PITT PACC Rapid-Response Workshop

Exploring-Low Mass Dark Matter Candidates: Abstracts

Juan Collar (University of Chicago): *Certainty and Uncertainty in Dark Matter Searches*

Departing from the context of CoGeNT and COUPP, two direct searches for WIMP dark matter, we will inspect the recent landscape of anomalies observed by these and several other detectors. The aim of this talk is to communicate an appreciation for the subtleties inherent to experimental efforts in this field, and for the considerable difficulties that await for those trying to make sense of WIMP search observations (or lack thereof).

Guillaume Plante (Columbia University): *Xenon 100*

The XENON100 experiment, currently taking data at the Laboratori Nazionali del Gran Sasso in Italy, aims at detecting WIMPs scattering off nuclei within its 62 kg liquid xenon (LXe) target by simultaneously measuring the scintillation and ionization signals produced by nuclear recoils. The ability to localize events in three dimensions within the target, the self-shielding power of LXe, and the discriminination of nuclear recoils from electronic recoils allow the selection of an inner fiducial volume with a very low background. In this talk I will present the recent XENON100 results obtained from 100 live days of data acquired in 2010 and briefly discuss our recent measurement of the relative scintillation efficiency of nuclear recoils in LXe at low energies. Finally, I will discuss the current status of the experiment and its evolution into XENON1T.

Richard Schnee (Syracuse University): *Results from CDMS and CRESST*

The CRESST-II and CDMS-II experiments use two-channel readout of cryogenically cooled crystals to search for dark matter. Phonon signals provide a precise measurement of the energy deposited by an interaction, allowing good sensitivity to low-mass WIMPs. The second signal, scintillation for CRESST and ionization for CDMS, allows discrimination of otherwise dominant backgrounds. I will discuss CRESST data taken in 2011, which result in more WIMP candidates than may be explained by estimates of expected backgrounds alone, and results from a low-energy analysis of CDMS-II data, which provides constraints on possible low-mass signals. I will also discuss the prospects for improving sensitivity over the next year.

Tom Shutt (Case Western): *TBD*

Abstract TBD

Nima Arkani-Hamed (IAS): *Thoughts on Particle Dark Matter*

Abstract TBD

Lian-Tao Wang (University of Chicago): *Probing Light Dark Matter at the LHC*

After a brief overview of searching for dark matter at the LHC, I will focus on the scenario of light dark matter. LHC has an unique advantage in searching for 10 GeV dark matter candidate and probing its interaction with matter. Recent work on this subject will be summarized.

Louis E. Strigari (Stanford University): *Fermi and ACT Limits on Dark Matter from Milky Way Satellite Galaxies*

The population of Milky Way satellite galaxies has increased significantly in recent years. Follow up spectroscopy on many of these objects has revealed them to be gravitationally bound, extremely dark matter dominated objects. In this talk, I will discuss observation and modeling of these objects, following a path of discovery in optical surveys, to targeted follow up spectroscopy, and then to searches for dark matter annihilation signals using high energy gamma-rays. I will show how for the first time astrophysical sources are reliably testing the regime of thermal relic particle dark matter. I will conclude by discussing how future galaxy surveys and gamma-ray telescopes can improve these limits.

Savvas Koushiappas (Brown University): *Exclusion of Canonical WIMPs from a Joint Analysis of the Milky Way Dwarfs with Data From the Fermi Gamma-ray Space Telescope*

We present new limits on the annihilation cross section of Weakly Interacting Massive Particles (WIMPs) based on the joint analysis of seven Milky Way dwarfs using a frequentist Neyman construction and Pass 7 data from the Fermi Gamma-ray Space Telescope. We exclude generic WIMP candidates annihilating into b-bbar with mass less than 40 GeV that reproduce the observed relic abundance. To within 95% systematic errors on the dark matter distribution within the dwarfs, the mass lower limit can be as low as 19 GeV or as high as 240 GeV. For annihilation into $\tau^+ - \tau^-$, these limits become 18 GeV, 12 GeV and 80 GeV.

Andrew Zentner (University of Pittsburgh): *How Dark Matter Can Alter the Conditions for Stardom*

I examine energy transport by asymmetric dark matter in the interiors of very low-mass stars and brown dwarfs. The motivation is to explore astrophysical signatures of ADM, which otherwise may not be amenable to conventional indirect dark matter searches. In viable models, the additional cooling of very-low mass stellar cores can alter stellar properties. ADM with mass $4 \lesssim M_{\rm x}/{\rm GeV} \lesssim 10$ and either spin-dependent (spin-independent) cross section of $\sigma_{\rm p}^{\rm SD} \sim 10^{-37}\,{\rm cm}^2$ ($\sigma_{\rm p}^{\rm SI} \sim 10^{-40}\,{\rm cm}^2$) can increase the minimum mass of main sequence hydrogen burning, partly *determining whether or not the object is a star at all!* Similar candidates reduce the luminosities of low-mass stars and accelerate the cooling of brown dwarfs. Light dark matter is of particular interest given results from the DAMA, CoGeNT, and CRESST dark matter searches. We discuss possibilities for observing dark matter effects in stars in the solar neighborhood, globular clusters, and, of particular promise, local dwarf galaxies, among other environments, as well as exploiting these effects to constrain dark matter properties.

