

Cygnus 2009 Directional Dark Matter Workshop Program v7 (6.10.09)

All talks will be held in the Pappalardo Community Room, 4-349. A standard LCD projector is available, if you require other media please contact the organizers.

Thursday, June 11 (8:00-9:00 Registration)

Session I: Motivation for Directional Detection

9:00-10:30

Session II: Theoretical Interpretation of Recent Results and Consequences for Directional Searches

11:00-12:30

Session III: Directional Dark Matter Experiments I

2:00-3:30

Session IV: Directional Dark Matter Experiments II

4:00-5:30

18:30 Workshop Dinner

Friday, June 12

Session V: Directional Detection Reconstruction & Analysis Techniques

9:00-10:30

Session VI: Directional Detection R&D and Backgrounds

11:00-12:30

Session VII: Beyond Dark Matter with Directional Detectors

2:00-3:30

Session VIII: Dark Matter Astrophysics

4:00-5:30

Saturday, June 13

Session IX: Future Planning Discussion

9:00-10:30

Session X: White Paper Discussion

11:00-12:30

**please reserve at least 5 minutes at the end of your talk for questions and discussion*

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Session I: Motivation for Directional Detection

Thursday, June 11

(chair: Prof. Gabriella Sciolla)

9:00 Welcome

Prof. Ed Bertschinger, MIT Department of Physics, Head
Prof. Gabriella Sciolla, Massachusetts Institute of Technology, USA

9:15 White Paper / Proceedings,

Dr. James Battat, Massachusetts Institute of Technology, USA

Talk abstract: I will discuss a proposal for a white paper on progress in directional dark matter detection to summarize this workshop, in lieu of proceedings.

9:30 Motivation for Directional Detection I,

Prof. Ioannis (J.D.) Vergados, University of Ioannina, GR

Talk abstract: In the standard direct dark matter searches one measures the energy of the recoiling nucleus. In such experiments, unfortunately, the interesting signal cannot be easily distinguished from the background. So, to minimize the background problems, one should exploit some characteristic signatures of the reaction, such as the modulation effect and, in directional experiments, the correlation of the event rates with the sun's motion. In the standard non directional experiments the modulation is small, less than two percent, and the location of the maximum depends on the unknown particle's mass. In directional experiments, in addition to the forward-backward asymmetry due to the sun's motion, one expects a larger modulation, which depends on the direction of observation. Such effects have previously been studied as a function of direction, fixed in galactic coordinates. In a direction fixed in the laboratory frame, such effects depend on the declination of the direction of observation and show very characteristic diurnal variation due to the rotation of the Earth.

10:00 Optimizing Directional Detectors,

Dr. Anne Green, University of Nottingham, UK

Talk abstract: I'll discuss work (carried out in collaboration with Ben Morgan) examining how the detection potential of directional experiments depends on the detector capabilities. In particular I will focus on the consequences of limited (i.e. statistical) sense determination. I'll also briefly review recent developments on the local dark matter distribution.

10:30 Coffee Break

Session II: Theoretical Interpretation of Recent Results and Consequences for Directional Searches

Thursday, June 11

(chair: Dr. Anne Green, TBC)

11:00 Hierarchy in the Phase Space and Dark Matter Astronomy,

Dr. Niayesh Afshordi, Perimeter Institute, CA

Talk abstract: Understanding small scale structure in the dark matter distribution is important in interpreting many astrophysical observations, as well as dark matter (direct or indirect) de-

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tection searches. With this motivation, I introduce a theoretical framework for describing the rich hierarchy of the phase space of cold dark matter haloes, due to gravitationally bound sub-structures, as well as tidal debris and caustics. I then argue that if/when we detect dark matter particles, a new era of Dark Matter Astronomy will be just around the corner.

11:30 Directional Modulation in Crystalline Detectors,
Dr. Paolo Gondolo, University of Utah, USA

Talk abstract: I will present recent work on the strength of modulation signals arising from channeling in crystalline detectors.

