The 59th Winter Nuclear & Particle Physics Conference (WNPPC2022)

Report of Contributions

Contribution ID: **2** Type: **Nuclear Structure**

Electromagnetic Transition Rate Studies in 28Mg

Tuesday, 15 February 2022 08:24 (12 minutes)

Neutron rich Mg isotopes far from stability belong to the island of inversion, a region where the single particle energy state description of the shell model breaks down and the predicted configuration of the nuclear states becomes inverted. Nuclei in this region also exhibit collective behaviour in which multiple particle interactions play a significant role in nuclear wavefunctions and transitions. This can be observed through electromagnetic transition strength measurements.

In-beam reaction experiments performed at TRIUMF, Canada's particle accelerator centre, allow for precision measurements of nuclei far from stability. Using TIGRESS in conjunction with the TIGRESS Integrated Plunger for charged particle detection, electromagnetic transition rates can be measured to probe nuclear wavefunctions and perform tests of theoretical models using the well-understood electromagnetic interactions.

In this talk, I will discuss an experiment performed using TIGRESS and the TIGRESS Integrated Plunger to measure the lifetime of the first excited state in ^{28}Mg. This experiment utilized both the Doppler Shift Attenuation Method and the Recoil Distance Method, which exploit the Doppler shift of gamma rays emitted in flight, in order to be sensitive to both short- and long-lived states in the nucleus. The current state of data analysis and the impacts on nuclear physics will be discussed.

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Please select: Experiment or Theory

Experiment

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Session Classification: Nuclear Physics

Contribution ID: **3** Type: **Dark Matter Searches**

The ANITA Anomalous Events and Axion Quark Nuggets

Wednesday, 16 February 2022 10:12 (12 minutes)

The Antarctic Impulse Transient Antenna (ANITA) collaboration have reported observation of two anomalous events with noninverted polarity. These events are proven to be hard to explain in terms of conventional cosmic rays (CRs). We propose that these anomalous events represent the direct manifestation of the
dark matter (DM) annihilation events within the so-called axion quark nugget (AQN) DM model, which was originally invented for completely different purpose to explain the observed similarity between the dark and the visible components in the Universe, i.e. $\Omega_{\rm DM} \sim \Omega_{\rm vis}$ without any fitting parameters. We support this proposal by demonstrating that the observations, including the frequency, intensity and time duration of the radio pulses nicely match the emission features of the upward going AQN events. We list a number of features of the AQN events which are very distinct from conventional CR air showers. The observations (non-observation) of these features may substantiate (refute) our proposal.

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Please select: Experiment or Theory

Theory

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Session Classification: Dark Matter Searches

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

Direct Population and Lifetime Measurement of the 2_1^+ State in ^{40}Ca via an Alpha-transfer Reaction

Tuesday, 15 February 2022 08:36 (12 minutes)

At TRIUMF, Canada's particle accelerator centre, the TIGRESS Integrated Plunger (TIP) and its configurable detector systems have been used for charged-particle tagging and light-ion identification in Doppler-shift lifetime measurements using gamma-ray spectroscopy with the TIGRESS array of HPGe detectors. An experiment using these devices to measure the lifetime of the 2_1^+ state of ^{40}Ca has been performed by projecting an ^{36}Ar beam onto a $^{\mathrm{nat.}}$C target. Analysis of the experimental gamma-ray spectra confirmed the direct population of the 2_1^+ state. The reaction mechanism was identified using Monte-Carlo simulations, which also enabled the use of charged-particle correlations to select reactions that populated a specific excited state in the ^{40}Ca immediately after its production. Selection of the 2_1^+ state with this additional sensitivity further eliminated feeding cascades, and therefore restricted the decay kinetics predominantly to first order. The current work is on expanding the simulation to incorporate the stopping of the ^{40}Ca and enabling the emission of gamma rays to provide a Doppler Shift Attenuation Method measurement of the lifetime of the 2_1^+ state in ^{40}Ca. Results of analysis of the experimental data and simulations will be presented and discussed.

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Experiment

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Session Classification: Nuclear Physics

Contribution ID: **5** Type: **QCD and Hadrons**

Simulating an Active Target Time Projection Chamber

Thursday, 17 February 2022 10:00 (12 minutes)

The A2 Collaboration uses the Mainz Microtron to conduct measurements probing hadron structure. An upcoming experiment will study Compton scattering off of helium-3 to obtain the polarizabilties of the neutron. To get a full picture of these events and reduce backgrounds, an active target is required. We intend to use a compact Time Projection Chamber (TPC) for this purpose, in combination with our existing CB-TAPS photon detector set-up.
In preparation for this experiment, I have been simulating the TPC in Geant4, and implementing an event reconstruction framework in the A2 data analysis software. Various limitations in Geant4 have made this project more challenging than expected, but the resulting simulation will help design electronics for the detector and optimize experimental parameters, to make the best possible measurement of the neutron polarizabilities.

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Experiment

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Session Classification: Scattering and Electrons

Contribution ID: **7** Type: **Nuclear and Particle Physics**

Mirror Symmetry in the $f_{1/2}$ Shell Below ^{56}Ni, Excited States and Electromagnetic Transition Rates in ^{55}Ni and ^{55}Co

Tuesday, 15 February 2022 08:48 (12 minutes)

Experiment S1758 aims to explore the charge dependence of the strong nuclear interaction by probing ^{55}Ni and ^{55}Co near the *doubly magic* ^{56}Ni. This will be achieved by impinging beams of radioactive ^{20}Na and stable ^{20}Ne upon ^{40}Ca targets to produce ^{55}Ni and ^{55}Co, respectively. Charged particles and γ-rays will be detected by combining TRIUMF-ISAC Gamma-Ray Escape Suppressed Spectrometer (TIGRESS), the TIGRESS Integrated Plunger (TIP) and the CsI Ball. This trio allows for a higher degree of sensitivity when in unison. Data analysis will involve: transition rate reconstruction using the Doppler-Shift Attenuation Method (DSAM), Doppler-shift lineshape profile extraction from Monte Carlo simulations via the GEANT4 framework, and lifetime extraction from minimizing a χ^2 goodness-of-fit between the measured and simulated lineshapes. The results will paint a clearer picture of the charge dependence of the strong nuclear interaction.

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Experiment

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Session Classification: Nuclear Physics

Contribution ID: **8** Type: **Dark Matter Searches**

Discovering Composite Dark Matter with the Migdal Effect

Wednesday, 16 February 2022 10:36 (12 minutes)

An intriguing possibility for dark matter is that it formed bound states in the early Universe, in a scenario called "composite"dark matter, much like the Standard Model fundamental particles formed nucleons, nuclei and atoms. One of the simplest composite dark matter models consists of dark matter fermions bound together by a real scalar field. Composite states that are massive enough source scalar fields so intense that nuclei, when coupled to this force, can recoil upon contact to energies capable of ionization through the Migdal effect. Combined with the large sizes of these composites, the ionization signal produced by their transit at dark matter experiments is detectable even for minuscule couplings between nuclei and the dark matter. In this talk, I will discuss the discovery prospects of composite states at noble element detectors like Xenon-1T and other underground experiments by considering the Migdal effect.

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Theory

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Session Classification: Dark Matter Searches

Contribution ID: **9** Type: **Nuclear and Particle Physics**

ATLAS Luminosity Measurement and Long Term Stability Studies with ATLAS-TPX Network During Run-2

Friday, 18 February 2022 13:48 (12 minutes)

A network of 15 pixelated detectors based on Timepix ASICs was installed in ATLAS cavern to measure the Radiation Field composition and Luminosity during CERN-LHC Run 2. The Timepix detectors are capable of measuring Luminosity with 5 different algorithms namely Cluster Counting Algorithm, Hit Counting Algorithm, Total Deposited Energy Algorithm, Thermal Neutron Counting Algorithm and MIPs (Minimum Ionizing Particles) Counting Algorithm. In addition to measuring the number of proton-proton collisions at the Interaction Point, these finely segmented detectors (55um Pitch) allow a high-quality track reconstruction which helps to identify the particle types.

Different algorithms that were developed for Luminosity measurement were tested by comparing the Integrated Luminosity measurements with other ATLAS Luminosity detectors. Most algorithms show good agreement with other ATLAS Luminometers, while some algorithms showed slight disagreements which opened the door for crucial studies like track overlapping correction and Activation measurement in ATLAS cavern. Each algorithm comes with its statistical and systematic uncertainties.

Study of the Long-Term Stability of the LUCID calibration is of paramount importance because it adds a major contribution to the total uncertainty in the ATLAS Luminosity measurement. These studies are important to ensure that the Van der Meer calibration of LUCID is valid throughout the data taking year. We have conducted Long Term stability studies with the ATLAS-TPX network for the complete Run-2. We propose to present results from different Luminosity measurement algorithms and Long-Term Stability studies for the year 2016, 2017 and 2018 with ATLAS-TPX network. We also propose to present the status report of ATLAS-Timepix3 network which is the upgrade for the CERN-LHC Run-3. The next generation Timepix3 pixel detectors promise a much better performance in ATLAS Cavern and are synchronized with the LHC clock.

