrate the electronic recoil energy scale as a function of position.

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Comment on Calculation of Positron Flux from Galactic Dark Matter

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Energetic positrons produced in annihilation or decay of dark matter particles in the Milky Way can serve as an important indirect signature of dark matter. Computing the positron flux expected in a given dark matter model involves solving transport equations, which account for interaction of positrons with matter and galactic magnetic fields. Existing calculations solve the equations inside the diffusion zone, where galactic magnetic fields confine positrons, and assume vanishing positron density on the boundaries of this zone. However, in many models, a substantial fraction of the dark matter halo lies outside the diffusion zone. Positrons produced there can then
enter the diffusion zone and get trapped, potentially reaching the Earth and increasing the expected flux. We calculate this enhancement for a variety of models. We also evaluate the expected enhancement of the flux of energetic photons produced by the inverse Compton scattering of the extra positrons on starlight and cosmic microwave background. We find maximal flux enhancements of order 20% in both cases.

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Constraining dark matter signal from a combined analysis of Milky Way satellites using the Fermi-LAT

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The Fermi LAT collaboration has recently presented constraints on a signal from annihilating dark matter from separate analyses of a number of dwarf spheroidal galaxies. Since the expected annihilation signal has the same physical properties regardless of the target (except for a normalization scale), the constraining power can be enhanced by a combined analysis, for which initial results will be presented here.

Plenary session : Indirect Searches and Neutrinos / 142

Constraining neutrinos masses in the PLANCK era

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Particle Physics teaches us that neutrinos do have a mass and therefore contribute to the matter energy budget in the universe. After reviewing by which mechanisms cosmology constrain the fraction of HDM, I will review the current bounds and extrapolate the results to the soon-to-come PLANCK data. In particular I will show how CMB lensing reconstruction can be performed for the first time with PLANCK, tightening even more the expected sensitivity to neutrino masses.

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Constraints on Dark Matter Annihilation from the Fermi-LAT Diffuse Gamma-Ray Measurement

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The diffuse measurement of the Fermi Large Area Telescope (LAT) can be a powerful tool in constraining the dark matter properties. In this talk, I will present constraints on dark matter models derived from the intensity and spectral shape of the Fermi-LAT Isotropic diffuse data. I will discuss the relation of the cosmological dark matter signal to the one coming from within our Galaxy, as well as preliminary dark matter constraints coming from the analysis of the Galactic diffuse data. Finally, I will comment on the benefits of complementarity between Fermi-LAT and ground-based Cerenkov observations to robustly constrain some particle physics models. (on behalf of the Fermi collaboration)

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Constraints on decaying-dark-matter models from simulations of isolated halos

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We explore a dark-matter model in which there are two dark-matter species nearly degenerate in mass, with $\epsilon = \delta M/M \ll 1$. The heavier particle undergoes two-body decay to the lighter dark-matter particle and a massless particle with a half-life τ. Unlike previous work on decaying dark matter, we explore the regime $\tau > 100$ Myr and non-relativistic kick speeds $v_k/c = \epsilon$. Using a set of N-body simulations of isolated dark-matter halos, we show how halos change as a function of τ and v_k. We show which parts of the $\tau - v_k$ parameter space are already ruled out by comparing the simulations to observations of dwarf-galaxy- to cluster-mass dark matter halos.

Plenary session : Indirect Searches 1 / 132

Cosmic Ray propagation uncertainties and Dark Matter

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Some of the antimatter (antiprotons or positrons) present in cosmic rays could be due to the annihilation of dark matter particles. Indirect searches based on these signals require to be able to model the propagation process, from the annihilation location to the Solar System. The physical processes are well known : diffusion, convection, energy losses and reacceleration. The physical parameters describing these effect (diffusion coefficient, convection velocity, etc) can be constrained by studying secondary-to-primary ratios of nuclei in cosmic rays. I will present the uncertainties related to this procedure and the importance for indirect searches or dark matter.

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Cosmic-ray mapping and the search for dark matter annihilation signal from the Sun

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The PAMELA satellite experiment is performing a precision study of the cosmic radiation with a particular focus on antiparticles. PAMELA is equipped with a silicon-microstrip magnetic spectrometer and silicon-tungsten imaging calorimeter. These two instruments allow particle species to be reliably identified. Particle rigidity and sign-of-charge is determined by fitting the track recorded by the magnetic spectrometer. Electron-proton separation is performed by studying the topology of the shower induced by charged particles in the calorimeter.

For each incident particle detected, we extrapolate the particle track recorded by the magnetic spectrometer and deduce the incoming particle direction with respect to the PAMELA rest frame. The incoming particle direction combined with the PAMELA position and orientation, allows the spatial distribution of cosmic rays to be reconstructed. This work will present a method to search for signature of dark matter annihilation within the sun by analysing positron and electron spatiale distribution.

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DAMA/LIBRA results

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The DAMA/LIBRA set-up (about 250 kg highly radiopure NaI(Tl)) is running at the Gran Sasso National Laboratory of the I.N.F.N.. Results of six annual cycles exploiting the model independent annual modulation signature for Dark Matter particles in the galactic halo are presented (exposure of 0.87 ton x yr). The cumulative exposure with those previously released by the former DAMA/NaI is now 1.17 ton × yr, corresponding to 13 annual cycles. The data further confirm the model independent evidence of the presence of Dark Matter particles in the galactic halo, giving a confidence level of 8.9 sigma; they satisfy all the many peculiarities of the Dark Matter annual modulation signature. In particular, the measured phase and the measured period are well in agreement with those expected for the Dark Matter particles.

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DARWIN: dark matter WIMP search with noble liquids

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DARWIN (DARk matter WImp search with Noble liquids) is a design study towards the realization of a ton to multi-ton scale dark matter facility in Europe, based on the liquid argon and liquid xenon time

projection chamber technique. Approved by ASPERA in late 2009, DARWIN brings together several European and US groups working on the existing XENON, WARP and ArDM experiments with the goal of providing a technical design report for the realization of the facility in three years from now. I will present the status and goals of DARWIN, as well as initial results from R&D studies.

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DM searches with H.E.S.S. towards dwarf spheroidal galaxies

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The H.E.S.S. experiment is an array of four identical imaging atmospheric Cherenkov telescopes in the Southern hemisphere, designed to observe very high energy gamma-rays (E > 100 GeV). These high energy gamma-rays can be used to search for annihilations of Dark Matter particles in dense environments. Dwarf galaxies dynamics shows that they are Dark Matter-dominated environments. Several observation campaigns on dwarf satellite galaxies of the Milky Way were launched by H.E.S.S.. The observations are reviewed. In the absence of clear signals, constraints on the Dark Matter particle annihilation cross-section have been derived in different particle physics scenarios. Some possible enhancements of the gamma-ray flux are studied, i.e., the Sommerfeld effect, the internal bremsstrahlung and the substructures in the Dark Matter halo.

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DMMW: A tool for multi-wavelength dark matter searches

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The level of emission expected from Dark Matter annihilation at radio frequencies, UV and at X-ray frequencies is comparable, and thus complementary, to searches in gamma rays with Fermi-LAT. However, unlike the prompt gamma-ray emission, the secondary inverse Compton, bremsstrahlung and synchrotron emission from leptons depends on the transport setup and the astrophysical properties of the object under consideration. At the same time Cosmic Ray electrons and positrons, as well as protons form a background which is subject to the same transport model uncertainties.
Here we present first results from DMMW (Dark Matter Multi-Wavelength), a tool which is capable of simultaneously fitting the multi-wavelength emission spectrum of a given object for generic Dark Matter models, density distributions and Cosmic Ray transport setups. DMMW allows the user to make reliable predictions about the radio, UV, X-ray and soft gamma-ray emission associated with the relativistic electrons and positrons produced in Dark Matter annihilation, as well as the relativistic electrons, positrons and protons produced in Cosmic Ray sources and Cosmic Ray interactions with the gas. The stable charged annihilation products are are propagated in the same framework as the Cosmic Rays, thus allowing the user to probe different transport setups and self-consistently constrain a possible signal from Dark Matter Annihilation from radio to soft gamma-rays.
We present results obtained with DMMW for a variety of astrophysical systems, such as dwarf galaxies in the Milky Way's halo, neighboring galaxies and clusters.

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DMTPC: a dark matter detector with directional sensitivity

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A WIMP detector with directional sensitivity could correlate signal events with astrophysical sources, thereby providing a definitive observable signature of dark matter. Our Dark Matter Time Projection Chamber (DMTPC) collaboration uses a gas-based detector with optical and charge readout to achieve directional sensitivity. We have built a 10-liter prototype detector and operated it in a surface laboratory. The detector consists of two back-to-back time projection chambers enclosed within a vacuum vessel which is filled with CF_4 gas at 75 Torr. I will report on the results from this run, including the first DMTPC limit on the spin-dependent cross-section. In addition, I will describe our next-generation detector, currently under construction, which we will deploy underground at the WIPP facility in New Mexico (1600 m.w.e.).

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Dark Matter Identification using Gamma Rays from Dwarf Galaxies

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Satellite dwarf galaxies in the vicinity of the Milky Way are ideal candidates for the detection of dark matter annihilation signals. If the positron fraction and combined electron positron flux excesses recently observed by PAMELA and FERMI are due to dark matter annihilation, ground-based atmospheric cherenkov telescopes (ACTs) may be able to observe energetic gamma rays from the accompanying final state radiation from these dwarf galaxies. After discussing the prospects of detecting such signals with current and future ACTs, we investigate the possibility of using ACT observations of dwarf galaxies to distinguish between different dark matter models from the energy distribution of this final state radiation. We find that this can reliably be accomplished with next generation ACTs and, under favorable circumstances, might also be possible at existing instruments.

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Dark Matter Search at SNOLAB with DEAP-3600

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The DEAP-3600 experiment will search for dark matter particle interactions on liquid argon at SNOLAB, located 2 km underground in Sudbury, Ontario. A first generation prototype detector (DEAP-1) with a 7-kg liquid argon target mass is currently operating in the underground facility. It has demonstrated a pulse-shape discrimination (PSD) of 6x10-8 for reducing beta/gamma backgrounds, and is currently acquiring data for improved PSD demonstration and further background rejection studies.

The larger detector containing a total mass of 3600 kg of liquid argon is currently under construction. The target sensitivity to spin-independent scattering on nucleons of 10-46 cm2 will allow an improvement in dark matter particle sensitivity. The status of the experiment and construction at SNOLAB will be presented.

