DMSS: A Dark Matter Summer School

Report of Contributions

Contribution ID: **2** Type: **not specified**

Introduction to Dark Matter

Monday 16 July 2018 09:00 (1h 30m)

Presenter: Dr BELLIS, Matt (Siena College)

Contribution ID: **3** Type: **not specified**

Supersymmetry

Monday 16 July 2018 10:45 (1h 30m)

Presenter: Dr FAN, JiJi (Brown University)

Contribution ID: **4** Type: **not specified**

Large Scale Structure Formation

Monday 16 July 2018 13:15 (1h 30m)

Presenter: Dr LIU, Jia (Princeton University)

Contribution ID: **5** Type: **not specified**

Roundtable Discussions

Monday 16 July 2018 14:45 (30 minutes)

Presenters: Dr BELLIS, Matt (Siena College); Dr FAN, JiJi (Brown University); Dr LIU, Jia (Princeton University)

Contribution ID: **6** Type: **not specified**

Dark Matter in the Milky Way

Tuesday 17 July 2018 08:30 (1h 30m)

Presenter: Dr NEWBERG, Heidi (Rensselaer Polytechnic Institute)

Contribution ID: **7** Type: **not specified**

Neutrinos

Tuesday 17 July 2018 10:15 (1h 30m)

Presenter: Dr BROWN, Ethan (RPI)

Contribution ID: **8** Type: **not specified**

Direct Detection of Dark Matter

Tuesday 17 July 2018 12:45 (1h 30m)

Presenter: Dr SZYDAGIS, Matthew (University at Albany)

Contribution ID: **9** Type: **not specified**

Roundtable Discussions

Tuesday 17 July 2018 14:15 (30 minutes)

Presenters: Dr NEWBERG, Heidi (Rensselaer Polytechnic Institute); Dr SZYDAGIS, Matthew (University at Albany, SUNY); Dr ZEMCOV, Mike (Rochester Institute of Technology)

Contribution ID: **10** Type: **not specified**

Indirect Dark Matter Searches

Wednesday 18 July 2018 08:30 (1h 30m)

Presenter: Dr SLATYER, Tracy (MIT)

Contribution ID: **11** Type: **not specified**

Statistical Methods used in Dark Matter

Wednesday 18 July 2018 10:15 (1h 30m)

Presenter: Dr HIMMEL, Alex (Fermilab)

Contribution ID: **12** Type: **not specified**

Axions

Thursday 19 July 2018 10:15 (1h 30m)

Presenter: Dr WINSLOW, Lindley (MIT)

Contribution ID: **13** Type: **not specified**

Cosmic Microwave Background

Thursday 19 July 2018 08:30 (1h 30m)

Presenter: Dr ZEMCOV, Mike (Rochester Institute of Technology)

Contribution ID: **14** Type: **not specified**

Non-SUSY Dark Matter

Thursday 19 July 2018 12:45 (1h 30m)

Presenter: Dr GIEDT, Joel (Rensselaer Polytechnic Institute)

Contribution ID: **15** Type: **not specified**

Roundtable Discussions

Thursday 19 July 2018 14:15 (30 minutes)

Presenters: Dr GIEDT, Joel (Rensselaer Polytechnic Institute); Dr WINSLOW, Lindley (MIT); Dr ZEMCOV, Mike (RIT)

Contribution ID: **16** Type: **not specified**

Dark Matter at the LHC

Friday 20 July 2018 08:30 (1h 30m)

Presenter: Dr SCIOLLA, Gabriella (Brandeis University)

Contribution ID: **17** Type: **not specified**

Dark Energy

Friday 20 July 2018 10:15 (1h 30m)

Presenter: Dr SEHGAL, Neelima (Stony Brook University)

Contribution ID: **18** Type: **not specified**

Roundtable Discussions

Friday 20 July 2018 12:45 (30 minutes)

Presenters: Dr SEHGAL, Neelima (Stonybrook University); Dr SCIOLLA, Gabriella (Brandeis University)

Contribution ID: **23** Type: **not specified**

Roundtable Discussions

Wednesday 18 July 2018 11:45 (30 minutes)

Presenters: Dr HIMMEL, Alex (Fermilab); Dr SLATYER, Tracy (MIT)

Contribution ID: **25** Type: **Talk (12+3min)**

Dark Matter search activity at the University of Montreal

Wednesday 18 July 2018 13:30 (15 minutes)

A brief overview of experimental activities at the University of Montreal is given concerning the search for the Dark Matter (DM) in the PICO experiment (SNOLAB, Ontario, Canada) as well as at the accelerator laboratory in Montreal. Newly proposed methods of DM detection using the superheated liquid gas will be briefly discussed.