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Please select: Experiment or Theory

Experiment

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Presenter: USMAN, Muhammad (Universite de Montreal)

Session Classification: Particle Physics

Contribution ID: **10** Type: **Dark Matter Searches**

Simulation-based Studies of the Fiducialization of SNOGLOBE for the NEWS-G Experiment

Tuesday, 15 February 2022 10:24 (12 minutes)

The NEWS-G direct dark matter experiment uses spherical proportional counters (SPCs) to search for low mass WIMPs. The next phase of this experiment consists of a large 140 cm diameter SPC, called "SNOGLOBE", which was recently installed at SNOLAB with improvements to overall detector performance and data quality. Prior to installation at SNOLAB, this detector was commissioned using pure methane gas at the LSM and a temporary water shield, providing a hydrogen-rich target and reduced backgrounds. For larger SPCs, a new sensor design with a more complex geometry was employed with the use of an 11-anode "ACHINOS"sensor. With an ACHINOS, the need for simulation-based studies of the detector's fiducialization are crucial for characterizing SNOGLOBE's low-energy signal acceptance. ACHINOS sensors group anodes using 2-3 electronic channels, allowing for the discrimination of event signals by detector volume. Alongside data analysis, electronic drift simulations of the sensor-wise distribution of primary electrons from observed events allow for further characterization of the fiducial volume for each channel. This talk will demonstrate the process for characterizing the total fiducialization of SNOGLOBE with a 2-channel ACHINOS sensor via simulation, as well as the feasibility for future simulation-based studies including SPC directionality with possibly more advanced sensory technology.

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Experiment

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Session Classification: Dark Matter Searches

Contribution ID: **11** Type: **Nuclear and Particle Physics**

Two Photon and Radiation-less Decay of Positronium Molecule

Wednesday, 16 February 2022 13:48 (12 minutes)

It has been known for many years that an electron and its antiparticle, the positron, may together form a metastable hydrogen-like atom, known as positronium or Ps. In 1946, Wheeler speculated that two Ps atoms may combine to form the positronium molecule (Ps) stable with respect to auto-dissociation. In 2007 the existence of Ps was confirmed experimentally.
I will present a determination of the radiation-less and two photon decay rates of Ps. We employ a simple technique to compute the amplitudes and write the products of spinors in terms of gamma matrices, which reduces the computational time and provides more insights into the physics of a reaction. After testing the method with the well known problem of positronium, I will demonstrate that the previously published results are incorrect.

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Theory

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Session Classification: Particle Physics

Contribution ID: **12** Type: **Nuclear and Particle Physics**

Between the s and r Process: Nuclear Data Needs of Radioactive Species to Understand Stellar Abundances from the Early Universe

Wednesday, 16 February 2022 08:24 (12 minutes)

The observation of elemental abundances in the most metal-poor stars have revealed the operation of a neutron-capture regime intermediate between the familiar slow (s) and rapid (r) process regimes. This i process can be activated when the H- and He-burning shells interact convectively, which is possible in low-metallicity conditions found in the early universe. The i process is the result of a sequence of neutron captures that involves unstable species two to six mass numbers away from the valley of stability. I will report 3D stellar hydrodynamic simulations that are now revealing the complex stellar conditions under which the i process operates, and the substantial body of work that has quantitatively established which nuclear data is most urgently needed to enable realistic modeling and interpretation of i-process observations of early universe stars. This is needed to pin down the exact location of the i process, which remains uncertain.

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Theory

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Session Classification: Nuclear Physics / Nuclear Astrophysics / Gravitational Waves

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

Injection Test: Building a Data Injector for the ATLAS Liquid Argon Signal Processor

Friday, 18 February 2022 10:24 (12 minutes)

A test-bench is created that injects digital pulses that emulate ATLAS Liquid Argon (LAr) Front End Board electronic signal pulses in order to test prototypes. The prototypes are for new electronics for an upgrade to the CERN Large Hadron Collider that increases the rate of proton-proton collisions by an order of magnitude. This High-Luminosity Large Hadron Collider requires a completely new Trigger and Data Acquisition system to deal with information from detectors.

One system that is being developed is the Liquid Argon Signal Processor (LASP) which has an architecture based on Field Programmable Gate Arrays (FPGA). Validation of individual modules of the LASP is of key importance in the development cycle. Additionally, verification of module behaviour with simulated ATLAS pulses will allow the full system to be tested with realistic conditions before data taking.

The injector project is implemented on an Intel Stratix 10 FPGA, that uses optimised GbE Ethernet technologies to communicate with a workstation in order to transfer Monte Carlo simulation pulses to the FPGA. The pulses are then buffered and injected to the LASP, mimicking the operation of the Front End Boards (FEB2s). The user is in complete control of the data pulses injected which is a vital property that enables the test of LASP behaviour for different cases and possible failure modes. A complete overview of the injector design, its performance, as well as its benefit to the LAr-LASP is shown in this talk.

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Instrumentation

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Session Classification: Instrumentation

Contribution ID: **14** Type: **Nuclear and Particle Physics**

MUTE: A Modern Calculation of Deep Underground and Underwater Cosmic Ray Muons

Tuesday, 15 February 2022 13:36 (12 minutes)

I present a new, open-source program, MUTE (MUon inTensity codE), which propagates cosmic ray muons from the atmosphere to laboratories deep underground and underwater using the most recent state-of-the-art computational tools. The evolution of cosmic rays in the Earth's atmosphere is computed with MCEq (Matrix Cascade Equation), using the latest theoretical primary and hadronic interaction models in order to calculate the muon flux at the surface. This flux serves as an input to the Monte Carlo code PROPOSAL (PRopagator with Optimal Precision and Optimised Speed for All Leptons) to propagate the muons through matter. A forward-prediction for muon spectra at different slant depths is calculated with the highest precision to date. The results, which have been submitted to The Astrophysical Journal (https://arxiv.org/abs/2109.11559), are compared to vertical muon intensity data from various sites underground and underwater. The implications of the results as well as the seasonal variation of the muon flux and the total flux under both flat and non-flat overburdens will also be discussed.

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Theory

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Presenter: WOODLEY, William (University of Alberta)

Session Classification: Particle Physics

Contribution ID: **15** Type: **QCD and Hadrons**

Numerical Methods for Finite Temperature Effects in Quantum Field Theory

Thursday, 17 February 2022 11:00 (12 minutes)

The basic structure of quantum field theory that is used to describe the Standard Model of fundamental interactions of nature is usually formulated for zero temperature. However, the effects of temperature are extremely important for understanding a number of physical processes such as the electroweak phase transition and quark-gluon plasma.
The extension of quantum field theory to non-zero temperature is achieved by modifying the propagators in loop integrations represented by Feynman diagrams.
The Python package pySecDec is designed for numerical calculation of dimensionally regulated loop integrals.
The research goal is to develop a methodology to numerically calculate loop integrations for finite temperature effects in quantum field theory by adapting pySecDec functions and implementing them for such a purpose.
In this study, the methodology is used on one-loop self-energy to achieve numerical calculation results. The pySecDec methodology is validated in comparison to existing analytic results for this topology.

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Please select: Experiment or Theory

Theory

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Presenter: Ms LI, Siyuan (University of Saskatchewan)

Session Classification: Scattering and Electrons

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

Toward Understanding the Nuclear Efficiency Threshold of Bubble Chamber Detectors

Tuesday, 15 February 2022 13:48 (12 minutes)

A bubble chamber using fluorocarbons or liquid noble gases is a competitive technology to detect a low-energy nuclear recoil due to elastic scattering of weakly interacting massive particle (WIMP) dark matter. It consists of a pressure and temperature-controlled vessel filled with a liquid in the superheated state. Bubble nucleation from liquid to vapor phase can only occur if the energy deposition is larger than a certain energy threshold, described by the "heat-spike"Seitz Model. The nucleation efficiency of low-energy nuclear recoils in superheated liquids plays a crucial role in interpreting results from direct searches for WIMPs-dark matter. In this research, we used molecular dynamics simulation to study the bubble nucleation threshold, and we performed a Monte Carlo simulation using SRIM to obtain the bubble nucleation efficiency curve. The goal is to construct a real physics model to explain the discrepancy observed between the experimental results and the current Seitz model. The preliminary results will be presented and compared with existing experimental data of current detectors.

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Please select: Experiment or Theory

Experiment

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Session Classification: Particle Physics

Contribution ID: **17** Type: **Physics Beyond the Standard Model**

Search for Vector-like Leptons in Multi-lepton Final States with the ATLAS Detector

Tuesday, 15 February 2022 13:24 (12 minutes)

According to the standard model, all flavours of leptons have equal couplings to gauge bosons - this is called lepton flavour universality. However, recently, experiments such as LHCb and Muon g-2 have reported findings, which suggest that this may not be the case, i.e. lepton flavour universality violation may occur. One way to explain these anomalies is through new particles called vector-like leptons (VLLs). The ATLAS detector at the LHC operating at the energy frontier has the potential to produce these new particles directly. In this talk, we will discuss how VLL signals could be detected using ATLAS.

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Please select: Experiment or Theory

Experiment

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Session Classification: Particle Physics

Contribution ID: **18** Type: **Nuclear Structure**

Temperature-dependent Cluster Decay Half-lives

Friday, 18 February 2022 08:48 (12 minutes)

A temperature (T)- dependent universal decay law (UDL) of cluster decay is investigated by fitting the half-lives calculated within the T-dependent Double Folding model (DFM), in which the temperature dependence of the effective potential is introduced through the charge and matter density distributions of the interacting nuclei, and the half-lives are calculated within a preformed cluster model. As a consequence of including the T dependence, the half-lives decrease with increasing temperature, which could be of interest for applications in astrophysics and heavy-ion collision.