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Dark Matter Searches with Germanium Detectors with sub-keV Sensitivities

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Experiments with sub-keV sensitivities open a window to search for WIMPs at the mass range of less than 10 GeV and for axions through resonant absorption. We will present data taken with a 500-g Point Contact Germanium detector at the Kuo-Sheng Neutrino Laboratory in 2009-2010, which improve over previous sensitivities [1]. A dedicated experiment is now under preparation at the new China Jin-Ping Underground Laboratory which has over 2500 m of rock overburden and has drive-in access [2]. Data taking is scheduled by Fall 2010. The status of construction of the laboratory and the experiment will be presented. Future plans will be discussed.

Reference:
1. S.T. Lin et al., Phys. Rev. D , 061101 (R) (2009).
2. D. Normile, Science 324, 1246 (2009).

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Dark Matter Subhalos In the Fermi First Source Catalog

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The Milky Way's dark matter halo is thought to contain large numbers of smaller subhalos. These objects can contain very high densities of dark matter, and produce potentially observable fluxes of gamma rays. In this article, we study the gamma ray sources in the Fermi Gamma Ray Space Telescope's recently published First Source Catalog, and attempt to determine whether this catalog might contain a population of dark matter subhalos. We find that, while approximately 20-60 of the catalog's unidentified sources could plausibly be dark matter subhalos, such a population cannot be clearly identified as such at this time. From the properties of the sources in the First Source Catalog, we derive limits on the dark matter's annihilation cross section that are comparably stringent to those derived from recent observations of dwarf spheroidal galaxies.

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Dark Matter multi-wavelength constraints from radio observations and from diffuse Fermi-LAT gamma-ray observations

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Electrons from Dark Matter (DM) annihilation produce radiation through synchrotron and Inverse Compton Scattering (ICS) interactions in the galactic environment. This multi-wavelength emission provides a complementary mean to test the DM hypothesis. I will present constraints coming from radio observations as well as ICS constraints from gamma-ray measurements by Fermi-LAT in the Galactic Halo region.

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Dark Matter that can form Dark Stars

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The first stars to form in the Universe may be powered by the annihilation of weakly interacting dark matter particles. These so-called dark stars, if observed, may give us a clue about the nature of dark matter. Here we examine which models for particle dark matter satisfy the conditions for the formation of dark stars. We find that in general models with thermal dark matter lead to the formation of dark stars, with few notable exceptions: heavy neutralinos in the presence of coannihilations, annihilations that are resonant at dark matter freeze-out but not in dark stars, some models of neutrinophilic dark matter annihilating into neutrinos only and lighter than about 50 GeV. In particular, we find that a thermal DM candidate in standard Cosmology always forms a dark star as long as its mass is heavier than about 50 GeV and the thermal average of its annihilation cross section is the same at the decoupling temperature and during the dark star formation, as for instance in the case of an annihilation cross section with a non-vanishing s-wave contribution.

Plenary session : Structure Formation & N-body Simulation / 154

Dark matter in the Galactic Centre and in Stars

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Plenary session : Indirect Searches and Neutrinos / 134

Dark matter searches with IceCube

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The construction of the IceCube neutrino observatory is practically terminated. With 79 strings taking data out of the 86 foreseen, we are one deployment season away from completion. The detector, however, has been taking data since 2006 in different partial configurations. We have evaluated these data for evidence of dark matter annihilations in the Sun, in the Galactic Center and in the Galactic Halo, searching for an excess neutrino flux over the expected backgrounds.
In this talk I will review the results of dark matter searches for WIMPs, Kaluza-Klein modes and superheavy candidates (Simpzillas), using past configurations of IceCube. The results are presented in the form of muon flux limits and constrains on the candidates' spin-dependent cross-section with protons, showing that IceCube is competitive even with direct search experiments in certain mass regions.
Moreover, the low-energy extension of IceCube, Deep-Core, which was commissioned earlier in 2010, offers exciting opportunities for dark matter searches down to candidate masses in the physically interesting region of about 50 GeV. I will also discuss the anticipated capabilities of the complete IceCube detector array in the search for dark matter.

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Diffusion and mobility measurements in CS2 and CS2 mixtures

Using a 10cm-long time projection chamber operating at 40 Torrs, we measured the mobility and diffusion of CS2- ions using pure CS2 and using mixtures where He, Ne, Ar and CF4 were added as a second gas. Measurements were made with electric fields varying from 40 to 600 V/cm. The electron temperature and drift velocity for all those mixtures and fileds were obtained from the code MAGBOLTZ. The CS2- lateral diffusion is consistent with room temperature while the longitudinal diffusion shows a marked increase at the higher fields that could be caused by a long electron attachment mean free path. The obtained longitudinal temperature at lower fields is larger that room temperature. Results will be presented. This analysis will allow us to better understand results obtained with the existing DRIFT detectors. This project is funded by NSF.

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Diffusion and mobility measurements in CS2 and CS2 mixtures.

Daniel Snowden-Ifft[1] ; Jean-Luc Gauvreau[1]

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Using a 10cm-long time projection chamber operating at 40 Torrs, we measured the mobility and diffusion of CS2- ions using pure CS2 and using mixtures where He, Ne, Ar and CF4 were added as a second gas. Measurements were made with electric fields varying from 40 to 600 V/cm. The electron temperature and drift velocity for all those mixtures and fileds were obtained from the code MAGBOLTZ. The CS2- lateral diffusion is consistent with room temperature while the longitudinal diffusion shows a marked increase at the higher fields that could be caused by a long electron attachment mean free path. The obtained longitudinal temperature at lower fields is larger that room temperature. Results will be presented. This analysis will allow us to better understand results obtained with the existing DRIFT detectors. This project is funded by NSF.

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Direct detection data and possible hints for low-mass WIMPs

Thomas Schwetz-Mangold[1]

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I discuss the status of data from direct detection experiments including DAMA, CDMS, CoGeNT and others, with a particular emphasis on the WIMP mass region around 10 GeV. The possibility to explain these data in terms of spin-independent or spin-dependent elastic or inelastic scattering is discussed.

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Directional direct non-baryonic dark matter detection with MIMAC

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MIMAC is a project of directonal direct detection of non-baryonic dark matter using a matrix of micro-tpc chambers with a 3D reconstruction of recoil tracks.
The directionality degree of freedom opens the possibility to reject the background efficiently by its isotropic spatial distribution as it has been shown in our recent papers (J.Billard et al.). The 3D reconstruction is possible due to the MIMAC electronics developed in the last three years coupled to a specially designed pixelized micromegas.
The first recoil tracks in 3D produced by neutrons of a few tens of keV will be presented. The very low energy threshold (~300 eV) and the fast read-out give access to the head-tail detection.
The exclusion plot of the final detector (50m3) will be presented showing the allowed SUSY model region to be explored.

Plenary session : Structure Formation & N-body Simulation / 141

Dwarf Galaxies, Milky Way Satellites and Stellar Streams: A Review

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The recent years have seen an abundance of discoveries of substructure in the haloes of the Milky Way and Andromeda galaxies. These have been driven by availability of high quality multi-band photometric data.
The “missing satellite” problem has been transformed with the doubling of the number of known Milky Way dwarf galaxies in the last few years. The number density of satellite galaxies continues to rise towards low luminosities, but may flatten at or below an absolute magnitude of -5. There is now rough agreement with theories of galaxy formation in CDM cosmologies, although the detailed luminosity function eludes prediction.

There have also been discoveries of many new tidal streams from dwarf galaxies and globular clusters, including the Orphan Stream and the GD-1 stream. These can be used to delineate the size and shape of the dark matter halo of the Galaxy, the rotation curve of the Galaxy, as well as to constrain the abundance of dark matter substructure. Detailed luminosity profiles of the largest stellar stream, the Sagittarius stream, allow us to reassemble its progenitor, which is comparable to the present-day Small Magellanic Cloud in brightness and dark matter content.

Implications of the panoply of discoveries for the dark matter distribution in the Milky Way as well as direct and indirect detection experiments for dark matter will be discussed.

Plenary session : Dark Matter Direct Searches 2 / 147

EURECA

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EURECA (European Underground Rare Event Calorimeter Array) is the European tonne-scale, cryogenic dark matter search. It is based on cryogenic technology with powerful event type recognition through phonon-ionisation (EDELWEISS) and phonon-scintillation (CRESST / ROSEBUD) detection. The aim is to explore scalar cross sections down to the 10E-10 pico-barn region. A major advantage of EURECA is its multi-element dark matter target, a key component for WIMP identification. We report on the current status of the design of the experiment and its future prospects.

Parallel session : Direct Searches 2 / 63

Effects of Residue Background Events in Direct Detection Experiments on Determining Properties of Halo Dark Matter

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We reexamine the model-independent data analysis methods for extracting properties of Weakly Interacting Massive Particles (WIMPs) using data (measured recoil energies) from direct Dark Matter detection experiments directly and, as a more realistic study, consider small fractions of residue background events, which pass all discrimination criteria and then mix with other real WIMP-induced signals in data sets. In this talk, the effects on the determination of the mass of halo Dark Matter particles as well as on the reconstruction of their velocity distribution will be discussed.

Parallel session : Indirect Searches 2 / 101

Effects of WIMP DM transport in the Sun

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We study the effects of transport and annihilations induced by WIMP DM
over the Sun, focusing in particular on the possible reduction of the solar neutrino fluxes due to the energy carried away by wimps from the innermost regions of the Sun, and to the consequent reduction of the temperature of the Solar core.
We find that for standard WIMPs, even in the very low-mass range between 4 and 10 GeV, recently advocated to explain the findings of the DAMA and CoGent experiments, the effects on neutrino fluxes are below current experimental sensitivities. For models with very small, or vanishing, self-annihilation cross section, such as the so-called asymmetric DM models, the effects of transport can become large, and we study the combination of DM masses and SD cross section which can be excluded
with current neutrino data.
We investigate also DM models with strong self-interactions, recently
invoked as a solution of the solar composition problem.
We do not find however any significant modifications of the sun structure,
unless the inner regions, in conflict with a previous claim.

Plenary session : Indirect Searches 1 / 127

Electron and antiproton measurements and Dark Matter Searches

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New interesting results on high-energy spectra of electron, positron and antiproton cosmic rays have been obtained in the recent years by balloon borne and satellite experiments. The data have been theoretically studied in an extensive way in terms of dark matter annihilation signals, pulsar contributions, new mechanisms of acceleration and propagation of cosmic rays in the Galaxy.
A review of the experimental indirect dark matter searches will be presented, as well with an overview of the main trends in the theoretical interpretation of the collected data.

Parallel session : Indirect Searches 3 / 81

Electroweak bremsstrahlung and indirect detection of Dark Matter by neutrino telescopes

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We study potential impacts of electroweak bremsstrahlung on indirect detection of supersymmetric Dark Matter by neutrino telescopes. Indeed these effects may modify observed neutrino fluxes coming from neutralino annihilations in the galactic halo or the Sun. We discuss two scenarios with high neutralino masses where such enhancements become relevant: a scenario with a pure bino neutralino and light scalar particles where large electroweak bremsstrahlung contributions arise from neutralino annihilation into two leptons and an additional gauge boson, and a scenario with a mixed neutralino where main electroweak bremsstrahlung corrections result of neutralino annihilations into three gauge bosons.