Author: STARINSKI, Nikolai (University of Montreal)

Presenter: STARINSKI, Nikolai (University of Montreal)

Contribution ID: **26** Type: **Talk (12+3min)**

Extra Dimensions in High-Mass Diphoton Spectrum at 13 TeV

Thursday 19 July 2018 15:15 (15 minutes)

Among the proposed explanations for the hierarchy problem, or the relative weakness of gravity compared to the other fundamental forces, is the existence of extra dimensions. To test this, we probe the diphoton spectrum for high-mass events using proton-proton collisions at $\sqrt{s}$ = 13 TeV. We present here the analysis results using 2016 data, corresponding to a 35.9 fb^{-1} integrated luminosity, collected from the CMS detector of the Large Hadron Collider at CERN. Resonant and nonresonant signatures of extra dimensions are searched using different background estimation techniques. Limits were set for both the warped (resonant) and large extra dimensional (nonresonant) models. We also show preliminary work on improving sensitivity in this spectrum. In particular, we explore the angular distribution of the diphoton final states in preparation for the analysis of the 2017 data.

Authors: CMS COLLABORATION; PEREZ, Cilicia Uzziel (The University of Alabama); Dr HENDERSON, Conor (The University of Alabama); BUCCILLI, Andrew (The University of Alabama); Dr WEST, Christopher Alan (The University of Alabama)

Presenter: PEREZ, Cilicia Uzziel (The University of Alabama)

Contribution ID: **27** Type: **Talk (12+3min)**

The XENONnT Time Projection Chamber

Tuesday 17 July 2018 16:00 (15 minutes)

Dual-phase time projection chambers (TPCs) filled with liquid xenon (LXe) are a widely-used technique for the direct search for dark matter in the form of weakly interacting massive particles (WIMPs). One of the upcoming experiments exploiting this technique is XENONnT, which aims at Dark Matter detection through the scattering of WIMPs off the xenon nuclei. XENONnT will be filled with 8 t of ultra-pure liquid Xenon, out of which will be 5.9 t in the active TPC. XENONnT will be located at the Laboratori Nazionali del Gran Sasso (LNGS) in Italy, at an average depth of 3600 m water equivalent. After an overview on the XENONnT project, this talk will present the working principles of the XENONnT TPC as well as the lessons learned from the operating XENON1T.
This work is supported by the Federal Ministry of Education and Research of Germany (BMBF).

Author: Mrs ROCCHETTI, arianna (uni-freiburg)

Presenter: Mrs ROCCHETTI, arianna (uni-freiburg)

Contribution ID: **28** Type: **Talk (12+3min)**

Calibration of the XENON1T experiment at low energies using a Kr83m source

Thursday 19 July 2018 15:45 (15 minutes)

In the last century, several astrophysical observations have provided strong evidences of the existence of dark matter in the Universe. This dark matter, non-luminous, and weakly interactive with ordinary matter, could be composed of massive particles called WIMPs.

XENON1T, the third direct detection experiment designed by the XENON collaboration, consists of a dual-phase (liquid-gas) time projection chamber (TPC), filled with xenon. XENON1T is the largest TPC ever built for dark matter search and conceived to detect an elastic scattering of a WIMP with the target nuclei. The energy transfer during such interaction induces a low energy nuclear recoil (below 100 keV).

In order to study the detector response to an energy deposit, the XENON collaboration carries out several calibration campaign with different sources. In particular, an internal source of Kr83m, which emits two radiations at low energies (32.2 keV and 9.4 keV), is used to calibrate XENON1T in the energy range where dark matter is expected.

Since data taking period dedicated to the search for dark matter lasts for several months, it is essential to monitor the detector stability and to study its response over time: regular Kr83m calibrations are carried out for this purpose.

Keywords: dark matter, direct detection, XENON1T, calibration

Author: Ms THERREAU, Chloé (CNRS)

Presenter: Ms THERREAU, Chloé (CNRS)

Contribution ID: **29** Type: **Talk (12+3min)**

Gravitational-wave ringdown echoes from black holes in massive gravity

Monday 16 July 2018 15:45 (15 minutes)

LIGO's detection of the black hole quasinormal modes has proved the existence of the light rings outside the event horizon. Other sub-dominant long-lived modes depend on the existence and properties of the horizon, as well as the black hole hairs outside. These modes may reveal themselves in future gravitational-wave detectors as echoes. In this work, we study the ringdown of a de Sitter-Schwarzschild black hole in the dGRT theory of massive gravity. We find interesting signatures of ringdown echoes as we turn on the coupling between spacetime perturbations and the background vector field outside the black hole.