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Please select: Experiment or Theory

Theory

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Presenter: ROJAS GAMBOA, Diego Ferney (Universidad de Los Andes)

Session Classification: Instrumentation

Contribution ID: **19** Type: **QCD and Hadrons**

AI-assisted Design of the Tracking System at the Electron Ion Collider

Friday, 18 February 2022 11:00 (12 minutes)

The Electron-Ion Collider (EIC) is a cutting-edge accelerator experiment proposed to study the origin of mass and the nature of the ‘’glue” that binds the building blocks of the visible matter in the universe. The proposed experiment will be realized at Brookhaven National Laboratory approximately 10 years from now, with the detector design and R&D currently ongoing. Notably, EIC can be one of the first facilities to leverage on Artificial Intelligence (AI) during the design phase. Optimizing the design of its tracker is of crucial importance for the EIC Comprehensive Chromodynamics Experiment (ECCE), a consortium that is proposing a detector design based on a 1.5T solenoid. The optimization is an essential part of the R&D process and ECCE includes in its structure a working group dedicated to AI-based applications for the EIC detector. In this talk, we describe an unprecedented study in AI-assisted detector design using full simulations based on Geant4. Our approach deals with a complex optimization in a multidimensional design space driven by multiple objectives that encode the detector performance while satisfying several mechanical constraints. We describe our strategy and show the results of the AI-assisted tracking system in ECCE.

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Please select: Experiment or Theory

Instrumentation

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Presenter: Mr SURESH, Karthik (University of Regina)

Session Classification: Instrumentation

Contribution ID: **20** Type: **Nuclear Structure**

Absolute Nuclear Charge Radius Measurements with EUV Spectroscopy at TITAN EBIT

Tuesday, 15 February 2022 09:00 (12 minutes)

The nuclear charge radius is a fundamental property of the nucleus, providing crucial information such as the emergence of deformation or unexpected "magicity". This structural information is paramount in probing the electroweak interaction, for example, through searches for atomic parity violation (APV) and electric dipole moments (EDM). Currently there are no experimentally measured absolute nuclear charge radii for elements beyond bismuth ($Z = 83$), except uranium ($Z = 92$) and thorium ($Z = 90$). At TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN) facility, an extreme-ultraviolet (EUV) spectrometer will be incorporated into the Electron Beam Ion Trap (EBIT) to measure the absolute nuclear charge radii. The first candidates we will study are ^{211}Fr and a suitable spin-0 isotope of Ra.

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Experiment

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Presenter: Ms WANG, Yilin (TRIUMF / UBC)

Session Classification: Nuclear Physics

Contribution ID: **21** Type: **not specified**

Quark and Gluon Jet Response from Dijet and Z/Gamma + Jet Events at ATLAS.

Friday, 18 February 2022 14:00 (12 minutes)

The most commonly produced objects in the ATLAS detector are jets, streams of particles spreading out from the proton-proton collision point. Jets develop from the constituent quarks and gluons of the protons. These particles carry color charge, and as such cannot exist freely under QCD confinement, and a chain reaction of quark/gluon production begins. Eventually, the quarks and gluons combine, forming hadrons. The ATLAS calorimeters measure much, but not all, of the energy of these jets. The measured fraction is known as the jet response, and jets initiated by quarks have a different response than those initiated by gluons. Here we seek to study the different responses by analyzing dijet, Z+jet and photon+jet events. While the photon and Z boson events can already be well analyzed by the missing energy projection fraction (MPF) calibration technique thanks to the well-defined reference objects (a single Z or photon), the dijet events must be handled differently. A study of jet characteristics allows the energy of one jet in certain dijet events to be corrected, and it may then be used as a reference for the other in MPF. Finally, quark and gluon jet responses can be extracted using the particle fractions in the three event types.

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Experiment

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Session Classification: Particle Physics

Contribution ID: **23** Type: **Nuclear and Particle Physics**

Rejecting the Cosmic Ray Background in the ALPHA-g Anti-hydrogen Gravity Experiment

Wednesday, 16 February 2022 13:36 (12 minutes)

The ALPHA project is a cornerstone of the effort to verify symmetries between matter and antimatter, with implications for understanding the baryon asymmetry and the evolution of our universe. The new ALPHA-g experiment aims to perform the first precision measurement the acceleration of anti-hydrogen atoms at rest in a gravitational field, a key piece of this puzzle.

This measurement requires the release of trapped anti-hydrogen atoms via a controlled relaxation of the confining magnetic fields; the anticipated time scale for this process is of the order of tens of seconds. Since the number of anti-atoms trapped is expected to be small, it becomes imperative to have a highly efficient system for identifying and rejecting events caused by the dominant background –cosmic rays.

To this end, a detector system called the Barrel Veto was constructed and installed, which uses the time-of-flight principle to reject externally incident particles. This requires resolving the time-of-flight of incoming particles to within a few hundred picoseconds, a feat which has been achieved through a number of precise calibrations. Although a detailed background rejection scheme is yet to be implemented, the detector was operated successfully in the 2021 commissioning run, and the initial results –presented here –look promising.

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Experiment

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Presenter: SMITH, Gareth (UBC/TRIUMF)

Session Classification: Particle Physics

Contribution ID: **24** Type: **Nuclear Structure**

Charge Changing Cross Section Measurements of Carbon Isotopes at the Neutron-drip Line

Wednesday, 16 February 2022 08:36 (12 minutes)

Exotic features like halo and the disappearance of the magic numbers were revealed by investigating the nuclei towards the neutron-rich region resulting from the large neutron/proton asymmetry. The halo occurrence in the neutron-rich nuclei originates due to a large spatial extension of the density of the outermost neutrons. The proton radius is an important property to understand the influence of significantly large spatial extension of the neutron wavefunction on the protons of the core nucleus. ^{22}C is a two neutron halo with a ^{20}C core, identified at the dripline. The systematic study of the evolution of proton radii together with the matter radii for the carbon isotopes will allow characterizing the two-neutron halo formation in ^{22}C and the shell evolution of these drip-line carbon isotopes. The presentation will describe the experiment, discuss the analysis and report the first measurement of charge changing cross-section (σ_{cc}) of the neutron drip-line carbon isotopes ^{20}C and ^{22}C at 345A MeV with a carbon target at RIKEN. The proton radii will be extracted from the measured σ_{cc} using the finite range Glauber model framework.

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Please select: Experiment or Theory

Experiment

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Presenter: SUBRAMANIYAM, P. (Saint Mary's University)

Session Classification: Nuclear Physics / Nuclear Astrophysics / Gravitational Waves

Contribution ID: **25** Type: **Nuclear Structure**

Gamma–ray Angular Correlation Measurements in 74Zn: Further Hints of Shape Coexistence Towards the Doubly Magic 78Ni

Thursday, 17 February 2022 14:00 (12 minutes)

Understanding nuclear structure near 78Ni is crucial to infer how chemical elements originate in the Universe. State-of-the-art shell model calculations agree with observations from recent experiments regarding the persistence of the N = 50 shell closure in neutron-rich nuclei. How collectivity manifests and evolves in this region of the Segr´e chart is still an open question, particularly concerning phenomena such as vibrational modes, triaxiality and shape coexistence. This is especially true in the Zn isotopic chain in the neutron-rich region beyond the valley of stability, in which even definitive spin assignments are unavailable except for the very low-lying states.
In this talk, results of an experiment aimed to study 74Zn (performed in August of 2019 at TRIUMF) will be presented. Excited states in this isotope were populated from the β-decay of 74Cu, and de-exciting γ rays were detected with the GRIFFIN spectrometer. With the use of γ − γ angular correlation measurements, definitive spin assignments of key states have been determined for the first time. The observed excitations have been placed in the context of the systematics in the Ni-Zn-Ge isotopic chains and considering collective and microscopic models. The structure of 74Zn will be discussed including the evidence for possible shape coexistence.

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Please select: Experiment or Theory

Experiment

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Presenter: ROCCHINI, Marco (University of Guelph, Guelph, Canada)

Session Classification: Nuclear Physics

Contribution ID: **26** Type: **Neutrino Properties**

Constructing a Muon Veto System for the MiniHALO Neutrino Detector for Neutrino-lead Cross Section Measurements

Thursday, 17 February 2022 08:36 (12 minutes)

In this talk I will summarize my work towards the development of a prototype detector named miniHALO that will be used to test the designed neutrino detection method to be employed in the HALO-1kT supernova neutrino detector. The miniHALO prototype will be placed at the COHERENT underground laboratory where it will be used to make the neutrino-lead cross section measurements at the supernova neutrino energy scale. In order to obtain very accurate measurements of the cross section, a muon veto system will be installed on the detector to detect the muon induced signals that can mimic the signals induced by the neutrinos. For building an optimized configuration of the scintillator plates for the muon veto, a suit of GEANT4 Monte Carlo simulations has been developed which include polyvinyltoluene polymer based scintillators that generate optical photons when traversed by the cosmic ray muons. Results from these simulations such as the energy deposited in the scintillator plates, neutrons multiplicities from muon-lead interactions in the detector, the optical photons generated in the scintillator plates from muon interactions will be discussed along with how these results can be used to veto muon induced signals in the detector.

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Experiment

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Session Classification: Neutrino Physics/Dark Matter/Neutrinoless Double Betadecay

Contribution ID: **27** Type: **Physics Beyond the Standard Model**

Upgrade of the ATLAS NSW

Tuesday, 15 February 2022 13:00 (12 minutes)

The ATLAS detector has been at the frontier of high energy physics, gathering data from proton-proton collisions at the LHC for more than a decade. The instantaneous luminosity of the Large Hadron Collider at CERN will be increased up to a factor of five to seven with respect to the design value for the High Luminosity LHC. Several sub-systems of the ATLAS detector will be upgraded in order to cope with the higher particle rate and to further improve the excellent performance of ATLAS. The largest upgrade project for the ATLAS Muon System is the replacement of the present first station in the high-rapidity regions with the so-called New Small Wheels (NSWs) that have just been completed. In this talk we will discuss how the NSWs work, and their current status in terms of construction, integration, and testing.