Parallel session : Indirect Searches 2 / 178

Energetic axion-like particle production in galaxies

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Relativistic axion-like particles originating from the stellar interiors, along with the ones coming from axion-photon mixing in the galactic magnetic fields, contribute together to make an energetic component of the axion content of the galaxies. Considering an isotropic distribution of galaxies in the universe, these highly relativistic axions (Lorentz factor at least of the order 10^6) could constitute an isotropic "background" of axions for helioscope-type experiments. Taking into account the sensitivity of such experiments, it is possible to derive a bound for the axion production in the galaxies.

Parallel session : Indirect Searches 1 / 91

Evaluating the dark matter contribution to galactic synchrotron radiation

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There is currently a significant effort to observe indirect evidence of dark matter annihilation in our galaxy. One interesting finding was an unexpected synchrotron haze (the "WMAP haze") with a similar intensity and morphology to those predicted by dark matter models. This might also be connected to another recent puzzle in cosmic ray physics: the excess of high energy positrons reported by the Pamela satellite. We create models of the synchrotron component expected from dark matter annihilation and compare these with the observed WMAP excesses. We further analyze the expected Fermi and Pamela signals stemming from these models, and place constraints on the magnetic fields necessary to match these multi-wavelength observations.

Parallel session : Direct Searches 1 / 82

Feasibility Study of Dark Matter Searches with the CUORE experiment

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CUORE is a 1-Ton experiment made of about 1000 TeO2 bolometers.
It will probe the neutrinoless double beta decay (0nuDBD) of 130Te,
a tool to test the neutrino nature and mass.
The experimental technique has been proved in CUORICINO, a 40 Kg
experiment that recently set a new limit on the 0nuDBD half-life.
The excellent energy resolution and the low background of these
detectors will make CUORE a leading experiment in this field,
improving the sensitivity to the half-life of 0nuDBD by more than an order of magnitude.
Bolometric detectors, however, are also sensitive to nuclear
recoils and can be used to search for Dark Matter interactions.
In principle CUORE, thanks to its mass, could look for an annual modulation
of the counting rate at low energies.
We are developing a pulse shape identification algorithm, applicable
as an on-line trigger, that allows to lower the energy threshold
down to the few keV region.
We present the preliminary results obtained on an array made of
four CUORE-like crystals (44 kg*days), and the prospects for a Dark Matter search in CUORE.

Plenary session : Dark Matter Candidates 1 / 167

Feebly Interacting Dark Matter

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Parallel session : Indirect Searches 3 / 174

Fermi Gamma-ray Haze via Dark Matter and Millisecond Pulsars

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Possible explanations for the haze of gamma-rays around the center of the
Milky Way reported by Dobler et al are considered.
It is found find that the most significant contributions may come from annihilating
dark matter and millisecond pulsars.

Parallel session : Indirect Searches 4 / 124

Fermi-LAT constraints on diffuse Dark Matter annihilation from the Galactic Halo

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Our Galaxy resides in the center of a vast "Halo" of Dark Matter (DM). This concentration produces, in many viable particle physics models, an indirect Weakly Interacting Massive Particle (WIMP)
annihilation signal that peaks in the Fermi-LAT's energy range. Our knowledge
of the diffuse background is essential to placing reasonable limits on the DM mass and
cross-section. We incorporate a systematic variation of the GALPROP galactic diffuse background model, constrained by current cosmic-ray measurements, into a profile likelihood analysis
and present upper limits on the DM annihilation cross-section using the Fermi-LAT data.

Plenary session : Dark Matter Searches at the LHC / 202

First LHC Results

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Since four month the Large Hadron Collider (LHC) is producing proton-proton collisions with a center of mass energy of 7 TeV
offering the potential of directly producing dark matter particles in an energy range never reached before in accelerator-based particle physics.
First the performance and first Standard Model measurements of the general purpose experiments CMS and ATLAS is presented.
This talk then focuses on their potential to detect dark matter candidates.
Results from ongoing physics analyzes are presented
and expectations for possible future discoveries are discussed.

Plenary session : Dark Matter Direct Searches 3 / 129

First Results of XENON100

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The XENON100 dark matter experiment, installed in the Laboratory Nazionali del Gran Sasso (LNGS, Italy), is searching for WIMP dark matter particles scattering off a 62 kg liquid xenon target in a dual phase (liquid/gas)
time projection chamber. Careful material selection, a novel detector design, and an upgrade of the passive shield, together with capitalizing the self-shielding power of liquid xenon, are crucial in order to achieve a background of less than 0.01 events/kg/keV/day in the fiducial volume. This background, which has been verified experimentally, is lower than in any other dark matter experiment

In this talk, I will present the experiment and its status, details about the detector calibration, and focus on recent analyses and results.

Poster session / **42**

From Galaxyzoo to dark matter

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Studies of dark matter particles are done , or by attempt to produce it (i.e. by LHC) or by searching indirect signs of it (let think to Pamela signal for possible decay of dark matter particles in high energy electron) In this paper it's showed a new way to study dark matter and dark energy too . , The paper starts with a description of the citizen science project Galaxyzoo with an hint to its huge scientific results In this project low-middle redshift galaxies of SSDS database are classified from point of view of their morphology . After the description it's showed as to widen this study to high or very high redshift galaxies databases Done it will be possible to compare galaxies cataloguing in the real universe with the features of galaxies in virtual universe produced by supercomputer simulations and , . because of simulations start from hypotheses on the features of dark matter and dark energy it will be possible to determine the features themselves . Final consideration will be done on rising impact of citizen science also in field until now reserved to professional scientists

Parallel session : Direct Searches 4 / **126**

GEANT4 Simulations of Neutron-Argon Interactions

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MiniCLEAN is a direct dark matter detection experiment currently under construction at SNOLab. It will utilize ~500 kg of liquid cryogen with a fiducial volume over 150 kg. This is interchangeable between argon and neon, as they provide different responses to signal and background. Nuclear recoils caused by neutron scattering are a background to dark matter events and are extensively simulated. The physics processes and cross-sections for neutron-Argon interactions implemented in GEANT4 are investigated and corrected to accepted values as necessary. Plans for additional measurements of neutron-Argon cross-sections will be outlined.

Poster session / **181**

Galaxy evolution as it appears at z < 1

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We study spectral evolution of galaxies in a magnitude limited sample in a pencil beam of ~10' x 10' from z = 1 down to 0.3. We concentrate on the large structures along the line of sight, and we bin our individual
galaxy spectra to obtain representative high S/N spectra of each structure. We divide the resulting average spectra in three groups to facilitate the analysis: galaxies with pure absorption line spectra, galaxies with emission lines and blue continua, and galaxies with emission lines and red continua. We restrict the analysis to the range
0.3 < z < 1.0, for which the statistical properties of the sample are well understood down to R=23.

We estimate the downsizing in emission-line galaxies between z = 0.9 and z = 0.45 in our pencil-beam and find the following results: (1) strong star formation in emission line galaxies, (2) aging in emission line galaxies,
(3) aging in absorption systems, are shifting from bright to faint systems as cosmological time increases. Each redshift bin is repopulated in new starbursts.

Therefore at redshifts z <1 galaxy formation is downsizing both in luminosity and number density. Cold
Dark Matter (CDM) models are hierarchical in the sense that large halos are built from the merging of small
halos. Our observations indicate that at z < 1 star formation and halo assemblage are no more in phase.

Parallel session : Indirect Searches 1 / 187

Gamma-ray and neutrino signatures of unstable dark matter

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We investigate the prospects of present and future neutrino observatories to constrain the lifetime of unstable dark matter in various decay modes at the level relevant to the observed cosmic-ray lepton anomalies. We also discuss the use of large-scale anisotropies in the diffuse gamma-ray flux as an important test of dark matter interpretations of the aforementioned anomalies.

Parallel session : Dark Matter Candidates 1 / 61

Gravitino dark Matter Candidate and Big Bang Nucleosynthesis

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In the context of supersymmetric models with R-parity conservation, the gravitino is a possible candidate for dark matter when it is the lightest supersymmetric particle. The gravitino can be

produced during reheating after inflation or from the decay of the next to lightest supersymmetric particle (NLSP). The unstable particle can be long-lived and decay during big bang nucleosynthesis. The decay alters the production of light elements and could be a solution to the possible "lithium problems". I will present some results related to the lithium problems and gravitino relic density as dark matter.

Parallel session : DM at colliders and neutrinos / 193

Higgs decays to dark sector

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We will discuss different constraints on higgs decays into dark sector and show that for light dark sector leading to cascade decays of higgs the mass of the higgs is actually substantially lower than SM limits at LEP. Through kinetic mixing the light dark sector at the last stage decays back to visible sector, producing an interesting novel signature of higgs decaying to lepton jets. After identifying the relevant collider observables that characterize this scenario, and study a wide range of LEP and Tevatron searches to recover the viable regions in the space of observables, we find that the Higgs decaying to lepton jets can be hidden when the event topology mimics that of hadronic backgrounds. Thus, as many as 10^4 leptonic Higgs and SUSY decays may be hiding in the LEP and Tevatron data. We present benchmark models with a 100 GeV Higgs that are consistent with all available collider constraints and dicsuss strategies for dedicated searches at LEP, the Tevatron and the LHC.

Parallel session : Direct Searches 5 / 37

Identification of galactic Dark Matter with directional detection

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Directional detection of galactic Dark Matter is a promising search strategy for discriminating genuine WIMP events from background ones. Indeed, due to the Earth rotation around the Galactic center through the dark matter halo, the WIMP-induced recoil distribution should be pointing toward the Cygnus Constellation.
I will present a comprehensive statistical method allowing to recover from a realistic simulated recoil map (containing both signal and background events), the main incoming direction of the WIMP signal, thus proving its galactic origin. Hence, the goal of this new statistical method is not to reject the background hypothesis, but rather to identify a genuine WIMP signal even in the case of a large signal to noise ratio.

Plenary session : Indirect Searches and Neutrinos / 135

Indirect Search for Dark Matter with the ANTARES Neutrino Telescope

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The ANTARES Collaboration is now operating the largest water Cherenkov neutrino telescope in the Nothern hemisphere. The apparatus, completed in May 2008, comprises 12 detection lines and a multidisciplinary instrumentation line installed at a depth of about 2500 m in the Mediterranean Sea offshore from France.

The goals of ANTARES are among others the search for astrophysical neutrino point sources and for neutrinos produced in self-annihilation of dark matter particles. Likely sources of the latter type of neutrino emission would be the Sun and the Galactic Centre, where dark matter particles from the galactic halo are expected to accumulate.