Author: DONG, Ruifeng (State University of New York at Buffalo)

Co-author: STOJKOVIC, Dejan (SUNY at Buffalo)

Presenter: DONG, Ruifeng (State University of New York at Buffalo)

Contribution ID: **30** Type: **Talk (12+3min)**

Atmospheric Tau Neutrino Appearance with IceCube/DeepCore

The IceCube Neutrino Observatory at the South Pole can measure atmospheric neutrinos at energies up to the TeV scale. DeepCore is the low-energy subarray that provides sensitivity in the neutrino energy range from roughly 10 GeV to 100 GeV, where Earth-crossing neutrinos are subject to oscillations. These neutrinos are muon and electron neutrinos produced in Earth's atmosphere via decays of particles from interactions between cosmic rays and the atmosphere. The primary oscillations detected are from muon neutrinos to tau neutrinos. I present the measurement of tau neutrino appearance using three years of IceCube-DeepCore data.

Author: HUANG, Feifei

Presenter: HUANG, Feifei

Contribution ID: **31** Type: **Talk (12+3min)**

Performance and Results of the COSINE-100 Experiment

Thursday 19 July 2018 16:30 (15 minutes)

COSINE-100 is a NaI(Tl) dark matter direct detection experiment, with the goal of testing DAMA's claim of dark matter detection by looking for an annual modulation signal. It consists of eight NaI(Tl) crystals, adding to a total of 106 kg, and 2000 liters of a liquid scintillator veto. Located at the Yangyang Underground Laboratory, South Korea, COSINE-100 has been running since September 2016. We observe a background rate of ˜3 counts/kg/keV/day between 2 and 6 keV and have performed several analyses based on the current energy threshold of 2 keV. I will present on the detector performance and recent results.

Author: BARBOSA DE SOUZA, Estella (Yale University)

Presenter: BARBOSA DE SOUZA, Estella (Yale University)

Contribution ID: **32** Type: **Talk (12+3min)**

Searching for signatures of dark matter using TeV gamma rays from the Sun with HAWC

Monday 16 July 2018 16:15 (15 minutes)

Very high energy gamma rays up to 200 GeV have been observed from the quiescent Sun. While this emission is thought to originate from hadronic cosmic rays interacting in the Sun's atmosphere, the mechanism is not well understood. Another potential source of gamma rays from the Sun is gravitationally captured dark matter. Weakly interacting massive particles (WIMPs) accumulating in the solar core can annihilate to long-lived mediators, which then decay to Standard Model particles. Gamma-ray emission from this process depends on the mass of the WIMPs, but is expected to become important above 1 TeV. Thus measurements of the Sun at TeV energies are crucial to constrain the properties of the WIMPs. The High Altitude Water Cherenkov (HAWC) Observatory is a wide field-of-view air shower array that is currently the only detector capable of measuring gamma rays from the Sun at multi-TeV energies. We present results from a search for excess gamma rays from the Sun using three years of data from HAWC. Our measurements provide the strongest upper limits on TeV gamma rays from the solar disk. We discuss the implications of these measurements on the origin of the solar gamma rays and present constraints for the spin-dependent WIMP-proton scattering cross section for masses above 1 TeV.

Author: NISA, Mehr Un (University of Rochester)

Presenter: NISA, Mehr Un (University of Rochester)

Contribution ID: **33** Type: **not specified**

HAYSTAC Dark Matter Axion Experiment

Thursday 19 July 2018 15:00 (15 minutes)

The HAYSTAC experiment looks for axions, a type of cold dark matter (CDM) particle predicted in the context of the standard model of electroweak interactions. If they exist, axions fall very low on the mass scale, and their presence could be detected when they convert to radiofrequency photons in the presence of a strong magnetic field. HAYSTAC consists of a microwave cavity resonator that is tunable and builds up the axion signal to a point where it is detectable, and a quantum limited amplifier that exploits the Josephson effect. I will discuss is current status, and plans for the upcoming run.

Author: VAN ASSENDELFT, Cady (Yale University)

Presenter: VAN ASSENDELFT, Cady (Yale University)

Contribution ID: **34** Type: **Talk (12+3min)**

Krypton Ingress Surveillance of LUX-ZEPLIN Prototype Cylinder

Thursday 19 July 2018 16:15 (15 minutes)

LUX-ZEPLIN is dark matter direct detection experiment which will take data a mile underground in Lead, South Dakota starting in 2020. Krypton backgrounds must be minimized to decrease backgrounds to an acceptable level. Special cylinders fitted with purge volumes around the neck of the cylinders will be constructed to store the xenon. The cylinders have an upper limit of 15 parts-per-quadrillion g_{Kr}/g_{Xe} when filled and a maximum ingress rate of 6 ppq/year g_{Kr}/g_{Xe} while in storage. Characterization of the prototype 80-kg cylinder, Cylinder ID LZ-R3d-CYL-01, concluded that LZ will meet the maximum ingress rate using LN boil-off as a purge gas for the fitted N\textsubscript{2} purge volume. We show that we can achieve a rise in krypton concentration of 4.08 ± 0.20 ppq/year while the volume around the neck of the prototype LZC is purged with LN boil-off.