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Please select: Experiment or Theory

Experiment

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Presenter: SHEPPARD, Damian

Session Classification: Particle Physics

Contribution ID: **28** Type: **Physics Beyond the Standard Model**

Spontaneous Symmetry Breaking and its Effects

Wednesday, 16 February 2022 08:48 (12 minutes)

In physics, symmetry breaking is a phenomenon in which (infinitesimally) small fluctuations acting on a system crossing a critical point decide the system's fate, by determining which branch of bifurcation is taken. To an outside observer unaware of the fluctuations, the choice will appear arbitrary. This process is called symmetry breaking, because such transitions usually bring the system from a symmetric but disordered state into one or more definite states. Symmetry breaking can be distinguished into two types, explicit symmetry breaking and spontaneous symmetry breaking, characterized by whether the equations of motion fail to be invariant or the ground state fails to be invariant. In spontaneous symmetry breaking, the equations of motion of the system are invariant, but the system is not. This is because the background (spacetime) of the system, its vacuum, is variant. The full effective potential can be expressed as
VEff = VTree + VCW + VCT + VT
where VTree is the tree-level potential, VCW is the one-loop Coleman-Weinberg (CW) potential, VCT are counter-terms, and VT is the thermal contribution. Spontaneous symmetry breaking can happen in two ways: In theories for which Coleman-Weinberg potential breaks the symmetry (conformal symmetry), and symmetry breaking which happens at tree-level potential (non-conformal symmetry). We are calculating the loop-corrected effective potential at non-vanishing temperature for both conformal and non-conformal in two Higgs doublet model (2HDM).

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Theory

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Presenter: Mr SHOKOLLAHIABHARI, Vahid (University of Saskatchewan)

Session Classification: Nuclear Physics / Nuclear Astrophysics / Gravitational Waves

Contribution ID: **29** Type: **Physics Beyond the Standard Model**

Phase Transition and Gravitational Wave Signatures

Wednesday, 16 February 2022 09:00 (12 minutes)

I will discuss the conformal and non-conformal two Higgs doublet model with a focus on their phase transition and gravitational wave signatures. The construction of the finite temperature effective potential of both models will be discussed in detail. Compared to the non-conformal case, the conformal model yields a very interesting phase diagram in the 2-dimensional parameter space corresponding to the phase transition. An exploration of other conformal hidden sector models (such as the well established real singlet and two real singlet models) suggests that the special shape of the phase diagram could be a universal feature in a generic class of conformal models.

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Please select: Experiment or Theory

Theory

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Presenter: PU, Hanxiao

Session Classification: Nuclear Physics / Nuclear Astrophysics / Gravitational Waves

Contribution ID: **30** Type: **not specified**

β-decay of 68Mn: Probing the N=40 Island of Inversion

Thursday, 17 February 2022 13:36 (12 minutes)

The breakdown of traditional magic numbers predicted by the shell model gives insight into the underlying nuclear interactions and acts as a test for existing models. Islands of inversion (IoI) in the nuclear landscape are characterized by the presence of deformed intruder ground states instead of the normal configurations predicted by the shell model. In the N=40 region, the relatively large energy gap separating the pf shell from the neutron $g_{9/2}$ orbital points towards a strong sub-shell closure at N=40 which has been supported by the observation of a high-lying 2^+ state and low B(E2) value in ^{68}Ni (Z=28) [1]. However, systematics of E(2^+) and B(E2) values have indicated a sudden increase in collectivity below Z=28 when approaching N=40, seen in the rapid drop of E(2^+) in Fe (Z=26) and Cr (Z=24) isotopes [2]. This increase in collectivity is thought to be due to the neutron occupation of intruder states from a higher shell, similar to the IoI around N=20 [3]. Recent studies also suggest the occurrence of a new IoI at N=50 and a proposed merging of the N=40 and N=50 IoIs [4]. Spectroscopic information of the Fe, Co, and Ni isotopes will be crucial to understand the structure of nuclei near and inside the N=40 IoI. An experiment was performed at TRIUMF-ISAC using the GRIFFIN spectrometer that utilized the β and βn decay of ^{68}Mn to populate excited states in ^{67,68}Fe, ^{67,68}Co and ^{67,68}Ni. Preliminary results from the analysis which includes a greatly expanded ^{68}Fe level scheme will be presented.
[1] O.Sorlin et al. PRL (2002)
[2] S.Naimi et al. PRC (2012)
[3] S.M.Lenzi et al. PRC (2010)
[4] C.Santamaria et al. PRL (2015)

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Experiment

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Presenter: Ms UMASHANKAR, Rashmi (Department of Physics and Astronomy)

Session Classification: Nuclear Physics

Contribution ID: **31** Type: **Physics Beyond the Standard Model**

Bayesian Method in Parity-violating Electron Scattering Experiments

Thursday, 17 February 2022 10:12 (12 minutes)

The parity-violating electron scattering technique can be used to probe new physics beyond the Standard Model. High precision measurements of the parity-violating asymmetry with a variety of kinematics and targets enable scientific reach in particle physics, nuclear physics, and hadronic physics. To achieve precise measurements, experimental corrections to the measured asymmetries are required. Experimental corrections arise from background processes that are characterized by fractional dilution factors and background asymmetries.
In this talk, frequentist methods which are commonly used in the parity-violating electron scattering experiments will be reviewed, and Bayesian analysis is investigated to improve understanding of uncertainties introduced by experimental corrections. A Bayesian model is proposed to infer dilution factors and background asymmetries based on observed quantities. This allows for a better assessment of the uncertainties in the model.
To test the method itself, we will start with some sets of actual parameters to apply the model for generating a set of mock data and then move backward with the same model to extract the parameters.

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Theory

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Session Classification: Scattering and Electrons

Contribution ID: **32** Type: **not specified**

SiPM Stability Tests for nEXO

Friday, 18 February 2022 08:36 (12 minutes)

nEXO is a next-generation experiment that aims to search for neutrinoless double beta decay in 5 tonnes of liquid xenon (LXe), enriched to 90% in the double beta decaying isotope Xe-136. The detector is designed as a single-phase time projection chamber where anti-correlated ionization and scintillation signals will be recorded and used to reconstruct the energy, position, and spatial time topology of each event. A large array of silicon photomultipliers (SiPMs) will detect the vacuum ultraviolet (VUV) scintillation light in nEXO. Stable and uniform performance of these SiPMs is required for the planned 10-year livetime of the experiment. In addition to electrical and optical characterization, nEXO SiPMs will be tested after controlled exposure to various amounts of VUV light. I will report on the in-vacuum response of Hamamtsu VUV4 SiPMs to Xe scintillation light following exposure to high density VUV light.

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Please select: Experiment or Theory

Experiment

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Session Classification: Instrumentation

Contribution ID: **34** Type: **Nuclear and Particle Physics**

ATLAS NSW sTGC Pad Efficiency

Friday, 18 February 2022 13:36 (12 minutes)

The New Small Wheel (NSW) detectors have recently been added to the ATLAS muon end-cap system. The detector is composed of two technologies: Micromegas (MM) and small-strip Thin Gap Chambers (sTGC). The sTGCs are fast tracking detectors that will allow ATLAS to veto fake muons and maintain a low trigger threshold. An sTGC quadruplet is composed of four gas volumes where an individual gas volume consists of thin wires centred between two cathode planes. One plane consists of fine pitched strips and the other of larger pads. Coincidences of pads across at least 3 layers are used for triggering the NSW.
The sTGC pad trigger was tested during the surface commissioning of one NSW via cosmic ray tests. In this talk I will discuss my work calculating the pad efficiency from cosmics and test beam data.

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Please select: Experiment or Theory

Experiment

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Presenter: BROWN, Leesa (UVic/TRIUMF)

Session Classification: Particle Physics

Contribution ID: **35** Type: **Nuclear and Particle Physics**

Mirror Design for an ARICH Detector in a Hadron Production Experiment

Thursday, 17 February 2022 08:48 (12 minutes)

EMPHATIC (Experiment to Measure the Production of Hadrons At a Testbeam In Chicagoland) is a low-cost, table-top-sized, hadron-production experiment located at the Fermilab Test Beam Facility (FTBF) that will measure hadron scattering and production cross sections that are relevant for neutrino flux predictions. High statistics data will be collected using a minimum bias trigger, enabling measurements of all relevant cross sections. Particle identification will be done using a compact aerogel ring imaging Cherenkov (RICH) detector, silicon strip detectors, a time-of-flight (ToF) wall, and a lead glass calorimeter array. The ARICH focuses on the kaons, pions and protons identification in a multitrack environment up to 8 GeV/c. In my presentation I will discuss the implementation of optical mirrors in the ARICH system used to reflect Cherenkov light outside of the PMT array acceptance onto the PMT array, thus increasing the angular acceptance of the experiment as a low cost improvement.

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Experiment

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Presenter: Mr FERRAZZI, Bruno (University of Regina)

Session Classification: Neutrino Physics/Dark Matter/Neutrinoless Double Betadecay

Contribution ID: **36** Type: **Neutrino Properties**

Reducing Background for the Hyper-Kamiokande's Intermediate Water Cherenkov Detector

Thursday, 17 February 2022 08:24 (12 minutes)

Hyper-K will be a next-generation long-baseline neutrino experiment with the goal of measuring neutrino flavour-mixing parameters and discovering CP-phase violation in the neutrino sector. To measure the unoscillated neutrino beam, Hyper-K will make use of the upcoming Intermediate Water-Cherenkov Detector, for which a new multi-photomultiplier photosensor module (mPMT) is being developed. Each mPMT will contain nineteen 3-inch photomultiplier tubes at the top, to detect the neutrino interactions, and a secondary scintillator-based detector at the bottom, to detect background particles. This scintillator plate will generate an electric pulse, or a "hit", when traversed by a charged particle or photon, such as produced by the interaction of neutrinos with the soil. This hit will be used in a time-coincidence circuit with other detectors at the outer region of IWCD to veto these particles'effect and reduce IWCD's background. The scintillator plate's basic mechanism is quite simple: When traversed by a background particle, the scintillator generates photons, which are guided by a wavelength-shifting fibre to a photo-sensor. In this presentation, I will describe the technical considerations behind the design of this scintillator plate, from its dimensions to the fibre configuration, and the characterization of the photo-sensor device. I will also describe the experimental measurements performed so far, to determine the light yield of the plate when hit by cosmic rays and electrons, and towards a definitive design for the plate.