Dan Hooper (Fermilab): *Indirect Evidence for Light WIMPs*

The spectrum and morphology of the gamma ray emission from the Galactic Center region are very difficult to explain in terms of known astrophysical phenomena, but can be easily accommodated with the annihilations of a relatively light ($\sim 7-12$ GeV) dark matter particle with a cross section consistent with that predicted for a simple thermal relic ($\sim 3 \times 10^{-26}$ cm^3/s). Furthermore, this model automatically provides an explanation for the peculiar spectral features observed from the Milky Way's non-thermal radio filaments, and leads to the prediction of a microwave signal consistent with the WMAP Haze. I will discuss these observations and future tests that will be able to either refute or strengthen the hypothesis that dark matter annihilations are responsible for these signals.

Neal Weiner (New York University): *Comparing Direct Detection Experiments without Halo Models*

Abstract TBD

Howard Baer (University of Oklahoma): *Mixed Axion/LSP Dark Matter*

If the strong CP problem is solved by the PQ mechanism in the context of SUSY, then the dark matter will be an axion/LSP mixture. Here, the LSP may be the lightest neutralino, the axino or the gravitino. I first address the axino=LSP case, and then the neutralino=LSP case. The latter calculation involves a coupled Boltzmann analysis of eight distinct contributions. The PQ/LSP dark matter has many attractive features that improve both SUSY alone or axion alone dark matter. For instance, in the PQMSSM, the PQ scale fa can be allowed nearly up to the GUT scale, which is where string theory generally expects it to be.

Jure Zupan (University of Cincinnati): *Light Dark Matter in Light of CRESST II*

Abstract TBD.

Seon-Hee Seo (Stockholm University): *DM-Ice: Exploring Low-Mass Dark Matter at the South Pole*

DM-Ice is a new initiative to conduct a low-mass dark matter search by taking annual modulation data using NaI(Tl) crystal under the deep ice ($\sim$ 2500 m) at the South Pole. The South Pole is considered to be the best site for a direct dark matter experiment at the southern hemisphere and thus DM-Ice is expected to provide an unambiguous check of the annual modulation signal reported by DAMA. We successfully deployed DM-Ice-17 detector consisting of 17 kg of NaI(Tl) crystal in two equal modules at the end of 2010 along with IceCube strings. We have been continuously taking data since March 2011 and working on understanding of our detector. In this talk, I will present the status of DM-Ice-17 and our future plans.

Shufang Su (University of Arizona): *Beyond the WIMP Miracle*

Weakly-Interacting Massive Particles (WIMPs) have been popular dark matter candidates, which naturally appear in many beyond the Standard Model new physics scenarios. In this talk, I will present several recent theoretical developments in dark matter candidates that are closely related to the WIMP miracle: superWIMP scenario and Wimpless scenario. I will also discuss how to study those dark matter scenarios at both high energy colliders and dark matter detection experiments.

Haibo Yu (University of Michigan): *On Symmetric and Asymmetric Light Dark Matter*

We examine cosmological, astrophysical and collider constraints on thermal dark matter (DM) with mass in the range 1 MeV to 10 GeV. Cosmic microwave background (CMB) observations, which severely constrain light symmetric DM, can be evaded if the DM relic density is sufficiently asymmetric. We determine the minimum annihilation cross section for achieving these asymmetries subject to the relic density constraint; these cross sections are larger than the usual thermal annihilation cross section. On account of collider constraints, such annihilation cross sections can only be obtained by invoking light mediators. These light mediators can give rise to significant DM self-interactions, and we derive a lower bound on the mediator mass from elliptical DM halo shape constraints. We map all of these constraints to the parameter space of DM-electron and DM-nucleon scattering cross sections for direct detection.

Chris Kelso (University of Chicago): *Toward a Consistent Picture for CRESST, CoGeNT, and DAMA*

Three dark matter direct detection experiments (DAMA/LIBRA, CoGeNT, and CRESST-II) have each reported signals which resemble that predicted for a dark matter particle with a mass of roughly $\sim$ 10 GeV. I will compare the signals of these experiments and discuss whether they can be explained by a single species of dark matter particle, without conflicting with the constraints of other experiments. I will show that the spectrum of events reported by CoGeNT and CRESST-II are consistent with each other and with the constraints from CDMS- II, although some tension with xenon-based experiments remains. Similarly, the modulation signals reported by DAMA/LIBRA and CoGeNT appear to be compatible, although the corresponding amplitude of the observed modulations are a factor of at least a few higher than would be naively expected, based on the event spectra reported by CoGeNT and CRESST-II. I will also discuss some ways that this apparent discrepancy could potentially be resolved.

Aravind Natarajan (Carnegie Mellon University): *CMB Bounds on Low-Mass WIMPs*

If the dark matter is made up of WIMPs, their annihilation at early times releases energy which results in partial ionization of gas. These excess electrons scatter CMB photons, thereby modifying the temperature and polarization power spectra. I discuss how precise measurements of the CMB obtained by the WMAP and SPT collaborations can place bounds on the particle mass. I also discuss how complementary probes such as galaxy cluster observations can improve these bounds.