Prior to its completion, ANTARES has been taking data for more than a year in an intermediate setup with a five and a ten line detector configuration. First results on the search for dark matter annihilation in the Sun with the data recorded in 2007 and 2008 are presented, as well as sensitivity studies on Dark Matter searches with the full ANTARES detector.

Parallel session : Indirect Searches 1 / 51

Indirect dark matter search with the PAMELA experiment

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The PAMELA apparatus was launched into space on June 15, 2006. The experiment is devoted to the precise and extensive measurements of cosmic rays in space, with particular focus on antiparticle from the cosmic radiation within an energy ranges from 100 MeV to 200 GeV. Since July 2006 measurements of antiprotons and positrons are being performed to search for exotic sources, such as a signatur of annihilating dark matter particle.

This talk will present newest results of the PAMELA data analyses, with a particular emphasis on the recent measurements of antiproton, positron and electron fluxes up to an energy of 200 GeV. A possible interpretation of the resent PAMELA data in term of secondary and primary production processes will also be discussed.

Plenary session : Indirect Searches 2 / 104

Indirect detection of Dark matter with gamma-rays

Jan Conrad[1]

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In my contribution I will review the status of indirect detection of Dark matter with gamma-rays, including results of the Fermi Gamma-ray Space Telescope as well as Air Cherenkov Telescopes, like HESS, MAGIC and VERITAS. I will also present perspectives for next generation instruments like the Cherenkov Telescope Array.

Parallel session : Indirect Searches 3 / **83**

Indirect searches of dark matter

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If dark matter decays into electrons and positrons, it can affect Galactic radio emissions and gamma ray fluxes as well as the local cosmic ray fluxes. We propose a new, more general analysis of constraints on dark matter. The constraints can be obtained for any decaying dark matter model by convolving the specific dark matter decay spectrum with a response function. We derive this response function from full-sky radio and gamma ray surveys as well as from the positron flux recently reported by PAMELA. We discuss the influence of astrophysical uncertainties on the response function, such as from propagation and from the profiles of the dark matter and the Galactic magnetic field. As an application, we find that some widely used dark matter decay scenarios can be ruled out under modest assumptions. We also calculate intensity and angular power spectrum of the cosmological background of synchrotron emission from cold dark matter annihilations into electron positron pairs. We compare this background with intensity and anisotropy of astrophysical and cosmological radio backgrounds. Under modest assumptions for the dark matter clustering we find that around 2 GHz average intensity and fluctuations of the radio background at sub-degree scales allows to probe dark matter masses >100 GeV and annihilation cross sections not far from the natural values ~ 3 x 10^(-26) cm^3/s.

Poster session / **176**

Instrumentation, Acquisition and Analysis of the SIMPLE Dark Matter Search Signals

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We describe new instrumentation for the SIMPLE experiment, and its use in identifying, validating and rejecting non-WIMP backgrounds in the project measurements. Besides acoustic intrinsic discrimination, evidence is provided for a possible discrimination between alpha and neutron events via analysis of the signal parameters.

Parallel session : Indirect Searches 5 / **183**

Internal bremsstrahlung in neutralino annhilition: revised impact on indirect detection by gamma rays

Author(s): Francisco Prada[1] ; Mario Emilio Gomez Santamaria[2] ; Miguel Angel Sanchez-Conde[3] ; Mirco Cannoni[2]

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After a brief review of the theory of internal bremsstrahlung photons in neutralino annihilation we present a detailed study of its impact on the indirect detection of dark matter with air Cherenkov telescopes in the halo of dwarf spheroidal galaxies using Draco as an example.

Parallel session : Direct Searches 1 / 70

Ion-Channeling in Direct Dark Matter Crystalline Detectors

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The channeling of the recoiling nucleus in crystalline detectors after a WIMP collision would produce a larger scintillation or ionization signal in direct detection experiments than otherwise expected. I present estimates of the importance of this effect in NaI, Si and Ge crystals, using analytic models developed from the 1970's onwards to describe channeling and blocking and blocking effect.

Parallel Session : Structure Formation & N-body simulations 3 / 136

JWST Detecting Dark Stars

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DM (dark matter) is essential for the formation of structure and the first stars in particular. If DM is a common thermal WIMP (for instance the LSP), DM heating due to annihilation of DM can dramatically alter the formation of the first stars. These "dark stars" are powered by DM and look dramatically different from typical stars. Dark stars would have been only a few hundred million years after the Big Bang, but may be detectable with JWST. They also can account for super massive black holes and may also explain the metallicity in metal poor stars.

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Keynote conclusion

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Plenary session : Dark Matter Direct Searches 2 / 162

LUX

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Parallel session : Direct Searches 1 / 123

LUX-ZEPLIN (LZ) - 3 tonne and 20 tonne LXe dark matter direct detection experiments

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It will be possible to push dark matter direct detection sensitivity to a WIMP-nucleon cross-section 10^-48 cm^2 (equivalent to 1 event/10 tonne/year) using a liquid xenon TPCs of up to 20 tonnes, surrounded by a combination of liquid scintillator and water shielding. I will report on the design studies and hardware tests, from the new LUX-ZEPLIN (LZ) collaboration, that have been conducted for 3 tonne and 20 tonne detectors. I will also discuss the potential radioactive, cosmogenic and astrophysical backgrounds for large target experiments. The detectors would be deployed in Sanford Lab-DUSEL at Homestake Mine, starting in 2012.

Parallel session : Direct Searches 5 / 54

Laboratory Searches for Dark Matter Signatures with Electron Beams at JLAB

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Cosmology and astrophysics indicate that our Universe contains a considerable amount of dark matter' that is associated with an unknown elementary particle. LIPSS experiment at Jefferson Lab used a high average-power laser beam from a Free Electron Laser to probe for two-photon coupling of such particles using alight shining through a wall' technique. Non-observation of a new scalar boson signal and kinetic mixing with hypothetical hidden-sector paraphotons provided new constraints on masses and coupling strength of these particles. Plans for future measurements, in particular, for high-sensitivity 'chameleon' searches and MeV-GeV scale A'-boson production will be outlined

Parallel session : Direct Searches 4 / 149

Leptophilic Dark Matter in Direct Detection Experiments and in the Sun

Joachim Kopp[1]

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Dark matter interacting predominantly with leptons instead of nuclear matter has received a lot of interest recently. In this talk, we investigate the signals expected from such 'leptophilic Dark Matter' in direct detection experiments and in experiments looking for Dark Matter annihilation into neutrinos in the Sun. In a model-independent framework, we calculate the expected interaction rates for different scattering processes, including elastic and inelastic scattering off atomic electron shells, as well as loop-induced scattering off atomic nuclei. In those cases where the last effect dominates, leptophilic Dark Matter cannot be distinguished from conventional WIMPs. On the other hand, if inelastic scattering off the electron shell dominates, the expected event spectrum in direct detection experiments is different and would provide a distinct signal. However, the tension between DAMA and other direct Dark Matter searches cannot be resolved by invoking leptophilic Dark Matter.

Parallel session : Dark Matter Candidates 2 / 143

Light neutralino DM in light Higgs scenario related with the CoGeNT, DAMA/LIBRA, and CDMS II results

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Recently, the CoGeNT collaboration reported the WIMP candidate signal events exceeding the expected backgrounds where light and strongly coupled WIMP models are supported. Motivated by this issue, we analyze a light neutralino dark matter scenario with a light CP-even Higgs mediation in the elastic scattering process, which provides the proper mass and direct detection cross section of the CoGeNT result. To be compatible with the result of LEP experiments, we assume the neutralino is lighter than a half of the Higgs mediator. Such scenario is realized in BMSSM context and model parameters are chosen not to consider the rare decay experiments. We also obtain the right relic abundance on viable parameter space, which makes our scenario highly promising.

Parallel session : Direct Searches 1 / 99

Low energy events in NaI scintillators. ANAIS status and prospects.

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The search of the annual modulation in the detection rates that could evidence the presence of galactic dark matter energy depositions in the detector is of utmost interest after DAMA/LIBRA positive result. Other experiment using the same target is required in order to confirm the effect, especially after the recent results from CDMS and CoGeNT. ANAIS is a project to be carried out at the Canfranc Underground Laboratory with such a goal, using about 250 kg of NaI(Tl) crystals to study the expected annual modulation in the galactic dark matter signal.

A 9.6 kg NaI(Tl) crystal, is being tested underground. Background and noise rejection mechanisms thoroughly studied at the very low energies of interest. A low energy population of 40K internal background events at 3.2 keV has allowed to study such issues. ANAIS present status and prospects for the experiment will be also presented.

Parallel session : Direct Searches 1 / 89

Lowering the low-energy threshold of xenon-based detectors

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The XENON10 Experiment has already reported exclusion limits for spin-independent, spin-dependent and inelastic couplings of nuclei to particle dark matter. Recently, there has been considerable (perhaps, renewed) interest in light-mass $\mathcal{O}(10)$~GeV dark matter candidates. In this mass range, the sensitivity of XENON10 drops sharply, due to the low-energy threshold. The low-energy threshold is limited by the collection of primary scintillation photons following a particle interaction, and begins to drop between $5-8$~keV nuclear recoil energy. We discuss recent modeling of that threshold, and show how this affects the resulting sensitivity of the experiment. The methods are applicable to other xenon-based detectors such as XENON100 and LUX. Finally, we explore the possibility of using only the proportional scintillation signal (the ionization channel). In so doing, traditional S2/S1 discrimination must be abandoned, but the resulting energy threshold of ~ 1~keV nuclear recoil energy leads to interesting constraints on viable dark matter models. This work will also be of interest to the possibile detection of coherent neutrino scattering.

Plenary session : Dark Matter Searches at the LHC / 156

Metastable Particles at the LHC

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Plenary session : Dark Matter Direct Searches 3 / 196

Microwave Cavity Searches for Axions

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[1] *Wahington*

The axion is a hypothetical elementary particle whose existence would explain the baffling absence of CP violation in the strong interactions. It's properties make it a good dark-matter candidate. Even though dark-matter axions would make up the overwhelming majority of mass in the universe, they are extraordinarily difficult to detect. However, by threading a high-Q microwave cavity with a large static magnetic field, nearby Milky-Way halo axions are stimulated to convert into microwave power within the cavity. This extremely tiny power could then be detected by sensitive electromagnetic detectors. Recently, these detectors have improved to where even the more pessimistically-coupled dark-matter axions could be detected. I will describe the progress made in this experimental search for dark-matter axions.

Parallel Session : Structure Formation & N-body simulations 2 / 45

Milky Way Satellites and Lambda Cold Dark Matter

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The observed properties of dark matter on Galactic scales provide a powerful test of structure formation and on the theory of Lambda-Cold Dark Matter (LCDM). In this talk I will present new results on the mapping of the observed Milky Way satellite population onto the dark matter halo population in LCDM-based theoretical models using the highest resolution numerical simulations. I will discuss how these results provide important information on the properties of the least luminous objects in the Universe and on the population of dark subhalos in our Milky Way.