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Experiment

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Presenter: KOERICH, Luan

Session Classification: Neutrino Physics/Dark Matter/Neutrinoless Double Betadecay

Contribution ID: **37** Type: **Nuclear and Particle Physics**

Light-only Liquid Xenon (LoLX) Detector for Cherenkov and Scintillation Light Investigation

Friday, 18 February 2022 10:36 (12 minutes)

The Light-only Liquid Xenon (LoLX) experiment is designed to study the properties of light emission and transport in liquid xenon (LXe) using silicon photomultipliers (SiPMs). In addition, we also plan to perform long-term stability studies of the SiPMs in LXe. Another important goal of the LoLX experiment is to characterize and utilize the differences in the timing of Cherenkov and scintillation light production to develop a background discriminator for low-background LXe experiments such as, neutrino-less double beta decay searches. The first phase of LoLX is operational and consists of an octagonal 3D-printed structure housing 24 Hammamtsu VUV4 SiPM modules, for a total of 96 individual SiPM channels. The LoLX structure is placed in a cryostat that allows for the liquefaction of Xe along with a Sr-90 beta-emitter placed at the center of the LoLX detector volume. The beta decay electrons on interaction with LXe produce Cherenkov and scintillation light to be studied using LoLX. This talk will cover the current status of the LoLX experiment and present the results obtained from the first runs of the experiment. This data-taking campaign focused on validating the optical transport simulations of LoLX done in GEANT4 by the collaboration. In addition, the effect of external cross-talk (eXT) between the SiPMs was also explored. The DAQ system has been recently upgraded with a 5GSPS ADC, allowing for improved timing resolution of the light signals.

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Please select: Experiment or Theory

Experiment

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Presenter: CHAMBERS, Christopher (McGill University)

Session Classification: Instrumentation

Contribution ID: **38** Type: **Dark Matter Searches**

DEAP-3600 Dark Matter Experiment Stability and 39Ar Decay Analysis

Tuesday, 15 February 2022 10:48 (12 minutes)

DEAP-3600 is a single-phase dark matter experiment searching for the direct detection of the dark matter signal using 3279 kg of liquid argon as the target material. In addition to the elastic interaction of the dark matter candidate, a Weakly Interacting Massive Particle (WIMP), with the argon nuclei, theories also predict the modulation in this signal rate with time due to the motion of the earth around the sun. The signals from the backgrounds in the experiment are not expected to show this modulation with time. The observation of this type of modulation signal will extend the sensitivity of the WIMP search in the experiment. To obtain this sensitivity limit, a complete detailed understanding of detector systematics is required. The study of the event rates with time also compliments many physics analyses such as 39Ar dating which will give a precise measurement for the lifetime of this isotope. The detector stability parameters in the DEAP-3600 data show the excellent stability of the detector over time which makes it ideal for these studies. In this talk, the stability of the DEAP-3600 detector will be presented with some preliminary measurements for the 39Ar lifetime analysis.

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Please select: Experiment or Theory

Experiment

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Session Classification: Dark Matter Searches

Contribution ID: **39** Type: **Dark Matter Searches**

Detector Response Simulation for NEWS-G Dark Matter Experiment

Wednesday, 16 February 2022 11:00 (12 minutes)

The Spherical Proportional Counter (SPC) is used in NEWS-G to search for low-mass Weakly Interacting Massive Particles (WIMPs). UV laser and Ar37 calibration data were previously taken at Laboratoire Souterrain de Modane (LSM) with a 1.35m diameter SPC filled with pure CH4 gas. To verify our understanding of the detector behavior and the physics model we use, a simulation of the SPC response to these two sets of calibration data is needed. The primary electrons originating from the same event will drift toward the high voltage sensor and a current is induced by the motion of secondary ions drifting away from the sensor. How much diffusion a swarm of electrons undergoes is parametrized by the "rise time"of the integrated charge pulse. Both rise times and drift times of electrons can be affected by the "space charges", which are secondary ions created near the sensor distorting the overall electric field within the detector. The simulation results will be compared with the calibration data and the effect due to space charges will be discussed. Finally, I will talk about the implication of the simulation results in cut efficiencies and WIMP signal acceptance to further extract the dark matter cross-section exclusion limits.

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Experiment

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Session Classification: Dark Matter Searches

Contribution ID: **40** Type: **Physics Beyond the Standard Model**

Laser Cooling of Antihydrogen

Wednesday, 16 February 2022 13:12 (12 minutes)

Antihydrogen, the simplest atomic antimatter system, is an excellent platform to search for matter-antimatter asymmetries. The kinetic energy (and thus velocity) of synthesized antihydrogen trapped in the laboratory setting is very large relative to the energy well depth of the trap providing the confining force. Accuracy of any measurements performed on trapped antihydrogen, and the complexity of future experiments, is sensitive to the kinetic energy of the sample. There are a variety of techniques used in atomic physics experiments to decrease a sample's temperature, but the additional constraints of working with trapped antimatter made laser cooling the most promising choice.

I demonstrate the ability to modify the kinetic energy distribution of a trapped sample of antihydrogen using the 1S-2Pf transition in antihydrogen using a vacuum ultraviolet (VUV) laser system (i.e. laser cooling). The change in kinetic energy is observed using a time-of-flight analysis from a pulsed laser spectroscopy run as well as a narrowing of the 1S-2S line shape. This development is greatly important to the future studies of the antihydogen system, as well as the search for physics beyond the standard model.

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Please select: Experiment or Theory

Experiment

Primary author: EVANS, Andrew (University of Calgary)

Presenter: EVANS, Andrew (University of Calgary)

Session Classification: Particle Physics

Contribution ID: **42** Type: **Nuclear and Particle Physics**

Microelectronic Simulations of the Proton in Silicon Using Geant4 for Beam Lifetime 3 Experiment

Friday, 18 February 2022 10:48 (12 minutes)

The Beam Lifetime 3 (BL3) experiment at the National Institute of Standards and Technology, USA, aims to improve the precision of neutron lifetime measurements and we hopefully resolve the inconsistency by improving the precision. In the BL3 experiment, a Geant4 based simulation has been used to model, develop, and optimize the experimental setup. The physics list, which is used to simulate particle transportation and interactions, was derived from one of the advanced examples of Geant4 and extended with a screened nuclear recoil model appropriate for low energy proton-nucleus scattering. This will allow many applications of the SRIM (Stopping and Range of Ions in Matter) software to be expanded into a much more general Geant4 framework where nuclear and other effects can be included.
In this project, the detection of proton hitting into a Silicon detector is simulated by microelectronics simulation in Geant4. Physics lists from Geant4 are applied to study energy deposition and backscattering of 35 keV protons in a 500 nm Silicon detector. The simulation was compared against Pysrim, a python wrapper for SRIM. I will demonstrate a benchmark comparison between Geant4 and Pysrim using the example of Boron implantation in silicon. Finally, I will discuss my comparison between Pysrim and Geant4 for the case of proton scattering in silicon.

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Experiment

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Presenter: Mrs MOAZAM, Jabia

Session Classification: Instrumentation

Contribution ID: **43** Type: **Dark Matter Searches**

Low-temperature Optical Properties of Materials for Rare-event Searches

Friday, 18 February 2022 10:12 (12 minutes)

Many particle detectors house their liquid scintillators in an acrylic vessel. The acrylic may be coated by a wavelength shifter in situations where the scintillation light is outside the range of the photodetectors. We have investigated the low-temperature properties of pyrene as an alternative to 1,1,4,4-tetraphenyl-1,3-butadiene (TPB) as pyrene has a much longer fluorescence time which could be useful for pathological background rejection in a detector. The fluorescence properties were studied for various concentrations and fluorescence grades of pyrene in the pyrene-polystyrene coatings. In addition, we have studied the fluorescence of the acrylic itself, as it could form a background in rare-event searches and compared the light yield results to those of TPB. All these materials were excited with 285 nm UV light and studied at various temperatures between 4 K and 300 K to cover the operating temperatures of most particle detectors. We present the changes in the spectra and light yields of all these materials with temperature and discuss an additional analysis of the change in the temperature dependence of the pyrene fluorescence time constants.

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Please select: Experiment or Theory

Instrumentation

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Presenter: ELLINGWOOD, Emma (Queen's University)

Session Classification: Instrumentation

Contribution ID: **44** Type: **QCD and Hadrons**

η Meson Photoproduction with the GlueX Experiment

Thursday, 17 February 2022 10:48 (12 minutes)

Studies of the exclusive production of the η meson in photonuclear reactions offer a wide range of physics insight. These include constraining models of hadron photoproduction, insight into the spectrum of excited N* states, and may even provide a probe into the structure of the nucleon at wide-angles of production. GlueX, a high-intensity photoproduction experiment located at Hall D of Jefferson Lab, measures exclusive η mesons off the proton with large statistics and comparatively low background. We present cross section measurements of η photoproduction at $E_\gamma =$ 6-11 GeV and find consistent results using the decay modes $\eta \to \gamma\gamma$, $\pi^+\pi^-\pi^0$, and $\pi^0\pi^0\pi^0$. When studied as a function of Mandelstam t, these cross sections can constrain models describing η production in terms of t-channel Reggeon exchange. Such measurements inform future searches for exotic hybrid mesons and serve as a benchmark for the Jefferson Lab Eta Factory, a future upgrade to the existing GlueX facility focused on rare η decays.