Author: Mr SWANSON, Nat (University of Maryland)

Presenter: Mr SWANSON, Nat (University of Maryland)

Contribution ID: **35** Type: **Talk (12+3min)**

Calculating the rotation curve due to visible matter in the Milky Way Galaxy

Wednesday 18 July 2018 14:15 (15 minutes)

In the Milky Way Galaxy, the rotation curve is related to the mass distribution of visible matter and dark matter. By comparing the measured rotation curve with the calculated rotation curve due to visible matter, we can determine the mass density of dark matter in our galaxy. The components of visible matter includes the black hole at the center of our galaxy, the two bulges, and the galactic disk. Due to their spherical symmetry (and the shell theorem) calculating the gravitational force due to the black hole and the bulges is relatively simple. Surprisingly, calculating the gravitational force due to the galactic disk is much harder. We break up the disk into numerous rings, calculate the gravitational force due to each ring, and sum the forces due to all rings. The total gravitational force, due to these four mass distributions, can be used to calculate the rotation curve due to visible matter. Using the measured rotation curve, we extract the rotation curve due to the dark matter in our galaxy. The rotation curve can be used to determine the mass distribution of the dark matter in our galaxy.

Author: QIE, Yufan

Presenter: QIE, Yufan

Contribution ID: **36** Type: **Talk (12+3min)**

The LZ Trigger

Monday 16 July 2018 16:30 (15 minutes)

The LUX-ZEPLIN (LZ) experiment aims to directly detect WIMP particles interacting with xenon nuclei. These interactions produce scintillation and ionization signals within the active region of the detector which identify their presence. It is the goal to trigger correctly on ionization pulses that come from WIMPs and to avoid triggering on dark current from PMTs. This presentation demonstrates the process of identifying the criteria for a trigger decision.

Author: Ms LONIEWSKI, Christina (University of Rochester)

Presenter: Ms LONIEWSKI, Christina (University of Rochester)

Contribution ID: **37** Type: **Talk (12+3min)**

Development of Cryogenic Thermal Detectors for Sub-GeV Dark Matter

Tuesday 17 July 2018 15:15 (15 minutes)

An important topic in dark matter research is the search for sub-GeV dark matter. Direct detection searches for sub-GeV dark matter can be conducted through scattering on Silicon nuclei utilizing a detector with energy threshold on the order of 10 eV. This low threshold can be achieved by thermalizing a Transition-Edge Sensor (TES) based detector with gram scale silicon absorbers. This talk describes the design of a 10 eV threshold TES based detector as well as recent fabrication and testing progress.

Author: PINCKNEY, Harold (University of Massachusetts at Amherst)

Co-authors: CHANG, Clarence (Argonne National Lab); Prof. FIGUEROA-FELICIANO, Enectali (Northwestern University); WANG, Gensheng (Argonne NAtional Laboratory); Dr BASTIDON, Noemie (Northwestern University); Dr NOVOSAD, Valentine (Argonne National Lab); Dr YEFREMENKO, Volodymyr (Argonne National Lab); Dr HONG, Ziqing (Northwestern University)

Presenter: PINCKNEY, Harold (University of Massachusetts at Amherst)

Contribution ID: **38** Type: **not specified**

Opening Remarks: Keith Earle, Chair of the Physics Department

Monday 16 July 2018 08:30 (15 minutes)

Contribution ID: **39** Type: **not specified**

Opening Remarks: Satyendra Kumar, Vice-President of Research

Monday 16 July 2018 08:45 (15 minutes)

Contribution ID: **40** Type: **not specified**

Closing Remarks: Susanna Fessler, Associate Dean of Arts and Science

Friday 20 July 2018 14:15 (15 minutes)

Contribution ID: **42** Type: **Talk (12+3min)**

Snowball Chamber: A Super-cooled Approach to Dark Matter Detection

Wednesday 18 July 2018 14:00 (15 minutes)

As higher mass particles are eliminated as possibilities in the search for dark matter, it is important to explore new types of detectors that are more specialized at looking for lower mass particles. For this purpose, super-cooled water has been explored as a target material for future detectors. This talk will go over the motivations for a detector of this type, the operational data that has been collected—including the first evidence of radiation induced nucleation of super cooled water, and additional applications beyond searching for dark matter.

Author: Mr KNIGHT, Corwin (UAlbany)

Presenter: Mr KNIGHT, Corwin (UAlbany)

Contribution ID: **43** Type: **Talk (12+3min)**

Search for Millicharged Particles using an Optical Trap

Thursday 19 July 2018 15:30 (15 minutes)

Standard searches for dark matter attempt to identify interactions with dark matter particles; a complementary search would involve looking for "dark forces". As an example, if a dark force mediated by a "dark photon"exists, dark matter particles could pick up a tiny electric charge due to kinetic mixing with normal photons. Stable millicharged dark matter particles could become bound in matter, and potentially be detected by using an optical trap to measure the response to an applied electric field on a charge-neutral object that may contain such particles. This is a very well-isolated system, with an acceleration sensitivity on the order of 500 n$g/\sqrt{\text{Hz}}$ for a 20um diameter SiO^2 levitated sphere. Within this experiment, the acceleration sensitivity can be translated to a fractional electron number sensitivity of 10^{-7}electrons$/\sqrt{\text{Hz}}$ regardless of the mass of the millicharged particle, allowing exploration of uncharted regions of parameter space for such dark matter candidates.