Plenary session : Indirect Searches 2 / 133

Multi-channel cosmic ray signatures of dark matter

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A crucial ingredient in the search for dark matter is correlating different signals with each other. I will here go through some of these multi-channel cosmic ray signatures for dark matter.

Parallel session : Direct Searches 5 / 97

Neutron background studies for direct dark matter searches in LSM

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One of the most promising particle candidates for DM is the supersymmetric neutralino or more generally a weakly interacting massive particle (WIMP). The expected interaction rate of WIMPs in direct search experiments is below 0.01 events / (kg day), thus rising up the importance of having a detailed understanding of potential background. Ambient and muon-induced neutrons constitute a prominent background component. Detailed studies carried out by the Edelweiss collaboration in this respect will be presented. This activity includes dedicated calibrations with neutron sources, monitoring the neutron flux with He3 detectors and measurements with a neutron counter based on Gd-loaded liquid scintillator as well as corresponding MC simulations with full event topology. The impact of the neutron background on current Edelweiss data-taking as well as for next generation experiments such as EURECA will be discussed. This work is in part supported by the German Research Foundation (DFG) through the Transregional Collaborative Research Center SFB-TR27 as well as by the EU contract RII3-CT-2004-506222 and the Russian Foundation for Basic Research (grant No. 07-02-00355-a).

Parallel session : Indirect Searches 2 / 90

New Approaches in the Search for Solar WIMPs

Author(s): Carsten Rott[1]

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The search for neutrinos from dark matter self annihilations in the Sun offer exciting ways to probe the WIMP-Proton scattering cross section. We discuss new approaches in the search for such signals and provide sensitivities for neutrino detectors.

Parallel session : Dark Matter Candidates 2 / 60

New Signatures of WIMPless Dark Matter

Jason Kumar[1]

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The recently proposed WIMPless dark matter scenario
provides a dark matter candidate which can have a wide range
of possible masses, while still retaining the naturally correct
thermal relic density of the WIMP scenario. This scenario
leads to possible detection signals which are quite
different from those usually expected of WIMPs. We review
the WIMPless scenario, and discuss examples which can potentially explain
data from DAMA/LIBRa and CoGeNT. We also describe more general
WIMPless models, and possible signals at the Tevatron, LHC and IceCube/DeepCore.

Parallel session : Dark Matter Candidates 1 / 100

New decay modes of gravitino dark matter

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We consider the three-body decays of gravitino dark matter in supersymmetric scenarios with bilinear R-parity violation. In particular, gravitino decays into lepton+W^*(lepton f\bar f') and \nu+Z^* (\nu f\bar f) are examined for gravitino masses below Mw. After computing the gravitino decay rates into these three-body final states and studying their dependence on supersymmetric parameters, we find that these new decay modes are often more important than the two-body decay, into a photon and a neutrino, considered in previous works. Consequently, the gravitino lifetime and its branching ratios are substantially modified, with important implications for the indirect detection of gravitino dark matter.

Plenary session : Dark Matter Candidates 2 / 201

On the stability of particle dark matter

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One of the main characteristic of the DM particle is that it is stable under cosmological time scales. We will review various new ideas which have been proposed recently to understand this stability from first principles rather than, as often done, by assuming an ad hoc global symmetry. This covers the remnant global symmetry of a gauge symmetry, hidden vector, heavy stable pions, unbroken gauge symmetry, ... frameworks. The associated phenomenology, unusual in some cases, will be discussed.

Plenary session : Indirect Searches 2 / 88

Radio and Microwave Constraints on Dark Matter

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Radio and Microwave observations of the inner Milky Way have the potential to see synchrotron emission from e+e- produced by certain WIMP models, especially those models with a large enough cross section to produce the PAMELA positrons. However, the radio and microwave emission produced by conventional astrophysics contributes significantly to the observed signals, and is not fully understood. I will review the status of the observations, and focus on the "haze," a large two-lobed structure spanning +- 20 deg in longitude and +-50 degrees in latitude. Parts of this structure appear in microwaves, xrays, and gamma-rays. I will argue that this structure – though very interesting – is unlikely to be related to dark matter. Further study of it is needed, both in its own right, and because it prevents us from realizing the full power of the inner galaxy constraints on DM annihilation and decay.

Parallel session : Dark Matter Candidates 3 / 116

Recent developments in supersymmetric QCD effects on dark matter annihilation

Björn Herrmann[1]

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The possibility to compute the relic density of the dark matter candidate is an interesting possibility to constrain the parameter space of supersymmetric models and to obtain complementary information with respect to collider searches and precision measurements. On the particle physics side of this calculation, the main uncertainty is due to the annihilation cross-section of the dark matter candidate, which can receive important corrections at the loop-level. I will present recent developments in the calculation of supersymmetric QCD corrections to the neutralino pair annihilation within the MSSM. I will discuss their impact on the annihilation cross-section and the resulting prediction for the relic density of the neutralino. Finally, I will show that the effect of the corrections is more important than the current experimental uncertainty of the WMAP measurements. In consequence, including the radiative corrections will become even more important when the satellite Planck will allow to determine the cosmological parameters with much better accuracy.

Parallel session : Indirect Searches 1 / 85

Reconstructing dark matter properties via gamma-rays indirect detection

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We study the capabilities of the FERMI satellite for identifying particle dark matter properties with gamma-ray observations from the Galactic Center. For the potential dark matter signal, besides the prompt gamma-ray flux
produced in dark matter annihilations, we also take into account the flux produced by inverse Compton scattering of the electrons/positrons generated in dark matter annihilations off the interstellar photon background. We
consider the full catalog of high-energy gamma-ray sources detected by FERMI, in addition to the diffuse galactic and extragalactic background. The impact of the degeneracies between the different dark matter annihilation
channels has been studied. We find that in many scenarios it will be possible to obtain significant constraints on the dark matter properties.

Parallel session : Indirect Searches 2 / 130

Reionizing the Universe with dark matter: constraints on self-annihilation cross sections

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I will show how it is possible to place sound constraints on DM self annihilation cross sections by making use of cosmological observables.
Current CMB measurements do in fact allow the possibility to test DM self-annihilation down to the thermal values for particle masses of few GeV, and to place constraints that depend only on cosmological parameters.
This kind of constraints, competitive at the quantitative level with galactic multimessenger ones, thus offer the qualitative advantage to be unplagued by astrophysical uncertainties typically correlated with structures.

Plenary session : Dark Matter Direct Searches 1 / 77

Results of the Edelweiss-II dark matter search experiment.

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A search for WIMP dark matter has been undertaken with new-generation germanium heat-and-ionization detectors in the EDELWEISS-II experiment. The InterDigit bolometers, with an interleaved electrode design, have proven excellent rejection performances against the surface event background which is limiting germanium bolometer dark matter searches. One year of continuous operation at the Laboratoire Souterrain de Modane has been achieved with an array of ten 400g detectors. Results will be presented and future prospects for this experiment will be discussed.

Parallel session : Direct Searches 3 / 175

SIMPLE

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We describe recent results of the SIMPLE dark matter search, comprising 15 superheated droplet detectors of ~0.200 kg total active mass operated over the last nine months.

Parallel Session : Structure Formation & N-body simulations 1 / 50

STERILE NEUTRINOS AND THE MILGROM'S LAW PROBLEM

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In 1983 Milgrom proposed an alternative explanation for the anomalous rotation of galaxies based upon a modification of Newtonian dynamics for small accelerations (MOND theory) [1] . A careful analysis of the rotation curves revealed that the effect of the supposed dark matter seems to activate

only when the orbital acceleration is smaller than 2x10^{-8} cm s^{-2}.
MOND theory still challenges the Dark Matter community because simulations of cold dark matter (CDM) accretion favour the formation of halos with a cusp at the center of the galaxies (Via Lactea II [2]). The calculations of galactic density profiles from the rotation curves contradict the prediction of an halo with a peak at the center of galaxies. This phenomenon is related with Milgrom's law because a galactic core almost free from DM will imply that there exists a critical orbit separating the inner regions of the galaxy, where rotation behaviour can be deduced from the observed mass, and the outer regions where DM must be invoked to explain the discrepancy.
We show that this problem is overcome in a Warm Dark Matter theory for sterile neutrinos with a mass around 3 keV [3]. These particle behave as collisionless Vlasov particles with a primordial typical velocity around 330 km s^{-1} and, consequently, they evaporated from galactic cores and reorganized in halos with a cusp at a finite distance from the galactic center (in contrast with Cold Dark Matter simulations which predict a cusp at the center of galaxies).

[1] M. Milgrom, A modification of the Newtonian dynamics as a possible alternative to the hidden mass hypothesis, Astrophysical Journal 270 (1983) 365; A modification of the Newtonian dynamics - Implications for galaxies, Astrophysical Journal 270 (1983) 371.
[2] M. Kuhlen et al., The Via Lactea INCITE simulation: galactic dark matter substructure at high resolution, J. Phys. Conf. Ser. 125:012008 (2008), arXiv 0810.3614.
[3] L. Acedo, A WDM for the evolution of Galactic Halos, JCAP07 (2009) 037.

Parallel session : Direct Searches 1 / 102

Search for inelastic dark matter with the CDMS experiment

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The Cryogenic Dark Matter Search experiment (CDMS) employs a total of 30 germanium and silicon detectors at the Soudan Underground Laboratory to detect weakly interacting massive particles (WIMPs) via their scattering from the target nuclei. Previous CDMS results, released in December 2009, set the world leading limit on the spin-independent WIMP-nucleon cross section above WIMP masses of ~50 GeV/c^2 assuming elastic scattering. In a subsequent analysis we investigated the inelastic dark matter scenario which was proposed to reconcile the disagreement between the results of DAMA/LIBRA and other existing dark matter search experiments. In order to maximize the sensitivity to this particular model a refined analysis in the range from 25 to 150 keV has been performed. Results emerging from this analysis will be presented.

Parallel session : Indirect Searches 5 / 189

Searches for DM signals from the Galactic Center region with HESS

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The H.E.S.S. experiment, an array of four Imaging Atmospheric Cherenkov Telescopes, observes the Galactic Center (GC) region in the very high-energy (VHE, E > 100 GeV) domain since 2004. The GC is believed to be the region with the highest Dark Matter (DM) density in our Galaxy, thus making it one of the primary targets for VHE gamma-ray observations, looking for signals from annihilation or decay of DM particles. The interpretation of the collected H.E.S.S. data with regard to possible DM signals is however complicated by the presence of several astrophysical sources of VHE gamma-ray radiation in this region. In this talk, the current status of the search for DM signals from the GC region is reviewed.