This work is supported by the Natural Sciences and Engineering Research Council of Canada Grant No. SAPPJ-2018-00021.

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Please select: Experiment or Theory

Experiment

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Presenter: ZARLING, Jonathan (University of Regina)

Session Classification: Scattering and Electrons

Contribution ID: **45** Type: **Nuclear and Particle Physics**

Characterization of a Spatially Resolved Multi-element Laser Ablation Ion Source for Barium Tagging with nEXO

Friday, 18 February 2022 10:00 (12 minutes)

The proposed nEXO experiment is searching for neutrinoless double beta decay ($0\nu\beta\beta$) in ^{136}Xe in a five tonne liquid Xe time-projection chamber (TPC). The addition of Barium tagging may allow for the positive identification of a candidate $0\nu\beta\beta$ event as a true $\beta\beta$ decay, by extracting and identifying the daughter Ba ion. The nEXO collaboration is pursuing various approaches to Barium tagging for future upgrades to the detector. One approach is to extract a small volume of liquid Xe at the location of a candidate event, which undergoes a phase-change to gaseous Xe, then transport and trap the extracted ions for identification in a linear Paul trap. Different parts of this Barium tagging system are currently under development at multiple Canadian institutions. Laser ablation ion sources (LAS's) are ideal for testing and calibrating the constituent devices of the Barium tagging system, since they can produce ions in vacuum or gas. Specifically, a LAS that can spatially resolve and selectively ablate different elements from a multi-element target is being used for the commissioning and calibration of a multi-reflection time-of-flight mass-spectrometer (MRTOF). The MRTOF will perform systematic studies of the ion extraction technique, as well as provide further identification of the Barium isotope. The capabilities of the LAS, such as the spatial resolution, scanning range and ion transport efficiency will be discussed, as well as progress towards the commissioning of the MRTOF.

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Instrumentation

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Presenter: MURRAY, Kevin (McGill University)

Session Classification: Instrumentation

Contribution ID: **46** Type: **Physics Beyond the Standard Model**

One Step Closer to Atomic Parity Violation in Francium: First Observation of the Highly Forbidden Magnetic Dipole (M1) 7S –8S Transition in Francium

Thursday, 17 February 2022 13:24 (12 minutes)

Precise tests of fundamental symmetries at low energy are an important tool for testing the Standard Model. Atomic parity violation (APV) measures the strength of highly forbidden atomic transitions induced by the parity violating (PV) exchange of Z bosons between electrons and quarks in heavy atoms. We are working towards measuring this effect in the heaviest alkali, francium, where the effect is predicted to be 18x larger than in cesium. Using the 7s-8s transition, we intend to measure the interference between the PV-induced E1 amplitude and a much larger Stark E1 amplitude from an externally applied electric field. Reversal of the latter will change the sign of the interference term. The Stark transition will be of comparable strength to a relativity and hyperfine-induced M1 transition which is about 13 orders of magnitude weaker than allowed atomic transitions. Its presence causes the leading systematic effects for APV and motivates its characterization. In this talk I will present our first measurement of M1 using our francium laser trap at TRIUMF's ISAC facility, and will give an outlook on our future plans towards APV.

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Presenter: Ms SHARMA, Anima (University of Manitoba)

Session Classification: Nuclear Physics

Contribution ID: **47** Type: **Physics Beyond the Standard Model**

Update of the Jefferson Lab Eta Factory and the Search for BSM Physics

Thursday, 17 February 2022 10:36 (12 minutes)

The planned Jefferson Lab Eta Factory (JEF) experiment relies on the construction of an updated electromagnetic calorimeter in the forward region of the GlueX detector in Hall D, to detect photons from eta and eta'meson rare neutral decays. Focus on these decay channels is motivated by the search for signatures beyond the Standard Model, probing portals that couple the SM sector to the dark sector via new gauge bosons (e.g., dark scalar (S) and lepto-phobic dark vector (B) bosons) in the invariant mass region below 1 GeV. In addition, these decays will allow access to certain C-violating/P-conserving reactions, as well as test chiral perturbation theory to O(p6) expansion. Updating the inner region of the Forward Calorimeter (FCAL) of the GlueX detector to higher granularity PbWO4 crystals will improve the reconstruction of multi-photon final states, minimize shower overlaps and optimize the energy and position resolutions. Machine Learning algorithms are being employed to improve shower classification and separation capabilities of the FCAL and will be compared to conventional reconstruction algorithms.

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Please select: Experiment or Theory

Experiment

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Presenter: MAHMOOD, Azizah (University of Regina)

Session Classification: Scattering and Electrons

Contribution ID: **48** Type: **Dark Matter Searches**

Nucleation Efficiency of Nuclear Recoils in Bubble Chambers

Tuesday, 15 February 2022 11:00 (12 minutes)

Bubble chambers using liquid xenon (and liquid argon) have been operated (resp. planned) by the Scintillating Bubble Chamber (SBC) collaboration for GeV-scale dark matter searches and to detect CEvNS from nuclear reactors. This will require a robust calibration of the nucleation efficiency of low-energy nuclear recoils in these target media. Such a program has been carried out by the PICO collaboration, which aims to directly detect dark matter using C_3F_8 bubble chambers. Neutron calibration data from mono-energetic neutron beam and AmBe source has been collected and analyzed, leading to a global fit of a generic nucleation efficiency model for carbon and fluorine recoils, at thermodynamic thresholds of 2.45 and $3.29\,\mathrm{keV}$. Fitting the many-dimensional model to the data (34 free parameters) is a non-trivial computational challenge, addressed with a custom Markov Chain Monte Carlo approach, which will be presented. Parametric MC studies undertaken to validate this methodology are also discussed. This fit paradigm demonstrated for the PICO calibration is applied to existing scintillating bubble chamber calibration data, and preliminary results will be presented.

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Please select: Experiment or Theory

Experiment

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Session Classification: Dark Matter Searches

Contribution ID: **49** Type: **Nuclear and Particle Physics**

Status of the KDK Experiment: A Measurement of 40K Relevant for Rare-event Searches

Friday, 18 February 2022 13:24 (12 minutes)

Potassium-40 (^{40}K) is a naturally-occurring, radioactive isotope of interest to rare-event searches as a challenging background. In particular, NaI scintillators contain ^{40}K contamination which produces an irreducible ~ 3 keV signal originating from this isotope's electron capture (EC) decays. In geochronology, the $\mathcal{O}(\mathrm{Gy})$ lifetime of ^{40}K is utilized in dating techniques. The direct-to-ground-state EC intensity (I_{EC}) of this radionuclide has never been measured, and theoretical predictions are highly variable ($I_{\mathrm{EC}} \sim (0.05(1)$–$0.22(4))\%$). The poorly understood intensity of this branch may affect the interpretation or precision of experimental results, including those probing DM signals in the (2-6) keV region. The KDK ("potassium decay") experiment is finalizing the first measurement of this I_{EC} branch, which uses a coincidence technique between a high-resolution $\mathcal{O}(\mathrm{keV})$ Silicon Drift Detector and a highly-efficient ($\sim 98\%$) $\mathcal{O}(\mathrm{MeV})$ Modular Total Absorption Spectrometer (Oak Ridge National Labs) to differentiate ground and excited state EC decays of ^{40}K. We report on the status of the main ^{40}K analysis leading up to unblinding, along with a preliminary measurement of Zinc-65 decays used to test analysis methods.

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Experiment

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Presenter: HARIASZ, Lilianna (Queen's University, Kingston, ON)

Session Classification: Particle Physics

Contribution ID: **50** Type: **Dark Matter Searches**

Machine Learning for Noise Removal in NEWS-G

Tuesday, 15 February 2022 10:36 (12 minutes)

The NEWS-G experiment searches for low mass dark matter using spherical proportional counters (SPCs). The primary ionization created by a particle interacting with the gas in the SPC drifts towards a central anode. When the ions approach the anode, the electric field becomes strong enough to trigger secondary ionizations, resulting in an amplified detector signal. In this talk I will present preliminary results regarding the application of machine learning techniques for noise removal on these signals. Evaluation of these techniques include tests on simulated pulses with added noise, and quantifying model effects on physics goals such as primary ion counting and energy resolution. Successful implementation of this technique will reduce errors on event measurements (energy, drift time, etc.) and lower the analysis threshold, thereby enabling the experiment to search for lower mass dark matter events.

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Experiment

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Session Classification: Dark Matter Searches

Contribution ID: **51** Type: **Dark Matter Searches**

New Background Discrimination Methods for the NEWS-G Dark Matter Search Experiment

Wednesday, 16 February 2022 10:48 (12 minutes)

In Fall 2019, the NEWS-G experiment used its latest detector, a 140 cm diameter Spherical Proportional Counter (SPC) to search for low mass dark matter at the *Laboratoire souterrain de Modane* (LSM), in France. When a particle interacts with an atom of gas inside the SPC, the ensuing recoil ionizes the gas and produces primary electrons that drift towards the centre of the sphere due to a radial electric field. Close to the central anode, the electric field is so strong that the electrons start themselves ionizing the gas, resulting in a Townsend avalanche. All the drifting secondary ions induce a current in the sensor which produces a characteristic signal.
Although lead and polyethylene shields protect the detector against most of the background coming from the environment, the majority of the detected signals are still unrelated to WIMP interactions. In particular, electronic spikes and events correlated to alpha particles are a significant source of undesirable signals. Some of these unwanted background events can be discriminated against by their pulse shape, which differs from the characteristic shape of physical pulses. The objective of the background discrimination is to correctly identify and remove a maximum of the background signals, while keeping the maximal proportion of potential events of interest. This talk will present a description of the newly developed algorithms to exclude the signals coming after alphas and differentiate spikes from WIMP candidate events.