12:00 Discussion

12:30 Lunch

Session III: Directional Dark Matter Experiments I
(chair: Prof. Daniel Santos, TBC)

Thursday, June 11

14:00 The DRIFT Experiment,
Prof. Dan Snowden-Ifft, Occidental College, USA

Talk abstract: Recent results from the DRIFT collaboration will be presented.

14:30 The Newage Experiment,
Prof. Kentaro Miuchi, University of Kyoto, JP

Talk abstract: I will discuss several topics on the NEWAGE experiment: detector description and performance (ref. APP31(2009)185), track reconstruction, and underground run results and backgrounds.

15:00 The DMTPC Experiment,
Dr. James Battat, Massachusetts Institute of Technology, USA

Talk abstract: The current status of the DMTPC project will be presented, including preliminary results from a recent surface run, and plans for our upcoming underground run at WIPP in New Mexico.

15:30 Coffee Break

Session IV: Directional Dark Matter Experiments II
(chair: Prof. Dan Snowden-Ifft, TBC)

Thursday, June 11

16:00 MIMAC Project : A Large Micro TPC For Directional Dark Matter Search
Prof. Daniel Santos, LPSC/CNRS/IN2P3/UJF, Grenoble FR

Talk abstract: The MIMAC project proposes to detect the recoil tracks left by the elastic collision of WIMPs on the nuclei of a gas of a micro-TPC by ionization and track measurements. The

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ionization quenching factor measurements and the recoil tracks at low energy will be shown as a validation of the proposed baseline.

16:30 Nuclear Emulsion for Directional Dark Matter Detection,
Dr. Toshiyuki Nakano, University of Nagoya, JP

Talk abstract: Nuclear Emulsion is a kind of photographic film and 3D tracking detector, and it is very high resolution detector. The resolution of usual emulsion is about 1 μ m. Especially, for modern analysis of emulsion, all automatic system based on the optical microscope is used. We propose the direction dark matter search with nuclear emulsion. The strongest point is to be able to make large mass because nuclear emulsion is solid detector. Then, predicted track length of nuclear recoil is less than about 500nm. So, we developed the new high resolution nuclear emulsion. This is called "NIT (Nano Imaging Tracker)". The ability of NIT to be able to detect the nuclear recoil track has been recognized by low velocity Kr ion. In this talk, I will present the idea and future plan for our project.

17:00 Discussion

18:30 Workshop Dinner

Session V: Directional Detection Reconstruction & Analysis Techniques Friday, June 12
(chair: Prof. Kentaro Miuchi, TBC)

9:00 Reconstruction in DRIFT,
Dr. Demitri Muna, New York University, USA

Talk abstract: Understanding the ability to measure and discriminate particle events at the lowest possible energy is an essential requirement in developing new experiments to search for weakly interacting massive particle (WIMP) dark matter. In this talk I will detail an assessment of the potential sensitivity below 10 keV in the 1 m³ DRIFT-II directionally sensitive, low pressure, negative ion time projection chamber (NITPC), based on event-by-event track reconstruction and calorimetry in the multiwire proportional chamber (MWPC) read-out. By application of a digital smoothing polynomial it is shown that the detector is sensitive to sulfur and carbon recoils down to 2.9 and 1.9 keV respectively, and 1.2 keV for electron induced events. The energy sensitivity is demonstrated through the 5.9 keV gamma spectrum of ⁵⁵Fe, where the energy resolution is sufficient to identify the escape peak. The effect of a lower energy sensitivity on the WIMP exclusion limit is demonstrated. In addition to recoil direction reconstruction for WIMP searches this sensitivity suggests new prospects for applications also in KK axion searches.

9:30 Reconstruction Strategies for CCD-based Directional Experiments,
Mr. Asher Kaboth, Massachusetts Institute of Technology, USA

Talk abstract: I will discuss strategies for reconstructing directional dark matter events in CCD images, including background subtraction, track finding, and directional reconstruction.

9:50 Backgrounds in DMTPC,
Mr. Tom Caldwell, Massachusetts Institute of Technology, USA

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Talk abstract: Background studies from a surface run of the DMTPC 10L detector will be presented.