Authors: Dr MONTEIRO , Fernando (Yale University); GHOSH, Sumita (Yale University); MOORE, David (Stanford University)

Presenter: GHOSH, Sumita (Yale University)

Contribution ID: **44** Type: **Talk (12+3min)**

Radon Screening for the LZ Dark Matter Experiment

Tuesday 17 July 2018 15:00 (15 minutes)

John Armstrong
University of Maryland
DMSS Abstract

Modern dark matter direct detection experiments such as LUX-Zeplin require low backgrounds to reach sensitivities necessary to claim detection. When deep underground and isolated from cosmic rays, the dominant backgrounds come from radioactive impurities. While a getter can effectively remove electronegative impurities, noble gas impurities must be removed from the xenon volume using other methods or screened. The radioisotope ^{222}Rn is particularly difficult to eliminate because it emanates from trace amounts of ^{226}Ra contained in detector components. It is necessary to screen detector components for ^{222}Rn before assembly to reduce and quantify the radon burden. We make use of an electrostatic chamber with a PIN diode target to collect and count radon daughters of detector components. I will discuss some of the more relevant analysis techniques and results in this talk.

Author: Mr AMSTRONG, John (University of Maryland)

Presenter: Mr AMSTRONG, John (University of Maryland)

Contribution ID: **45** Type: **Talk (12+3min)**

Demonstrating Parts Per Quadrillion Sensitivity of Krypton in Xenon gas

Thursday 19 July 2018 16:00 (15 minutes)

Krypton 85 is a long lived source of electron recoil backgrounds in LUX-ZEPLIN (LZ), a large scale 2-phase liquid xenon time projection chamber (TPC). Being a noble gas makes krypton difficult to remove using getters, and its long half life compared to the livetime of LZ (5 years), means that krypton impurities must be measured and tracked throughout xenon preparation, and use in the detector. The concentration of krypton must remain below the allowed concentration of 15 ppq. This talk outlines the motivation, equipment, and procedure to quantify ppq levels of krypton impurities.

Author: SILK, John

Presenter: SILK, John

Contribution ID: **46** Type: **Talk (12+3min)**

Study of radon reduction in gases for rare event search experiments

Tuesday 17 July 2018 15:30 (15 minutes)

In noble liquid detectors searching for rare interactions, radon, a decay product of trace amounts of natural uranium present in detector components, leads to the dominant background of the detector. The results of the R&D studies of radon reduction system for noble liquid detectors preformed at The University of Michigan will be presented. The adsorption characteristics of radon in nitrogen, argon, and xenon carrier gases on various types of charcoals with different adsorbing properties and intrinsic radioactive purities have been studied in the temperature range of 190-295 K at flow rates of 0.5 and 2 standard liters-per-minute. Performances of different charcoals have been quantified using parameters such as average breakthrough time, dynamic adsorption coefficient, and number of theoretical stages.

Authors: PUSHKIN, K.; AKERLOF, C.; ANBAJAGANE, D.; ARMSTRONG, J.; ARTHURS, M.; BRINGEWATT, J.; EDBERG, T.; HALL, C.; RAYMOND, R.; SAINI, D.; SANDER, A.; SCHAEFER, J.; SEYMOUR, D.; SWANSON, N.; WANG, Y.; LORENZON, W.

Presenter: ARTHURS, M.

Contribution ID: **47** Type: **Talk (12+3min)**

Mitigating Single-Electron Backgrounds in Liquid Xenon TPCs

Tuesday 17 July 2018 16:45 (15 minutes)

Many leading WIMP direct detection experiments use liquid xenon as a target to observe scattering dark matter. Currently, these detectors search for WIMPS in the GeV-TeV mass energy range, and require larger and larger detectors to gain sensitivity. An alternate analysis channel investigates the energy spectrum of individual extracted electrons. Through this channel, xenon TPCs, regardless of size, may be sensitive to MeV/c^2 dark matter. However, backgrounds from so-called electron trains make this analysis challenging. The focus of the new LBECA collaboration is to design a small xenon TPC with minimal single-electron backgrounds to search for dark matter through this analysis channel. This talk presents the progress of the LBECA Collaboration in identifying leading sources of these backgrounds and in the work to reduce them, with the goal of rapidly realizing a dedicated low-mass dark matter search experiment.

