WNPPC2023 - 60th Winter Nuclear Particle Physics Conference

Report of Contributions

Contribution ID: **1** Type: **Contributed Oral**

Reconstruction of Semi-Leptonic Top Anti-top Pair Production with Deep Learning

Friday, 17 February 2023 22:00 (15 minutes)

As the heaviest known fundamental particle, the top quark plays a special role in many theories of new physics beyond the Standard Model. Reconstruction of top anti-top pair production to the best possible resolution is therefore crucial to enhancing our sensitivity to Beyond Standard Model effects in precision measurements and searches at the Large Hadron Collider (LHC), from improved mass resolutions for bump hunting to more diagonal unfolding matrices for differential cross-section measurements. As such, we've designed a deep neural network (TRecNet) that infers the four-vectors of the top and anti-top quarks from detector-level decay products in the semi-leptonic decay channel. The performance of TRecNet and several slight variations of the network are compared to traditional top reconstruction algorithms based on likelihood fits and are shown to improve upon both reconstruction efficiency and resolution.

Supervisor

Dr. Alison Lister

Funding Agency

NSERC

Supervisor Email

alister@phas.ubc.ca

Your Email

jennachisholm@phas.ubc.ca

Primary author: CHISHOLM, Jenna (The University of British Columbia)

Presenter: CHISHOLM, Jenna (The University of British Columbia)

Session Classification: February 17 Evening Session

Track Classification: Particle Physics

Contribution ID: **2** Type: **Contributed Oral**

The KDK Experiment: A novel measurement of ^{40}K for rare-event searches and geochronology

Sunday, 19 February 2023 09:00 (15 minutes)

Potassium-40 (^{40}K) is a naturally-occurring, radioactive isotope impacting understanding of nuclear structure, geological ages spanning timescales as old as the Earth, and rare-event searches including those for dark matter and neutrinoless double-beta decay. The long-lived ^{40}K radionuclide undergoes electron capture decays to either the excited or ground state of its Ar daughter, of which the latter has previously not been measured, and estimates of its branching ratio are highly variable ($I_{\mathrm{EC}^0} \sim (0-0.8)\%$). In many dark matter searches, ^{40}K contamination produces a challenging 3~keV background from these electron capture decays in the expected direct-detection signal region, and the ill-known ground state contribution may affect interpretation of the DAMA/LIBRA dark-matter claim. In geochronology, the common omission of this decay branch impacts calculated ages. This rare third-forbidden unique decay additionally provides an estimate for the associated weak axial-vector coupling constant, the quenching of which affects calculated half-lives of neutrinoless double-beta decay. The KDK ("potassium decay") experiment has completed the first, successful measurement of this elusive ^{40}K branch using a coincidence technique between a high-resolution silicon drift detector to observe X-rays, and a high-efficiency ($\sim 98\%$) Modular Total Absorption Spectrometer (Oak Ridge National Labs) to tag gammas, ultimately differentiating ground and excited state electron capture decays of ^{40}K. With our measurement, the re-evaluated ^{40}K decay scheme yields $I_{\mathrm{EC}^0} = 0.098\% \overset{\mathrm{stat}}{\pm} 0.023\% \overset{\mathrm{syst}}{\pm} 0.010\%$. We report on the ^{40}K analysis, the extensive applications of our measurement, and a complementary result for zinc-65.

Supervisor

Philippe Di Stefano

Funding Agency

Queen's University

Supervisor Email

distefan@queensu.ca

Your Email

16lmh@queensu.ca

Primary author: HARIASZ, Lilianna (Queen's University)

Co-authors: FIJALKOWSKA, A (University of Warsaw); RASCO, BC (Oak Ridge National Laboratory); ROULEAU, C (Oak Ridge National Laboratory); STRACENER, DW (Oak Ridge National Laboratory); LUKOSI, ED (University of Tennessee); PETRICCA, F (Max-Planck Institute for Physics); DAVIS, H (University of Tennessee); YAVIN, I; CARTER, J (Berkeley Geochronology Center); KOSTENSALO, J (Natural Resources Institute Finland); NINKOVIC, J (MPG Semiconductor Laboratory); SUHONEN, J (University of Jyvaskyla); GOETZ, KC (Oak Ridge National Laboratory); RYKACZEWSKI, KP (Oak Ridge National Laboratory); MORGAN, LE (U.S. Geological Survey); MANCUSO, M (Max-Planck Institute for Physics); STUKEL, M (Queen's University); WOLINSKA-CICHOCKA, M (Oak Ridge National Laboratory); BREWER, NT (Oak Ridge National Laboratory); LECHNER, P (MPG Semiconductor Laboratory); DI STEFANO, PCF (Queen's University); RENNE, PR (Berkeley Geochronology Center); ICKERT, RB (Purdue University); GRZYWACZ, RK (Oak Ridge National Laboratory); LIU, Y (Oak Ridge National Laboratory); GAI, Z (Oak Ridge National Laboratory)