11:10 The Maximum Patch Method for Directional Dark Matter Detection,
Mr. Shawn Henderson, Massachusetts Institute of Technology, USA

Talk abstract: Present and planned dark matter detection experiments search for WIMP-induced nuclear recoils in poorly known background conditions. In this environment, the maximum gap statistical method provides a way of setting more sensitive cross-section upper limits by incorporating known signal and background information. I will give a recipe for the numerical calculation of maximum gap cumulative distribution functions in 1D and demonstrate the extension of the method to 2D for planned directional dark matter detection experiments. I will also discuss on-going efforts to measure backgrounds relevant to applying this new method.

10:25 Coffee Break

Session VI: Directional Detection R&D and Underground Backgrounds Friday, June 12
(chair: Prof. Neil Spooner, TBC)

11:00 R&D Status for Directional Dark Matter Search with Nuclear Emulsion,
Mr. Tatsuhiro Naka, University of Nagoya, JP

Talk abstract: Main R&D for dark matter search with nuclear emulsion are the way of readout of nuclear recoil track and background (electron, γ etc) rejection. To recognize 100nm order track is very difficult because this length is less than optical resolution, but high resolution microscope (ex. electron microscope etc.) is impossible to read the large volume emulsion. So we are doing R&D of new techniques for readout nuclear recoil track by optical microscope. For background rejection, sensitivity control is important both emulsion itself and development treatment. In addition, high background rejection may be possible by using difference of the mechanism of development between nuclear recoil and background. I will report about these R&D statuses in this talk.

11:30 QPIX R&D for Large Directional Detectors,
Prof. Kentaro Miuchi, University of Kyoto, JP

Talk abstract: I will discuss QPIX and ASIC development for scaling-up NEWAGE to a large directional dark matter detector.

12:00 TPC R&D for DMTPC,
Dr. Denis Dujmic, Massachusetts Institute of Technology, USA

Talk abstract: A DMTPC detector prototype uses mesh-based electrodes that allow optical and charge readout of the ionization signal. I will present recent measurements of detector performance, and some studies of gas properties.

12:25 Neutron Background Measurement at SNO,
Prof. Joe Formaggio, Massachusetts Institute of Technology, USA

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Talk abstract: The Sudbury Neutrino Observatory is an underground heavy water Cerenkov detector located 2 kilometers underneath the Earth's surface. SNO is sensitive to a variety of phenomena underground, including solar neutrinos, atmospheric neutrinos, cosmic rays, and muon spallation. This talk will discuss SNO's recent measurement of the cosmic ray muons and spallation neutrons produced at depth.

12:40 Lunch Break

Session VII: Beyond Dark Matter with Directional Detectors

Friday, June 12

(chair: Prof. Michael Gold, TBC)

14:00 Negative Ion Avalanche R&D,
Prof. Jeff Martoff, Temple University/Fermilab, USA

Talk abstract: Recent work on the mechanism of avalanche initiation in negative ion mixtures will be discussed, as well as a new capture agent and its application to X-ray polarimetry.

14:30 Time Projection Chamber R&D for the Linear Collider and Dark Matter,
Dr. Sven Vahsen, Berkeley Lab, USA

Talk abstract: We report on a simple prototype Time Projection Chamber (TPC), where the charge is read out via Gas Electron Multipliers (GEMs) and pixels. This charge readout has good spatial and time resolution, sufficient to meet requirements for reading out a TPC at a future linear collider. With some re-optimization this technology may also be applicable to directional dark matter detection via low pressure gas TPCs.

15:00 Neutron Detection with Directional Dark Matter Detectors,
Mr. Hidefumi Tomita, Boston University, USA

Talk abstract: Neutrons, known to mimic Dark Matter interaction, are one of the biggest background noises that we need to understand thoroughly in search for Dark Matter. Motivated as a study for background of Dark Matter research, the neutron detecting project has begun to stand on its own feet. Our new project, Cylon, is a neutron detector that can obtain the energy, length and angular distribution information of fast neutron induced recoil tracks. Heavy nuclei (such as plutonium) emit neutrons with known energy, and thus, Cylon can be used as a sensitive nuclear weapon detecting device with the strength of directionality. Cylon is a TPC (Time Projection Chamber) filled with mixture of CF₄ and He₄ gas to achieve the maximum scintillation and interaction efficiency.