Author: KOPEC, Abigail (Purdue University)

Presenter: KOPEC, Abigail (Purdue University)

Contribution ID: **48** Type: **Talk (12+3min)**

Internal Calibration Source Injection in Liquid Xenon Time Projection Chambers

Tuesday 17 July 2018 16:15 (15 minutes)

Self-shielding in ton-scale liquid xenon (LXe) time projection chambers (TPCs) presents a unique challenge for calibrating detector response to interactions in the TPCs innermost LXe volume. Calibration isotopes must be injected directly into the LXe to reach the central volume of the TPC, where they must either decay away with a short half life, or be purified out. I present a summary of the hardware effort at UMass Amherst, which is designed to refine techniques for the injection and removal of precise activities of various calibration isotopes that are useful in LXe TPC experiments such as LUX-ZEPLIN.

Author: NEDLIK, Christopher (University of Massachusetts Amherst)

Presenter: NEDLIK, Christopher (University of Massachusetts Amherst)

Contribution ID: **49** Type: **Talk (12+3min)**

Electron Trains in LXe TPCs

Tuesday 17 July 2018 16:30 (15 minutes)

XENON1T is a liquid xenon time projection chamber (TPC) designed to look for elastic recoils of dark matter particles with xenon nuclei. To increase the sensitivity of the experiment, we need to decrease the background in the detector. One background that is specific to low-energy recoils comes from so called single electrons trains that follow interactions in the TPC over time scales of hundreds of milliseconds. To mitigate this background, we first need to understand where it comes from. This talk will discuss different theories for these electron trains and how I test these ideas through analysis of XENON1T data.

Author: DEPOIAN, Amanda (Purdue University)

Presenter: DEPOIAN, Amanda (Purdue University)

Contribution ID: **50** Type: **Talk (12+3min)**

222Rn-related background in nEXO

Friday 20 July 2018 13:30 (15 minutes)

nEXO (next-generation Enriched Xenon Observatory) is a proposed experiment to search for neutrinoless double beta (0νββ) decay of 136Xe with a projected half-life sensitivity of ~10^28 years using 5×10^3 kg of isotopically enriched liquid-xenon in a time projection chamber (TPC). Targeting this sensitivity requires addressing and reducing the backgrounds in the detector. Of particular interest is the 222Rn daughter 214Bi, whose decay includes a γ-ray line at 2448 keV, close to the 136Xe 0νββ decay Q-value of 2458.07 ± 0.31 keV. 214Bi decays are followed in close time-succession by the alpha decay of 214Po. These pairs of correlated decays are easy to tag if they occur in the bulk of detector. However, 214Bi that drift and decay at the cathode are tagged with much reduced efficiency and represent a non-negligible background for nEXO. Using data from EXO-200, ~80% of 214Bi decays in nEXO will occur at the cathode. Additionally, 214Bi decays occurring behind the TPC field cage can also contribute to nEXO background if they cannot be tagged using scintillation-only BiPo coincidences. We explore strategies to identify event-by-event and with high efficiency the 214Bi decays at the nEXO cathode and in the xenon outside the field cage. This study includes optimizing the light collection efficiency for alpha and beta decays occurring on detector surfaces, as well as careful design of the cathode electrode.

Author: FEYZBAKHSH, Sara (UMass Amherst)

Presenter: FEYZBAKHSH, Sara (UMass Amherst)

Contribution ID: **51** Type: **Talk (12+3min)**

Angular Resolution of a Solid State 0vbb-Decay Detector

Friday 20 July 2018 13:45 (15 minutes)

The search for neutrinoless double beta decay has spawned dozens of detectors looking for this rare decay and to determine whether neutrinos are Majorana or Dirac particles. Majorana neutrinos are required for most See-Saw Mechanisms for mass generation, as well as many models of sterile neutrinos, but is severely limited in what mechanisms it can rule out. Should a discovery be made, the next stage in 0vbb research requires the ability to resolve the angular/energy spectrum of 0vbb-decay. This spectrum is dominated by various nuclear processes as as well as different mass generation mechanisms and right/left handed current mixing for neutrinos. Making measurements of these spectra would then shed light on the nature of heavy right handed neutrinos and neutrino generation. Presented is preliminary work for a thin-film tracking calorimeter based of CdTe semiconductor research. This design allows for investigation of multiple 0vbb candidate isotopes simultaneously, and the tracking ability provides both a significant background reduction by means of vetoing external sources, and the ability to discern angular spectra. The design and simulation of this detector is done with Geant4 simulation toolkit, and convolutional neural net development has begun with simulated signals to resolve energy and and angle of the two emitted electrons.