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Experiment

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Presenter: COQUILLAT, Jean-Marie (Queen's University)

Session Classification: Dark Matter Searches

Contribution ID: **52** Type: **Dark Matter Searches**

Direct Detection Constraints on Super Heavy Dark Matter Using DEAP-3600 Detector

Wednesday, 16 February 2022 10:24 (12 minutes)

The DEAP-3600 experiment (Dark matter Experiment using Argon Pulseshape discrimination) at SNOLAB in Sudbury, Ontario is searching for dark matter via the elastic scattering of argon nuclei by dark matter particles as they traverse through the detector. The detector uses 255 photomultiplier tubes (PMTs) looking at ~3300kg of liquid argon in a spherical vessel. In addition to being sensitive to weakly interacting massive particles (WIMPs), DEAP-3600 is also sensitive to superheavy dark matter candidates with masses up to the Planck scale.

In this talk, we present the search for this candidate particle in three years of data (using a blind analysis), looking for multiple-scatter signals. No signal events were observed leading to direct detection constraints for dark matter masses between 8.3e6 and 1.2e19 GeV and dark matter-nucleon cross-section between 1e-23 and 2.4e-18 cm^2 (first direct detection constraints on Planck-scale mass dark matter).

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Please select: Experiment or Theory

Experiment

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Session Classification: Dark Matter Searches

Contribution ID: **53** Type: **Nuclear and Particle Physics**

The Current Status of the TUCAN Ultracold Neutron Source

Wednesday, 16 February 2022 14:00 (12 minutes)

The TUCAN (TRIUMF Ultra-Cold Advanced Neutron) Collaboration aims to build a new, intense source of ultracold neutrons (UCN). The first experimental use of the TUCAN source will be to complete a world-leading measurement of the neutron electric dipole moment (nEDM), the discovery of which would support the search for new sources of CP violation beyond the Standard Model. Neutrons will be produced via spallation using the TRIUMF cyclotron, and then moderated through a series of materials before being downscattered in superfluid helium (He-II) in the production vessel. The UCN are then transported along the guide, ultimately escaping, at room temperature, to the nEDM experiment. The He-II in the production vessel and UCN guide are maintained at $\sim$ 1 K by a He-II cryostat, which supplies cooling through the evaporation of ^{3}He. Cooling required by the liquid deuterium (LD_2) moderator will be supplied by an LD_2 cryostat, consisting of a single-phase thermosyphon refrigerated by a He cryocooler. The He-II cryostat was developed and tested in Japan, and is now undergoing assembly and further testing at TRIUMF. The LD_2 moderator loop and UCN production volume are the responsibility of the Canadian collaborators, and are under development. In this presentation, the current status of the TUCAN source will be discussed, as well as plans for the immediate future.

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Experiment

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Session Classification: Particle Physics

Contribution ID: **54** Type: **not specified**

In Situ Magnetometry for Experiments with Antihydrogen

Friday, 18 February 2022 08:24 (12 minutes)

The Antihydrogen Laser Physics Apparatus (ALPHA) is based at the European Organization for Nuclear Research (CERN). Using low energy antiprotons we produce, trap, and study the bound state of an antiproton and positron, antihydrogen [1]. Given the long history of atomic physics experiments with hydrogen, experiments with antihydrogen offer some of the most precise tests of quantum electrodynamics and charge-parity-time symmetry [1]. A test of the weak equivalence principle is on the horizon with a major addition to ALPHA, ALPHAg, aiming to measure the gravitational free fall of antihydrogen. All experiments in ALPHA require precise measurements of the magnetic field inside the apparatus; this is especially important for ALPHAg [2]. A technique developed in ALPHA determines the magnetic field by measuring the cyclotron frequency of an electron cloud. Microwave pulses on resonance with the cyclotron frequency, which is magnetic field dependent, heat the electrons [3]. A campaign to characterize the accuracy of this technique in a magnetic field gradient is required before a measurement of the effect of Earth's gravity on antimatter can be made. I will discuss recent progress made towards realising this goal including the application of this measurement in a field gradient.

1. Characterization of the 1S–2S transition in antihydrogen, ALPHA Collaboration, Nature, 557, 71, (2018)
2. Description And First Application Of A New Technique To Measure The Gravitational Mass Of Antihydrogen, ALPHA Collaboration, Nature Communications 4, 1785 (2013)
3. Electron Cyclotron Resonance (ECR) Magnetometry with a Plasma Reservoir, E. D. Hunter et al, Physics of Plasmas 27, 032106 (2020)

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Experiment

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Presenter: POWELL, Adam (University of Calgary)

Session Classification: Instrumentation

Contribution ID: **55** Type: **Physics Beyond the Standard Model**

Search for Long Lived Particles with Innovative Tracking Algorithm in the ATLAS Experiment

Tuesday, 15 February 2022 13:12 (12 minutes)

New Long-lived particles (LLPs) - ones that could travel long distances before decaying- are among numerous exotic signatures that would help address the universe's biggest mysteries such as Dark Matter. Many Beyond the Standard Model theories that aim to address the limitations of the standard model point to the Higgs boson as a possible portal to new physics, where the Higgs successively may decay to LLPs. The ATLAS analysis software has undergone significant improvement ahead of Run-3, in particular, Large Radius Tracking (LRT). LRT is a dedicated track reconstruction algorithm that aims at efficiently reconstructing the displaced charged particles produced in LLP decays. In this talk, we will discuss the expected performance of LRT for Run 3 data taking and highlight the significantly improved sensitivity for LLP searches due to the new LRT using the example of a search of LLPs via Higgs boson production in association with the Z boson.

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Experiment

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Presenter: HANIF, Hamza (Simon Fraser University)

Session Classification: Particle Physics

Contribution ID: **56** Type: **not specified**

Numerical Description of High Energy Electrons Propagating in a Coulomb Field

Friday, 18 February 2022 09:00 (12 minutes)

The goal of our project is to determine the radiation of photons emitted in a nuclear beta decay including the effect of the interaction with the parent nucleus. In this talk, I will explain in an accessible way Schwinger's proper-time method and illustrate how it determines the electron's Green Function. As one application, I will describe the electron's anomalous magnetic moment (g-2).

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Theory

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Presenter: Mr REZA, Syed Navid (University of Alberta)

Session Classification: Instrumentation

Contribution ID: **57** Type: **Nuclear and Particle Physics**

Precision Antihydrogen Annihilation Reconstructions Using the ALPHA-g Detector

Wednesday, 16 February 2022 13:24 (12 minutes)

The ALPHA (Antihydrogen Laser PHysics Apparatus) collaboration aims to test fundamental symmetries with matter and antimatter by testing CPT (charge conjugation, parity reversal, time reversal) theory and observing whether antimatter follows Einstein's Weak Equivalence Principle (WEP), where the acceleration due to gravity that a body experiences is independent of its structure or composition. A measurement of the gravitational mass of antimatter has never been done before, as previous experiments used charged particles, which meant the experiments were dominated by electromagnetic forces. The ALPHA-g apparatus will use electrically neutral antihydrogen atoms produced in a vertical Penning-Malmberg trap and hold the antihydrogen in a magnetic well. Once the antihydrogen is released, the position of the resulting annihilations can be reconstructed with a radial time projection chamber (rTPC) surrounding the trapping volume. Tracing the annihilation position within the rTPC is imperative to measuring the gravitational mass of antihydrogen. Simulations of antihydrogen annihilations, and how to calibrate the detector for z-positions will be discussed. This data will be used to measure the gravitational mass of antihydrogen; an important measurement in testing the fundamental symmetry of matter and antimatter. The ALPHA-g apparatus is currently being commissioned at CERN, and the first gravitational measurements of antihydrogen are underway.

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Experiment

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Session Classification: Particle Physics

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

An Implementation of Atomic Form Factor

Wednesday, 16 February 2022 13:00 (12 minutes)

The discrete-discrete atomic form factor is calculated for two non-equal masses of particles. The integral involving the product of Bessel functions and associated Laguerre polynomials is used to calculate the radial integral. An explicit analytical expression for the discrete-discrete transition form factor is presented exactly in the way they are implemented in the program. This atomic form factor for non-equal masses can be used in the decay rate calculation of exotic atoms, such as pionic hydrogen to muonic hydrogen.

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Theory

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Session Classification: Particle Physics

Contribution ID: **59** Type: **Nuclear Structure**

Investigating the Nuclear Shell Evolution in Neutron-Rich Calcium

Thursday, 17 February 2022 13:48 (12 minutes)

Nuclei away from the line of stability have been found to demonstrate behavior that is inconsistent with the traditional magic numbers of the spherical shell model. This has led to the concept of the evolution of nuclear shell structure in exotic nuclei, and the neutron-rich Ca isotopes are a key testing ground of these theories; there have been conflicting results from various experiments as to the true nature of a sub-shell closure for neutron-rich nuclei around ^{52}Ca. In November of 2019, an experiment was performed at the ISAC facility of TRIUMF; ^{52}K, ^{53}K, and ^{54}K were delivered to the GRIFFIN gamma-ray spectrometer paired with the SCEPTAR and the ZDS ancillary detectors for beta-tagging, as well as DESCANT for neutron-tagging. Using this powerful combination of detectors we combine the results to construct level schemes for the isotopes populated in the beta-decay. Preliminary results from the analysis will be presented and discussed in the context of an N=32 shell closure in neutron-rich nuclei.