Parallel session : Dark Matter Candidates 1 / 68

Semi-annihilation of Dark Matter

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We show that the thermal relic abundance of dark matter can be affected by a new type of reaction: semi-annihilation. Semi-annihilation takes the schematic form X_i X_j -> X_k phi, where X_i are stable dark matter particles and phi is an unstable state. Such reactions are generically present when dark matter is composed of more than one species with "flavor" and/or "baryon" symmetries. We give a complete set of coupled Boltzmann equations in the presence of semi-annihilations, and study two toy models featuring this process. Semi-annihilation leads to non-trivial dark matter dynamics in the early universe, often dominating over ordinary annihilation in determining the relic abundance. This process also has important implications for indirect detection experiments, by enriching the final state spectrum from dark matter (semi-)annihilation in the Milky Way.

Parallel session : DM at colliders and neutrinos / 78

Sensitivity Enhancement for the Searches of Neutrino Magnetic Moments through Atomic Ionization

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Co-author(s): Shin-Ted LIN [2] ; Tsz-King Henry WONG [2]

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A new detection channel on atomic ionization for possible neutrino electromagnetic interactions was identified and studied. Orders of magnitude enhancement in sensitivities can be expected when the energy transfer to the target is of the atomic-transition scale. Interaction cross-section induced by neutrino magnetic moments (mu_nu) was evaluated. New upper limit of mu_nu < 1.3×10^-11 μ_B at 90% confidence level was derived using current data with reactor neutrinos. Potential reaches of future experiments are discussed. Experiments with sub-keV sensitivities can probe mu_nu to 10^-13 μ_B. Positive observations of mu_nu in this range would imply that neutrinos are Majorana particles. Analysis with new data will be presented.

Reference :
H.T. Wong, H.B. Li and S.T. Lin, arXiv:1001.2074 (2010).

Poster session / 114

Shield design for the XENON1T experiment at LSM

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The direct search for dark matter experiment, XENON100, using liquid xenon has been in the process of taking data since January 2010 and will continue to do so for another year to reach a never yet achieved sensitivity on the WIMP cross section and ultimately, maybe detect a WIMP.
In addition, the experiment is already being pushed towards its next phase, XENON1T, which will be much larger with a fiducial volume of about 1 ton of liquid xenon. Reducing the background, it would be a hundred times more sensitive.
While the previous phases were located at the Laboratori Nazionali del Gran Sasso (LNGS), in Italy, the location of XENON1T is still uncertain. One of the considered option is to put it in the Laboratoire Souterrain de Modane (LSM), in France.
The LSM site and its different level of gamma, neutron and muon background with an emphasis on the muon induced neutrons coming from the environmental rocks, have been investigated.
Considering the available space at LSM and the final background level necessary for a dark matter search, an efficient and optimal shielding design has been established.
All the results of these studies will be presented in this poster.

Parallel Session : Structure Formation & N-body simulations 3 / 117

Signatures of Dark Star Remnants in the Galactic Halo

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The very first stars likely formed from metal-free, molecular hydrogen-cooled gas at the center of dark matter minihalos. Prior to nuclear fusion, these stars may have been supported by dark matter heating from annihilations in the star. As the dark matter fuel supply became depleted, nuclear fusion and standard stellar evolution would have begun, and today the objects that began their lives as so-called Dark Stars would exist as a population of remnant intermediate mass black holes surrounded by dark matter spikes. Here we explore the signatures of dark matter annihilations in the dark matter spikes surrounding these black holes for a range of dark star formation scenarios, black hole masses, and dark matter annihilation modes.

Parallel session : Direct Searches 2 / 171

Spin-Dependent Limits from DRIFT

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The DRIFT dark matter detector is a 1 m^3 scale TPC with direction sensitivity to WIMP recoils operating in the Boulby Mine in England. For many years DRIFT operated with CS2 as our target gas. Recently we have researched the possibility of mixing a spin-dependent gases to the electronegative CS2 gas. This effort was successful and we have recently begun underground operation of a 30 Torr CS2 - 10 Torr CF4 gas mixture. Spin-dependent limits from these data will be presented.

Parallel session : Direct Searches 2 / 67

Status of Nuclear Emulsion for Directional Dark Matter Search

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We are approaching the R&D of high resolution nuclear emulsion:NIT for directional dark matter search. NIT is the only detector that is direction-sensitive and solid.
Now this project is developing for construction of prototype detector and test running. In this talk, status of new production system of nuclear emulsion and readout system of recoil tracks will be reported.

Parallel session : Direct Searches 3 / 182

Status of the XMASS Experiment

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The XMASS project aims to study low-energy solar neutrinos,
dark matter and double beta decay using ultra pure liquid xenon.
As a first step of the project, a detector with 800kg of liquid xenon
in a signle phase was proposed. The detector is now finishing its
construction in the Kamioka mine in Japan. Construction of the
detector will be reported and commissioning plan will be discussed.

Parallel session : DM at colliders and neutrinos / 94

Status report and performance of the T2K experiment

Eike Frank[1]

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The talks aims to present the results of the first physics run of T2K and give an update on the status and performance of the experiment. T2K is the first long baseline off-axis neutrino oscillation experiment and aims to refine the measurements of the oscillation parameters Dm_23 and theta_23, discovered by Super-Kamiokande with atmospheric neutrinos, respectively at a level of 10% and <1% uncertainties in disappearance neutrino oscillation mode. Moreover these parameters are fundamental ingredients for the key research item of T2K that is the discovery of theta_13 by measuring the appearance of electron neutrinos, which is furthermore needed to understand CP violation in the leptonic sector. This will be done by comparing the flux of a high intensity neutrino beam at a near detector station, ND280 (composed of on-axis and 2.5 degree off-axis detectors at roughly 280 m from the neutrino source) with the flux 2.5 degree off-axis at the far detector, Super-Kamiokande (295 km from the source).

Plenary session : Dark Matter Candidates 2 / 145

Sterile neutrino dark matter

Author(s): Oleg Ruchayskiy[1]

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An extension of the Standard Model by three right-handed (sterile) neutrinos with their masses below the electroweak scale allows to explain the data on neutrino flavor oscillations, allows for generation of baryon asymmetry of the Universe and provides a dark matter candidate. Dark matter made of sterile neutrinos can be warm, cold or mixed and satisfies all existing astrophysical and cosmological bounds. I will overview these bounds and discuss the prospects for future searches.

Parallel session : Direct Searches 3 / 106

Study of the performances of the shield and muon veto of the XENON1T experiment.

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Presented by M. Selvi on behalf of the XENON1T collaboration.

Within the XENON program, we are operating a double-phase TPCs using liquid xenon (LXe) as target material. The current phase, XENON100 installed in the LNGS, is in science mode since the beginning of 2010, with a sensitivity goal of 2 x 10-45 cm2.
For the next step, we propose to build a detector with a total mass of 2.4 tons of LXe (1.1 fiducial): XENON1T. The goal is to reduce the background by two orders of magnitude with respect to XENON100, reaching a sensitivity of about 5 x 10-47 cm2.

Therefore it is crucial to reduce the external backgrounds: gammas and neutrons from the ambient radioactivity and the most dangerous muon-induced neutrons.
A careful study of the shield and muon veto needed by the experiment has been carried on with a full Geant4 MC simulation.
Two possibilities for the experimental site are considered: LNGS or LSM.
To shield the experiment at LNGS a water tank of 10 m diameter and 10 m height will be necessary; moreover the water will be instrumented with PMTs to act as a Cherenkov muon veto.
At LSM (where the muon flux is reduced by about a factor 50 with respect to LNGS , because of its larger rock overburden) a similar result could be achieved with a conventional passive shield and a plastic scintillator muon veto.
The results obtained for the two site options are presented in this work.

Plenary session : Dark Matter Candidates 2 / 188

SuperWIMP dark matter and astrophysical connections

Manoj Kaplinghat[1]

[1] *UC Irvine*

I will discuss superWIMP dark matter models and differentiate their predictions from that of WIMP dark matter, focusing on the differences in the BBN era and for small-scale structure formation. I will draw some generic lessons for the connection between the particle properties of dark matter and structure of dark matter on sub-galactic scales and discuss present status and future observations that aim to discern this structure.

Parallel Session : Structure Formation & N-body simulations 2 / 72

Superdense dark matter clumps

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Amplification of dark matter annihilation signal due to the small-scale clumpiness of the Galactic halo provides the unique possibility of the indirect dark matter particle identification. We describe a cosmological scenario for formation of superdense dark matter clumps from superheavy particles. As an illustrative example it is considered the case of superheavy neutralino. The small-scale superdense clumps may form from a non-standard spiky spectrum of perturbations during the radiation dominated era. These clumps are not destroyed by tidal interactions and can be extremely dense. Superdense clumps can be observed by the gamma-radiation from dark matter annihilations and by the gravitational wave detectors, while the production of primordial black holes constrains this scenario.

Plenary session : Dark Matter Direct Searches 2 / 80

The ArDM Experiment

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The Argon Dark Matter (ArDM) experiment is based on a ton-scale double-phase liquid argon detector, currently in the commissioning phase at CERN. The scientific goal is the direct search of WIMP Dark Matter through detection of nuclear recoils induced by WIMP scattering on an Ar nucleus.
The active mass is 850 kg of liquid argon. An array of 14 8" cryogenic photomultiplier tubes immersed in liquid argon detects the scintillation light generated by the nuclear recoil, while the ionization charge is detected with a multi stage large electron multiplier (LEM) in the vapor phase. The ionization charge is drifted over a length of more than one meter, extracted at liquid-vapor interface, multiplied by a factor of thousand or more in the LEM and induces a detectable signal on a finely segmented anode, providing millimeter position resolution.
Full 3D imaging capability with high segmentation provides an important handle in dealing with the background, together with self-shielding of the liquid argon, pulse shape discrimination for the scintillation light between nuclear and electron recoils, and charge-to-light ration that again is different for nuclear and electron recoil.
In Spring 2009 the ArDM detector was operated with liquid argon for the first time for about a month, providing an important test of the cryogenics, liquid argon purification and stability of the purity level, and test of a partially completed light readout system, which in turn allowed a first measurement of the light yield.
More tests are foreseen in 2010 to complete the commissioning phase, after which ArDM will be moved underground for the science run.

Poster session / 36

The Assembly of the Milky Way halo

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We present a set of numerical Nbody simulations to investigate the formation of the outer Milky Way's halo trough accretion events. The aim is to explore the orbital conditions where a retrograde signal in the outer part of the halo can be obtained in order to give a possible explanation of the observed rotational properties of the Milky Way stellar halo.