Author: Mr ODGERS, Kelly (RPI)

Presenter: Mr ODGERS, Kelly (RPI)

Contribution ID: **52** Type: **Talk (12+3min)**

Superheated Droplet Geyser Based on Water

Wednesday 18 July 2018 13:45 (15 minutes)

Weakly interacting massive particles (WIMPS), the leading candidate for dark matter, interacts differently than what we would expect with ordinary baryonic matter. These interactions require very sensitive detectors. Being much cheaper than xenon, when superheated, ultra-purified water can act as a sensor to detect these rare events. Alongside replicating other WIMP detectors the bubble chamber can also be used to validate through detection of neutrons, which should elastically scatter through the same mechanism as dark matter. The design of this sensor consists of four essential parts: an temp-adjustable hotplate, a thermal bath, a test tube that holds both the metastable liquid and oil that acts as a surface tension buffer, and a recondenser that is attached to the test tube. We've reached the rate of one major event per minute. The approximate average cosmic-ray background, dominated by GeV-scale muons near sea level, and partially verified that a statistically significant increase in rate occurs in the presence of neutron sources like AmBe or Cf-252, but not in gammas.

Author: ELLIS, Anthony (SUNY Albany)

Presenter: ELLIS, Anthony (SUNY Albany)

Contribution ID: **53** Type: **not specified**

Reconstructing Double Neutron Scatters in XENON1T

Monday 16 July 2018 16:00 (15 minutes)

Many dark matter search experiments active today, and to be activated in the future, utilize xenon as a target mass in dual phase time projection chambers (TPC). Although xenon has seen widespread use in liquid noble gas detectors, and is currently employed by the XENON1T, LUX, and PandaX-II detectors; the process of energy deposition for nuclear recoils in liquid xenon is not precisely understood. This process has been described from first principles and measured precisely in the cases of liquid helium and argon, but this remains prohibitively difficult in the case of liquid xenon. The XENON1T detector possesses an external mono-energetic neutron source via deuterium-deuterium plasma fusion, producing neutrons with peaks at 2.2 Mev and 2.7 Mev. This research aims to reconstruct double scatter events using these mono-energetic neutrons, thus providing valuable information to constrain present understanding of energy deposition for nuclear recoils in liquid xenon.

Author: SWORDY, Leaf (Xenon ar RPI)

Presenter: SWORDY, Leaf (Xenon ar RPI)

Contribution ID: **54** Type: **Talk (12+3min)**

Machine Learning for Classification and Data Analysis in XENON1T

Wednesday 18 July 2018 13:15 (15 minutes)

An important step in the XENON1T analysis pipeline is distinguishing electronic recoil events (ERs) from nuclear recoil events (NRs) inside the detector. ERs come from background, while NRs are evidence of a possible signal. This is currently done by hand using a profile likelihood method. The goal is to maximize the acceptance of correctly classified NRs while rejecting as many ERs as possible; this step has a significant impact on the amount of background that can be discarded and therefore the sensitivity of the detector. This is a binary classification problem, a well-understood domain for machine learning and one of its major strengths. Various supervised learning algorithms were tested on calibration data. The best-performing algorithm, a support vector machine (SVM), approximately matched but did not exceed the performance of the profile likelihood method. Various ways that the quality of the dataset affects the performance of machine learning algorithms are discussed. It is shown that machine learning has a comparative advantage over manual statistical analysis only when dealing with large, high-dimensional, poorly-understood datasets. Although many different types of data are collected on each recoil event, most of it can be used to distinguish calibration events from run events, invalidating its use for machine learning. A more promising approach is to use exploratory machine learning techniques to augment human analysis.

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Contribution ID: **55** Type: **Talk (12+3min)**

Studying the presence of krypton-85 in the DarkSide detector

Thursday 19 July 2018 16:45 (15 minutes)

Significant evidence, both astrophysical and cosmological, points to the existence of dark matter. The fundamental nature of dark matter, however, remains unknown. One appealing candidate for dark matter is the weakly interacting massive particle (WIMP). Direct detection experiments aim to observe the low energy scattering of WIMP particles off normal matter, and detectors based on noble liquid technology lead the way in WIMP sensitivity at high WIMP masses. To this day, no conclusive WIMP signals have been observed. The DarkSide experiment uses a liquid argon target in a dual-phase time projection chamber to search for WIMP dark matter. The DarkSide-50 (DS-50) experiment is located at Gran Sasso National Laboratory (LNGS) in Italy and its argon target comes from underground sources, shown to have much reduced 39Ar radioactivity compared to atmospheric argon. It nonetheless (and somewhat unexpectedly) contains measurable amounts of the radioactive contaminant 85Kr.
The work described in this talk covers the analysis of Monte Carlo simulated as well as real data from the DS-50 detector to search for a tell-tale delayed coincidence signature of 85Kr decays to the 85mRb state. The results of this search provide valuable information about the backgrounds inside of the detector as well as on its energy and spatial resolution, thus aiding in the search for WIMPs.