15:30 Coffee Break

Session VIII: Dark Matter Astrophysics

Friday, June 12

(chair: Prof. Paolo Gondolo, TBC)

16:00 Inelastic Dark Matter and Directional Detection,
Prof. Doug Finkbeiner, Harvard University, USA

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Talk abstract: The DAMA/LIBRA signal is compatible with upper limits from other experiments for the case of inelastic dark matter (iDM), in which the WIMP has an excited state ~ 120 keV above the ground state. The iDM theory, as implemented by Tucker-Smith and Weiner, together with the DAMA result, constrain the WIMP to a tight contour in sigma-delta space, where delta is the mass difference between the ground state and excited WIMPs. An urgent priority in direct detection is to test this scenario. The crucial test of the iDM explanation of DAMA is an experiment with directional sensitivity, which can measure the daily modulation in direction. Because the contrast is 100%, it is a sharper test than the much smaller annual modulation in the rate, and the modulation rate of 1 sidereal day causes any day/night signal to be orthogonal to the WIMP signal over 1 year. I will describe an experiment that could confirm or refute this scenario and estimate the significance of the result obtained as a function of the mass splitting, the cross section, the background, and other parameters. Because the inelastic cross section implied by DAMA is much higher than the elastic cross section, the proposed experiment severely constrains the DAMA/iDM scenario even with modest exposure time.

16:30 Gamma Flux from SUSY Dark Matter Annihilation,
Dr. Mario E. Gomez, Universidad de Huelva, ES

Talk abstract: We review the gamma production derived from neutralino annihilation in the MSSM. After imposing the constraints derived from Particle Physics and the bounds derived from LSP relic density we analyse the gamma flux prediction on the selected space of parameters.

17:00 Six-dimensional mapping of the Milky Way: techniques to disassemble the Galaxy,
Dr. Nitya Kallivayalil, Massachusetts Institute of Technology, USA

Talk abstract: Tidal Streams provide a powerful probe of the potential of the Milky Way halo over large Galactocentric distances and their detailed phase-space structure gives us clues as to the nature of dark matter. Powerful theoretical techniques are now available to re-construct the underlying potential from the six dimensional phase space parameters that describe stellar tracers. Notably absent from the presently available data-sets are full 3-D velocities. I will describe an ongoing project to remedy this situation that focuses on tracers that will provide the most powerful discriminant of halo shape and distribution, and what we ultimately hope to learn.

19:00-21:00 The meeting room is available for white paper working group discussions.

Session IX: Future Planning Discussion
(chair: Dr. Jocelyn Monroe)

Saturday, June 13

This session is open, feel free to prepare a few slides. If you would like to be listed in the agenda, please email the organizers at cygnus2009meeting AT gmail.com

9:00 The Cygnus Campaign,
Prof. Kentaro Miuchi, University of Kyoto, JP

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Talk abstract: I will discuss a proposal for a simultaneous observation campaign (DRIFT-NEWAGE-DMTPC-etc), as in the gravitational-wave community.

9:15 Directional Detection and DUSEL

Prof. Dan Snowden-Ifft, Occidental College, USA (TBC)

Prof. Peter Fisher, Massachusetts Institute of Technology, USA

9:45 Future Plans in Europe,

Prof. Neil Spooner, University of Sheffield, UK

10:00 Discussion

10:30 Coffee Break

Session X: White Paper Discussion

Saturday, June 13

(chair: Dr. James Battat)

11:00 White Paper Planning

Dr. James Battat, Massachusetts Institute of Technology, USA

Talk abstract: I will discuss progress on a white paper summarizing this workshop, in lieu of proceedings.

11:15 Reports from White Paper Working Groups

12:00 Discussion

12:30 End of Workshop

14:00-17:00 The meeting room is available for white paper working group discussions.

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