Parallel session : Direct Searches 3 / 107

The CAST experiment: status and perspectives

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The status of the solar axion search with the CERN Axion Solar Telescope (CAST) will be discussed. Results from the first part of CAST phase II where the magnet bores were filled with 4He gas at variable pressure in order to scan ma up to 0.4 eV will be presented. From the absence of excess X-rays when the magnet was pointing to the Sun, we set a typical upper limit on the axion-photon coupling of ga
. 2.17×10−10GeV−1 at 95% CL for ma< 0.4 eV, the exact result depending on the pressure setting. Our search for axions with masses up to about 1.2 eV using 3He as a buffer gas is in progress in the second part of CAST phase II. Expectations for sensibilities will be given. Near future perspectives as well as more long term options for a new helioscope experiment will be evoked.

Plenary session : Dark Matter Direct Searches 1 / 58

The CDMS II Experiment: Dark Matter results from the complete data set

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Over the past decade, the Cryogenic Dark Matter Search (CDMS II) experiment has provided world-leading sensitivity for the direct detection of Weakly Interacting Massive Particle (WIMP) dark matter. This presentation will discuss the results from the anaysis of the complete CDMS II Ge data set in which two nuclear-recoil events where seen with an expected background of 0.9±0.2 events. Although this does not constitute statistically significant evidence for a WIMP signal the CDMS II data is able to place strong constraints on the WIMP-nucleon spin-independent scattering cross-section for a wide range of WIMP masses, excluded new parameter space in inelastic dark matter models as well as exclude parameter space for for other hypothesise dark matter models. The present status and future plans for the followup SuperCDMS experiment will also be discussed.

Parallel session : Direct Searches 4 / 62

The CHASE laboratory search for chameleon dark energy

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A scalar field is a favorite candidate for the particle responsible for dark energy. However, few theoretical means exist that can simultaneously explain the observed acceleration of the Universe and evade tests of gravity. The chameleon mechanism, whereby the properties of a particle depend upon the local environment, is one possible avenue. I present the results of the Chameleon Afterglow Search (CHASE) experiment, a laboratory probe for chameleon dark energy. CHASE marks a significant improvement other searches for chameleons both in terms of its sensitivity to the photon/chameleon coupling as well as its sensitivity to the classes of chameleon dark energy models and standard power-law models. Since chameleon dark energy is virtually indistinguishable from a cosmological constant, CHASE tests dark energy models in a manner not accessible to astronomical surveys.

Poster session / 140

The Dark-Matter Density Profiles and Binary Black Holes

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It is known that galactic centers could host single or binary black holes, and observations show that black-hole masses are correlated with the properties of galaxies. Moreover, in terms of center's density profiles, early-type galaxies can be classified into power-law or core galaxies. Therefore, in this project, we study the dynamics near galactic centers with given galactic dark-matter density profiles and binary black holes. Our results could constrain the properties of binary black holes in their host galaxies.

Parallel session : Indirect Searches 1 / 87

The Electron Injection Spectrum Determined by Anomalous Excesses in Cosmic Ray, Gamma Ray, and Microwave Signals

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Recent cosmic ray, gamma ray, and microwave signals observed by Fermi, PAMELA, and WMAP indicate an unexpected primary source of e+e- at 10-1000 GeV. We fit these data to "standard backgrounds" plus a new source, assumed to be a separable function of position and energy. For the spatial part, we consider three cases: annihilating dark matter, decaying dark matter, and pulsars. In each case, we use GALPROP to inject energy in log-spaced energy bins and compute the expected cosmic-ray and photon signals for each bin. We then fit a linear combination of energy bins, plus backgrounds, to the data. We use a non-parametric fit, with no prior constraints on the spectrum except smoothness and non-negativity. In addition, we consider arbitrary modifications to the energy spectrum of the "ordinary" primary source function, fixing its spatial part, finding this alone to be inadequate to explain the PAMELA or WMAP signals. We explore variations in the fits due to choice of magnetic field, primary electron injection index, spatial profiles, propagation parameters, and fit regularization method. Dark matter annihilation fits well, where our fit finds a mass of ~1 TeV and a boost factor times energy fraction of ~70. While it is possible for dark matter decay and pulsars to fit the data, unconventionally high magnetic fields and radiation densities are required near the Galactic Center to counter the relative shallowness of the assumed spatial profiles. We also fit to linear combinations of these three scenarios, though the fit is much less constrained.

Plenary session : Indirect Searches 1 / 103

The Galactic electron and positron "excesses": astrophysical versus dark matter interpretations

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The observation by PAMELA of a rising positron fraction up to 100 GeV, further complemented with the ATIC / Fermi / HESS data on the electron+positron spectrum up to a few TeV, has led to significant adjustments in our understanding of the local high energy electron-positron budget. Many interpretation attempts have invoked dark matter annihilation or decay to fill the gap between the "standard" predictions and the apparent "excesses", while some more conventional explanations were proposed from studying the contributions of local pulsars and/or supernova remnants. In this talk, we will discuss the status of these different scenarios, and we will sketch a potential roadmap (i) to close the case of the positron "excess" (ii) for future improvements in our general understanding of cosmic ray electrons and positrons.

Parallel session : Indirect Searches 3 / 53

The General Antiparticle Spectrometer (GAPS) - Hunt for dark matter using low energy antideuterons

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The GAPS experiment is foreseen to carry out a dark matter search using low energy cosmic ray antideuterons (< 0.3GeV/n) using a novel detection approach. The theoretically predicted antideuteron flux resulting from secondary interactions of primary cosmic rays, e.g. protons, with the interstellar medium is very low. So far not a single cosmic antideuteron has been detected by any experiment but well-motivated theories beyond the standard model of particle physics, e.g. supersymmetry or universal extra dimensions, contain viable dark matter candidates which could led to a significant enhancement of the antideuteron flux due to self-annihilation of the dark matter particles. This flux contribution is believed to be especially large at small energies which leads to a high discovery potential for GAPS.
In comparison to other experiments, GAPS will be able to measure antideuterons at lower energies than the upcoming AMS-02 experiment and will partly cover complementary parameter space regions of dark matter scenarios studied by direct dark matter underground searches.
GAPS is designed to achieve its goals via a series of ultra-long duration balloon flights (bGAPS) at high altitude in Antarctica, starting in 2014. The detector itself will consist of 13 planes of Si(Li) solid state detectors and a time-of-flight system. The antideuterons will be slowed down in the Si(Li) material, replace a shell electron and form an excited exotic atom. The atom will be deexcited by characteristic x-ray transitions and will end its life by the formation of an annihilation pion star. This unique event structure will deliver a nearly background free detection possibility.
To prove the performance of the different detector components at stratospheric altitudes a prototype flight (pGAPS) will be conducted in 2011 from Taiki, Japan. This flight will also be important to understand the particle and x-ray backgrounds which might influence the final bGAPS design.
This presentation will report on the general bGAPS concept and on the status of the pGAPS instrument and flight preparations.

Parallel Session : Structure Formation & N-body simulations 2 / 152

The Impact of Dark Matter Microhalos on Signatures for Direct and Indirect Detection

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Detecting dark matter as it streams through detectors on Earth relies on knowledge of its phase space density on a scale comparable to the size of our solar system. Numerical simulations predict that our Galactic halo contains an enormous hierarchy of substructures, streams and caustics, the remnants of the merging hierarchy that began with tiny Earth mass microhalos. If these bound or coherent structures persist until the present time, they could dramatically alter signatures for the detection of the wimp.
Using numerical simulations that follow the coarse grained tidal disruption within the Galactic potential and fine grained heating from stellar encounters, we find that microhalos, streams and caustics have a negligible likelihood of impacting direct detection signatures implying that dark matter constraints derived using simple smooth halo models are relatively robust. We also find that many dense central cusps survive, yielding a small enhancement in the signal for indirect detection experiments.

Parallel Session : Structure Formation & N-body simulations 3 / 139

The Inter-Galactic Populations and Unbound Dark Matter

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The diffused light between galaxies, as first discovered by
Zwicky (1951), has been an interesting issue related with the
evolution of galaxies. N-body simulations of
mergers of galaxies with dark matter have been employed to address
this topic. By N-body simulations, we investigate the production of
intergalactic populations through head-on mergers. Our results
show that single head-on mergers cannot explain the observations,
and the main conclusions are:
(1)head-on merging events make a considerable fraction of dark metter
become unbound;
(2)some luminous intergalactic populations are in fact trapped in dark halo
and gravitationally bounded;
(3)multiple and minor mergers shall have contributions on
intergalactic populations.

Parallel session : Direct Searches 3 / 115

The MiniCLEAN Direct Dark Matter Search

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This talk reviews the MiniCLEAN dark matter detector's technology and status, where CLEAN stands for Cryogenic Low Energy Astrophysics with Noble gases. MiniCLEAN uses single phase argon or neon as detection medium and relies on pulse-shape discrimination to remove electronic recoil backgrounds. The anticipated sensitivity of the 150 kg of argon in its fiducial volume to the spin-independent WIMP-nuclear scattering cross-section is 10^-45cm^2. MiniCLEAN is currently under construction and will be deployed underground at SNOLAB. It is part of the larger DEAP/CLEAN effort that ultimately proposes to construct a 50 ton scale detector that will also measure the solar pp neutrino flux.

Parallel session : DM at colliders and neutrinos / 148

The NEXT experiment in the new Canfranc Underground Laboratory

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Neutrinos are the least understood and the most elusive of the known fundamental particles in the Standard Model of particle physics, though they are the second most abundant in the universe. Neutrino oscillation experiments have shown that neutrinos have finite rest mass, but their absolute mass scale is still unknown. The exploration of the degenerate hierarchy, which corresponds to an effective neutrino mass up to 50 meV , is the goal of the next generation of neutrino-less double beta decay experiments. These experiments could also elucidate whether the neutrino is a Majorana or a Dirac particle.

The aim of NEXT collaboration is to build a 100 kg high-pressure Xe gas TPC enriched with 136Xe for the search of neutrinoless double-beta decay in the new LSC (Canfranc Underground Laboratory) in the Spanish Pyrenees. The high pressure TPC offers the excellent energy resolution and the background rejection power provided by the topological information of the electron tracks obtained by a photosensor array (SiPMs, APDs or PMTs) or a Micromegas plane. Here we will present the experiment and especially the results of the first generation of prototypes studying both the electroluminiscence signal and the charge amplification signal with Micromegas in pure HPGXe.

Parallel session : Dark Matter Candidates 2 / 119

The Sommerfeld Enhancement for Inelastic Dark Matter

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Recently measured excesses in electron and positron cosmic rays have motivated models of dark matter with a velocity-dependent Sommerfeld enhancement to the annihilation rate. These models frequently feature nearly-degenerate excited states for the dark matter; such excited states may also furnish explanations for the DAMA/LIBRA annual modulation and INTEGRAL 511 keV line. I will present an accurate semi-analytic approximation for the Sommerfeld enhancement in models with a single excited state, and discuss novel features of the enhancement relative to the case with no excited states. I will also show the range of annihilation cross sections that can be achieved in the local dark matter halo, for models of this type, where the dark matter is a thermal relic with the correct relic abundance and constraints from the cosmic microwave background are respected.