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Contribution ID: **56** Type: **Talk (12+3min)**

Measurement of Background Gamma Flux in the Davis Cavern for the LZ Experiment

Monday 16 July 2018 15:30 (15 minutes)

The LUX-ZEPLIN (LZ) experiment will search for dark matter particle interactions with a liquid xenon TPC in the Davis cavern at the Sanford Underground Research Facility, Lead, South Dakota, 4850 feet below the surface. The underground environment reduces the cosmic ray flux by a factor of 10^6, but there remains a potential background from γ-rays emitted from the decays of ^{40}K, ^{238}U and ^{232}Th naturally occurring in the rock surrounding the laboratory. In-situ γ-ray measurements were taken with a sodium iodide detector in several locations within the cavern, yielding average radioactivity levels. We will present the radioactivity levels determined with these measurements, and a first attempt at mapping suspected non-uniformities in the γ-flux due to differences in rock composition.

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Contribution ID: **57** Type: **not specified**

TBD

Contribution ID: **58** Type: **not specified**

TBD

Contribution ID: **59** Type: **Talk (12+3min)**

The Noble Element Scintillation Technique Version 2.0 (NESTv2.0)

Tuesday 17 July 2018 15:45 (15 minutes)

The latest release of the Noble Element Scintillation Technique (NEST) is presented here. Noble element target media have become common in rare event searches, and an accurate comparison model is critical for understanding and predicting signals and unwanted backgrounds. Like its predecessors, NESTv2.0 is a simulation tool written in C++ and is based heavily on experimental data, taking into account most of the existing ionization and scintillation data for solid, liquid, and gaseous xenon. Due to the large amount of precise data for liquid xenon, most theoretical models in NEST have been replaced with simple,well-behaved, empirical formulas, such as sigmoids and power laws. NESTv2.0 also uses an empirical, non-binomial, recombination fluctuations model. In addition, NESTv2.0 simulates S1 and S2 scintillation signals with correct energy resolutions in dual-phase xenon time-projection chambers, and this is done without using an external package. While NEST can be used with GEANT, NESTv2.0 is fully capable of operating as a stand-alone command-line tool.

Authors: RISCHBIETER, Gregory; NEST COLLABORATION

Presenter: RISCHBIETER, Gregory

Contribution ID: **60** Type: **Talk (12+3min)**

DAMIC - Dark Matter In CCD: Looking for Dark Matter with CCDs

Friday 20 July 2018 14:00 (15 minutes)

DAMIC for Dark Matter in CCDs, will search for dark matter particle interaction with silicon CCDs. The experiment takes place at SNOLAB where 8 CCDs are used. We measure the energy spectrum of ionization events in the bulk silicon of charge-coupled devices down to a signal of 60 eV electron equivalent. Thus it's necessary to measure and understand our background noise. I will give an introduction on the DAMIC experiment (pros and cons of the CCDs, Dark Matter Particles). Then I will give a presentation of the different works produced to evaluate the background noise (Geant4 simulations, Analysis of the data).

Author: Mr DA ROCHA, Joao (LPNHE)

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Contribution ID: **61** Type: **Talk (12+3min)**

Detector design for the precise measurement of scintillation light in liquid xenon

Friday 20 July 2018 13:15 (15 minutes)

Liquid Xenon detectors are playing a pivotal role in the search for both dark matter and neutrinoless double beta decay. The principle of these detectors is based upon the measurement of scintillation light from the liquid xenon. The light response of these detectors to nuclear and electronic recoils must therefore be particularly well understood. While many such calibrations have been performed before, none have ever been done spanning a full energy range from sub-keV to MeV. As liquid xenon detectors are getting bigger and more multiphysics oriented, such a full calibration becomes not only important but necessary. To do this, a liquid xenon detector is being built at UAlbany. Once the detector's response to light is properly modelled for both nuclear and electronic recoils, this detector will be used to investigate means of increasing scintillation yield in liquid xenon.

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Presenter: FUCARINO, Andrew (Rensselaer Polytechnic Institute)

Contribution ID: **62** Type: **Talk (12+3min)**

Developing a search for annual modulation of various elements in atmospheric aerosols

Wednesday 18 July 2018 14:30 (15 minutes)

If dark matter interacts weakly then one possible experimental signal would be an annual modulation in the interaction rate caused by the combined motion of the sun and earth moving through the dark matter halo. The DAMA-LIBRA experiment has observed such a modulation in their detector in a way not described by known modulating backgrounds such as atmospheric muon rate (thickness/density of atmosphere), radon gas, or solar neutrino interactions (apogee/perigee effect). In this talk, we describe the prototype development of a device to collect aerosols on a daily basis to search for modulations of atmospheric concentrations of elements which have naturally occurring radioactive isotopes like potassium. Depending on the size of the effect, this background process could theoretically be misinterpreted as a dark matter signal.

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