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Experiment

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Presenter: COLEMAN, Robin (University of Guelph)

Session Classification: Nuclear Physics

Contribution ID: **61** Type: **Dark Matter Searches**

The Piezoaxionic Effect

Wednesday, 16 February 2022 10:00 (12 minutes)

Axion dark matter (DM) constitutes an oscillating background that violates parity and time-reversal symmetries. Inside piezoelectric crystals, where parity is broken spontaneously, this axion background can result in a mechanical stress. We call this new phenomenon "the piezoaxionic effect". When the frequency of axion DM matches the natural frequency of a bulk acoustic normal mode of the piezoelectric crystal, the piezoaxionic effect is resonantly enhanced and can be read out electrically via the piezoelectric effect. We also point out another, subdominant phenomenon present in all dielectrics, namely the "electroaxionic effect". An axion background can produce an electric displacement field in a crystal which in turn will give rise to a voltage across the crystal. Near-future experimental setups that probe these two effects are applicable for axion masses between 10^{-11} eV and 10^{-7} eV, a challenging range for most other detection concepts.

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Theory

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Presenter: MADDEN, Amalia (Perimeter Institute)

Session Classification: Dark Matter Searches

Contribution ID: **62** Type: **Electroweak and Higgs Physics**

Leptonic Tensor Approach to Calculate Scattering Cross Sections for Distinguishable Target Particles

Thursday, 17 February 2022 10:24 (12 minutes)

We perform Next-to-the Leading Order (NLO) and quadratic level (NNLO) covariant approach to get the leptonic tensor for a general QED scattering process with a distinguishable target particle. The Feynman diagram of the scattering process in question is divided into upper (leptonic) and lower (either leptonic or hadronic) parts. The QED quadratic leptonic tensor is of the order of α^3 which is usually obtained by multiplying two loop level photon self energy with tree level diagram. However, in this work it is obtained by squaring one loop level photon self energy and vertex correction diagrams. Hence this approach is more suitable if one wants to calculate NNLO corrections without using two loop level diagrams.

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Theory

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Session Classification: Scattering and Electrons

Contribution ID: **63** Type: **Dark Matter Searches**

The Scintillating Bubble Chamber (SBC) Experiment for Dark Matter and Reactor CEvNS

Tuesday, 15 February 2022 10:00 (24 minutes)

The Scintillating Bubble Chamber (SBC) experiment is a novel low-background technique aimed at detecting low-mass (0.7-7 GeV/c2) WIMP interactions and coherent scattering of reactor neutrinos (CEvNS). The detector consists of a quartz-jar-filled liquid Argon (LAr), which is spiked with ppm-levels of liquid Xenon (LXe) acting as a wavelength shifter. The target fluid is de-pressurized into a super-heated state by a mechanically controlled piston. Particles interacting with the superheated medium can generate heat (bubbles) and scintillation light, depending on the energy intensity and density. The detector is further equipped with cameras to take pictures of the bubbles, Silicon-Photo-Multipliers to measure the scintillation light, and piezo-acoustic sensors to listen to the bubble's formation. By combining these observables, the SBC detector is aiming to reach a threshold for nuclear recoils of 100 eV and a projected WIMP-sensitivity of 3.0x10-43 cm2, for a WIMP mass of 0.7 GeV/c2. In this talk, I will present the design of the SBC experiment and provide an update on the ongoing construction and commissioning at Fermilab. Finally, I will discuss the collaboration's plans for installation and operation at SNOLAB and the parallel reactor CEvNS search.

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Please select: Experiment or Theory

Experiment

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Presenter: GIAMPA, Pietro (SNOLAB)

Session Classification: Dark Matter Searches

Contribution ID: **64** Type: **Physics Beyond the Standard Model**

The DarkLight Experiment at TRIUMF and the Hunt for a New Boson

Friday, 18 February 2022 13:00 (24 minutes)

Despite the success of the Standard Model of particle physics, there are still phenomena such as dark matter that it doesn't explain. New particles light enough to be created at accelerators could resolve many of these issues, but could exist anywhere across a very wide range of masses and behaviours. Physicists are using many different experiments to search for them, each optimised for a different target. This talk will discuss the motivation for new bosons interacting with the dark sector and introduce a new experiment that will search for them: DarkLight, to be built at the 30 MeV ARIEL electron accelerator at TRIUMF.

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Experiment

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Session Classification: Particle Physics

Contribution ID: **65** Type: **not specified**

Exploring Novel Dark Matter-Neutrino Connections

Thursday, 17 February 2022 08:00 (24 minutes)

The recent discoveries of the Higgs boson and gravitational waves marked the triumph of two cornerstones of modern physics, the standard model of elementary particles and Einstein's theory of gravity. However, overwhelming evidence from cosmology suggests that the standard model is inadequate for understanding our universe. There is stuff gravitating that we cannot see with light. In particular, the identity of dark matter which comprises eighty-percent of the matter in the universe, remains unknown. In this talk, I will discuss potential intimate connections between dark matter and neutrinos from early universe to the present. I will tell a new story of an old dark matter candidate, the sterile neutrino, and highlight how theories for neutrino self-interaction are driving us to novel frontiers of dark matter searches.

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Please select: Experiment or Theory

Theory

Primary author: ZHANG, Yue

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Session Classification: Neutrino Physics/Dark Matter/Neutrinoless Double Betadecay

Contribution ID: **66** Type: **Nuclear and Particle Physics**

Accelerator Projects in Nuclear and Particle Physics - A Canadian Perspective

Friday, 18 February 2022 08:00 (24 minutes)

In this talk I will present developments and potential upgrades for TRIUMF's ARIEL and ISAC facilities from an accelerator physicist's point of view. I will start my talk with ongoing projects on ISAC, i.e increase beam time through model based beam tuning and reaching higher charge states with two frequency heating of the charge state booster. I will then continue with potential future upgrades to reach higher beam energies and adding a storage ring to the ISAC facility. Finally I will present examples how TRIUMF and UVic are involved in large international accelerator projects for particle physics.

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Instrumentation

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Session Classification: Instrumentation

Contribution ID: **67** Type: **Nuclear and Particle Physics**

Nucleosynthesis and Neutrinos in Explosive Astrophysical Events

Wednesday, 16 February 2022 08:00 (24 minutes)

The heaviest elements observed in nature are understood to be produced by the rapid neutron capture process (r process), but which astrophysical site(s) host this process remains an open question. The extreme astrophysical conditions required to synthesize neutron-rich nuclei points to explosive events, and in fact core-collapse supernovae (CCSNe) were a long favored site of heavy element production. However modern hydrodynamic simulations now predict CCSNe to not significantly synthesize elements past silver, leaving the origins of elements like europium, gold, and uranium uncertain. Excitingly, the era of multi-messenger observations of the gravitational waves, electromagnetic emission, and neutrino signals from events such as supernovae and neutron star mergers offers promising avenues to understand heavy element origins. Nuclear physics is simultaneously undergoing its own era of revolution, with both theoretical approaches and experiments such as those at TRIUMF pushing towards an understanding of the properties of neutron-rich species populated at crucial times during the r process. Since nucleosynthesis outcomes encode the interplay between nuclear physics, neutrino physics, and astrophysics, studies at the intersection of these areas present valuable opportunities for theory, experiment, and observation to inform one another. In this talk I will discuss the science questions driving my newly established research program at TRIUMF with the hopes of igniting new collaborations within the Canadian subatomic physics community.

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Theory

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Session Classification: Nuclear Physics / Nuclear Astrophysics / Gravitational Waves

Contribution ID: **68** Type: **not specified**

Invited Talk - Welcome

email address

Please select: Experiment or Theory

Session Classification: Particle Physics

Contribution ID: **69** Type: **not specified**

Invited Talk - Welcome

email address

Please select: Experiment or Theory

Session Classification: Nuclear Physics

Contribution ID: **70** Type: **Nuclear and Particle Physics**

St Talk

Session Classification: Nuclear Physics

Contribution ID: **71** Type: **not specified**

Invited Talk at 08:00 (Yue)

Session Classification: Neutrino Physics/Dark Matter/Neutrinoless Double Betadecay

Contribution ID: **72** Type: **not specified**

Welcome & Orientation

Presenter: FRANKE, Beatrice (TRIUMF)

Session Classification: Nuclear Physics

Contribution ID: **73** Type: **not specified**

Welcome & Orientation

Tuesday, 15 February 2022 08:00 (24 minutes)

Presenter: FRANKE, Beatrice (TRIUMF)

Contribution ID: **74** Type: **not specified**

Radioactive Molecules: Novel Probes for New Physics

Thursday, 17 February 2022 13:00 (24 minutes)

Molecules in which one or more of its constituting atoms contain a radioactive nucleus represent unexplored probes for new physics beyond the Standard Model of particle physics [1]. Radioactive atoms provide an additional degree of freedom to design molecular systems with, for instance, unmatched sensitivity to hitherto undiscovered permanent electric dipole moments (EDMs). Because of the link between EDMs and a violation of the combined symmetry of charge conjugation and parity (CP), the discovery of an EDM could resolve one of the most tantalising puzzles in contemporary physics, the matter-antimatter asymmetry in the universe.
In order to take advantage of the science potential of radioactive molecules, the newly-formed RadMol collaboration aims to establish a novel laboratory at TRIUMF, Vancouver, dedicated to the study of radioactive molecules and fundamental physics.
This talk will introduce the physics opportunities of radioactive molecules as well as new experimental methods necessary to master these unique precision probes.
[1] R. F. Garcia Ruiz et al., Nature 581, 396–400 (2020)

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Please select: Experiment or Theory

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Presenter: MALBRUNOT-ETTENAUER, Stephan (CERN)

Session Classification: Nuclear Physics

Contribution ID: **76** Type: **not specified**

Close out

Friday, 18 February 2022 15:20 (20 minutes)

Presenter: FRIESEN, Timothy (University of Calgary)