Parallel Session : Structure Formation & N-body simulations 2 / 192

The distribution of dark matter around galaxies : Mean surface density profile and outer structure

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We study the matter distribution in and around dark halos in the standard Λ cold dark matter (ΛCDM) universe.
We use the outputs of high resolution N-body simulations to compute the mean surface density profile around galactic size dark matter halos.
The result is compared with the observed surface density profile from the lensing magnification measurement of quasars in Sloan Digital Sky Survey (SDSS) recently reported by Menard et al. (2010).
We show that the ΛCDM simulations reproduce the observed surface density profile remarkably well over a wide range of radial distance of $10 - 10^4 h^{-1}$kpc.
The mean surface density profile at small separation lengths is consistent with the theoretical prediction that dark halos have a universal Navarro-Frenk-White density profile.
The observed single power-law of $\Sigma \propto R^{-0.8}$ over the distance range is explained by a simple analytic model based on a halo approach.
%The time evolution of the mean surface density profile is studied to make predictions for future observations.
We also study the distribution of dark matter in the outer part of the halos by measuring the mass enclosed within $\alpha R_{\rm virial}$, as a function of α.
Our simulations suggest that more than a half of total matter is contained in about 10\% volume associated with galactic halos.
Assuming the SDSS galaxies are hosted by dark halos with mass $2 \times 10^{12} - 10^{14} M_\odot$, the total mass around the halos amounts to 30 percent of the total mass in the local universe.

Parallel Session : Structure Formation & N-body simulations 3 / 75

The observational signatures of high-redshift dark stars

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The annihilation of dark matter particles in the centers of minihalos may lead to the formation of so-called dark stars, which are cooler, larger, more massive and potentially more long-lived than conventional population III stars. Here, we investigate the prospects of detecting high-redshift dark stars with upcoming James Webb Space Telescope (JWST). We find that individual dark stars with masses below 1000 Msolar are intrinsically too faint for JWST. However, by exploiting foreground galaxy clusters as gravitational telescopes, certain varieties of dark stars should be within range at z~10-15. Since the JWST colours of these objects are very different from those of mundane interlopers in front of, within or behind the lensing clusters, such dark stars should be readily identifiable in JWST imaging surveys. We also argue that, if the the life times of dark stars are sufficiently long, many such objects may congregate inside the first galaxies. This could give rise to peculiar features in the integrated spectra of high-redshift galaxies.

Plenary session : Dark Matter Candidates 2 / 157

Theoretical Perspectives on DAMA in Light of Recent Searches

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Plenary session : Dark Matter Searches at the LHC / 131

Theoretical expectations for dark matter detection at the LHC

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Dark matter candidates emerge naturally in many theories of particle physics beyond the Standard Model.
In the case of supersymmetry, several compelling candidates emerge: the neutralino, the gravitino, the axion/axino multiplet and others. While dark matter won't be directly observable at LHC, the host of new
particles associated with the new physics giving rise to dark matter should be.
For supersymmetric theories, we expect large rates for multi-jet plus multi-lepton plus missing E_T events
(depending on sparticle masses). I detail what LHC can be expected to accomplish during Run 1 for supersymmetry and dark matter. In the case of Yukawa-unified SUSY, as expected from SO(10) SUSY GUTs,
LHC should be able to either discover or exclude this compelling class of theories.

Parallel session : Direct Searches 2 / 170

Towards a Massive Directional WIMP Detector

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Directional WIMP experiments are now reaching a level of maturity that suggests a scale-up towards a very large experiment able to identify a directional galactic signal for WIMPs is feasible. This is being widely discussed in the context of the CYGNUS cooperation of world groups active in directional technology. Progress towards possible concepts will be explored, including the new design for the DRIFT III experiment.

Parallel Session : Structure Formation & N-body simulations 1 / 128

Universal Mass Accretion Rates and Concentrations of Dark Matter Halos

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Dark matter halos constitute cosmic structures, host galaxy formation, bend light from faraway galaxies and so are very important objects to study. In the past few years, a large amount of observations have constrained cosmological parameters and the initial density fluctuation spectrum to a pretty high accuracy. However, cosmological parameters change with redshift and the power index of the power spectrum varies with mass scale dramatically in the so-called concordance Lambda CDM cosmology. Thus, any successful model for cosmic structural evolution should work well simultaneously for various cosmological models and different power spectra.
With a large set of high-resolution N-body simulations of a variety of structure formation models (scale-free, standard CDM, open CDM, and Lambda CDM), we disentangled and modeled the dependences of halo mass accretion rate (MAR) on all relevant factors and connected halo interior mass concentrations with their mass accretion histories (MAHs) in a simple way. These models can be used to predict the MAHs, the mass & redshift dependence of concentrations and the individual concentration evolution histories of dark matter halos, which significantly disagree with the much-used empirical models in the literature. These models are accurate and universal: the same set of model parameters works well for different cosmological models and for halos of different masses at different redshifts and the model predictions are highly accurate even when the histories are traced to very high redshift. These models are also simple and easy to implement. A web calculator and a user-friendly code to make the relevant calculations are available from http://www.shao.ac.cn/dhzhao/mandc.html .
We also explained why histories of Lambda CDM halos on nearly ALL mass scales consist of two phases which are distinct in many physical characteristics, as found by Zhao et al. (2003a, 2003b).

Parallel session : Indirect Searches 5 / 113

VERITAS Indirect Search for Dark Matter Program

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A leading candidate for astrophysical dark matter (DM) is a massive particle in the range from 50 GeV/c^2
to greater than 10 TeV/c^2 and an interaction cross section on the weak scale. The self-annihilation of
such particles in astrophysical regions of high DM density can generate stable secondary particles including very high energy gamma rays with energies up to the DM particle mass. Dwarf spheroidal galaxies of the Local Group are attractive targets to search for the annihilation signature of DM due to
their proximity and large DM content. We report on gamma-ray observations taken with the Very Energetic Radiation Imaging Telescope Array System (VERITAS) of several dwarf galaxy targets and discuss
the implications of these measurements for the parameter space of DM particle models.

Parallel Session : Structure Formation & N-body simulations 3 / 110

WIMP capture for dark stars in the early universe

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The first stars to form in the universe may have been Dark Stars, powered by dark matter annihilation instead of nuclear fusion. The initial amount of dark matter gathered by the star gravitationally can sustain it only for a limited period of time. It has been suggested that capture of additional dark matter from the environment can substantially prolong the dark star phase and the star's life time. In analyzing the capture process in detail one however finds that it is very hard for the dark star to sustain high capture rates for an extended period of time. The star's WIMP capture rapidly depletes the population of WIMPs that is easy for the star to capture, resulting in such a large drop in the WIMP capture rate that it can no longer sustain the dark star.

Parallel Session : Structure Formation & N-body simulations 3 / 111

Watching dark matter stars burn - possible signatures of Dark Stars in the EBL

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Recently, it has been proposed that self-annihilating dark matter could have a
significant effect on the formation and development of the first stars in
the universe. In such a model, the energy from self-annihilation of dark matter particles
may be the main power source for this class of young stellar objects
called Dark Stars (DS). Their features (e.g. luminosity, temperature, lifetime)
differ from normal POP III stars and therefore makes them distinguishable.
The contribution of DS to the extragalactic background light considering multiple

initial parameters is calculated. By comparing our results with existing data of the EBL we can derive first observational limits on Dark Stars in the early universe. Future observations will improve these constraints.

Parallel session : Indirect Searches 1 / 96

What can we really learn from positron flux 'anomalies'?

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We present a critical analysis of the observational constraints on, and of the theoretical modeling of, aspects of cosmic ray (CR) generation and propagation in the Galaxy, which are relevant for the interpretation of recent positron and anti-proton measurements. We give simple, analytic, model independent expressions for the secondary antiproton flux, and an upper limit for the secondary positron flux, obtained by neglecting positron radiative losses, e+/(e++e−) < 0.2±0.1 up to ~ 300 GeV. These expressions are completely determined by the rigidity dependent grammage, which is measured from stable CR secondaries up to ~ 150 GeV/nuc, and by nuclear cross sections measured in the laboratory. Antiproton and positron measurements, available up to ~ 100 GeV, are consistent with these estimates, implying that there is no need for new, non-secondary, antiproton or positron sources. The radiative loss suppression factor fs,e+ of the positron flux depends on the positron propagation in the Galaxy, which is not understood theoretically. A rough, model independent estimate of fs,e+ ~ 1/3 can be obtained at a single energy, E ~ 20 GeV, from unstable secondary decay and is found to be consistent with positron measurements, including the positron fraction measured by PAMELA. We show that specific detailed models, that agree with compositional CR data, agree with our simple expressions for the positron and antiproton flux, and that the claims that the positron fraction measured by PAMELA requires new primary positron sources are based on assumptions, that are not supported by observations. If PAMELA results are correct, they suggest that fs,e+(E) is slightly increasing with energy, which provides an interesting constraint on CR propagation models. We argue that measurements of the positron to antiproton ratio are more useful for challenging secondary production models
than the e+/(e+ + e−) fraction.

Parallel session : Dark Matter Candidates 3 / 118

XENON10/100 dark matter constraints: examining the L_eff dependence

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The determination of dark matter constraints from liquid Xenon experiments depends upon the amount of scintillation light produced by nuclear recoils in the detector, a quantity that is characterized by the scintillation efficiency factor L_eff. I will examine how uncertainties in the measurements of L_eff and the extrapolated behavior of L_eff at low recoil energies (where measurements do not exist) affect the constraints from experiments such as XENON10 and XENON100, particularly in the light WIMP regions of interest for the DAMA and CoGeNT experimental results.

Plenary session : Dark Matter Direct Searches 2 / 161

Zeplin-III

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Parallel session : Dark Matter Candidates 2 / 48

keV sterile neutrino Dark Matter in gauge extensions of the Standard Model

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It is known, that a keV scale sterile neutrino is a good Warm Dark Matter (WDM) candidate. We study how this possibility could be realised in the context of gauge extensions of the Standard Model (SM). The naive expectation leads to large thermal overproduction of sterile neutrinos in this setup. However, we find that it is possible to use out-of-equilibrium decay of the other right-handed neutrinos of the model to dilute the present density of the keV sterile neutrinos and achieve the observed DM density. We present the universal requirements that should be satisfied by the gauge extensions of the SM, containing right-handed neutrinos, to be viable models of WDM, and provide a simple example in the context of the Left-Right symmetric model.