Presenter: HARIASZ, Lilianna (Queen's University)

Session Classification: February 19 Morning Session

Track Classification: Nuclear Physics

Contribution ID: **3** Type: **Contributed Oral**

Higgs Boson Production via Quark mediated Gluon Fusion at High Energy at Next-to-Next-to-Leading Power in Quark Mass

Friday, 17 February 2023 11:45 (15 minutes)

In perturbative QCD, processes involving quark scattering provide the simplest way of studying non-Abelian scattering amplitudes. To that end, in this talk I will discuss our calculation for the Form Factor of the Higgs boson production via light quark mediated Gluon Fusion process in the high energy/small quark mass limit, where the leading contribution comes in the form of large double logarithms for each power of the strong coupling constant (α_s). We reproduced the leading coefficient (Next-to-Leading order in quark mass (m_q)) for the asymptotic expansion of the form factor in the high energy approximation; and extended the analysis to next coefficient which is at Next-to-Next-to-Leading order (O(m_q^3)). Three distinct sources of diagrams contribute to this coefficient at this order; the complete analytic result for which is presented at three loops. We also present all order analysis in the large-N_c limit of QCD as well as for the opposite Abelian limit. Our results provide a universal estimate of the light quark effects at the higher orders for both the Higgs boson production and decay processes.

Supervisor

Alexander Penin

Funding Agency

University of Alberta

Supervisor Email

penin@ualberta.ca

Your Email

smodi@ualberta.ca

Primary author: MODI, Sneh (University of Alberta)

Co-author: Prof. PENIN, Alexander

Presenter: MODI, Sneh (University of Alberta)

Session Classification: February 17 Morning Session

Track Classification: Electroweak and Higgs Physics

Contribution ID: **4** Type: **Contributed Oral**

Understanding Hadronic Mass Through Light Meson Structure at the EIC

Friday, 17 February 2023 11:00 (15 minutes)

The Electron-Ion Collider (EIC) is a new US$2 billion high-luminosity accelerator that is expected to be operational at Brookhaven National Laboratory, USA at the beginning of the next decade. One of the main goals of the EIC is to understand the origin of hadronic mass, this is the majority of visible mass (>99%) in the universe. From the little that we understand, we know that the mass of these systems is intricately connected to their internal structure. To understand this structure, and therefore these mass generation mechanisms, we can examine one of the simplest hadronic systems we know of, mesons. My research work involves the study of light mesons (in particular K+) through Deep Exclusive Meson Production (DEMP) reactions. I have recently upgraded a DEMP [1] event generator to investigate K+ structure studies at the EIC. In this talk, I will present an update on these ongoing K+ studies and the modifications to the DEMP event generator that were required to conduct this study.

[1] https://github.com/JeffersonLab/DEMPGen.

Supervisor

Garth Huber

Funding Agency

NSERC - SAPPJ 2021-00026

Supervisor Email

huberg@uregina.ca

Your Email

Love Preet

Primary author: PREET, Love (University of Regina)

Co-authors: Mr HUBER, Garth (University of Regina); Dr KAY, Stephen (University of Regina)

Presenter: PREET, Love (University of Regina)

Session Classification: February 17 Morning Session

Track Classification: Particle Physics

Contribution ID: **5** Type: **Contributed Oral**

The Electron Ion Collider –The Quest to Make Sense of QCD

Friday, 17 February 2023 10:45 (15 minutes)

Many important questions in Quantum Chromodynamics (QCD) remain unanswered, despite decades of investigation. For example, we cannot adequately explain how the fundamental properties (mass, spin) of objects such as the proton and neutron emerge from their constituent quarks and gluons. Interactions and structure in nuclear matter are intricately connected, the observed properties of composite objects emerge from this complex system. To attempt to understand these complex, dynamic systems requires a facility with a unique set of capabilities, the upcoming Electron-Ion Collider (EIC). The EIC is the only new accelerator facility scheduled to be built anywhere in the world in the coming decade. In this talk, I will outline the unique features of this facility and the fundamental questions that it seeks to answer, with a focus on Canadian contributions to this upcoming facility.

Supervisor

Garth Huber

Funding Agency

NSERC - SAPPJ-2021-00026

Supervisor Email

huberg@uregina.ca

Your Email

Stephen.kay@uregina.ca

Primary author: Dr KAY, Stephen (University of Regina)

Co-authors: Prof. HUBER, Garth (University of Regina); Mr PREET, Love (University of Regina)

Presenter: Dr KAY, Stephen (University of Regina)

Session Classification: February 17 Morning Session

Track Classification: QCD and Hadrons

Contribution ID: **6** Type: **Poster Presentation**

Beta-decay study of the shape coexistence in ^{98}Zr.

Understanding the phenomenon of shape evolution in atomic nuclei has been one of the main quests in nuclear physics. While throughout the nuclear chart the evolution of a spherical ground-state shape into a deformed one is usually a gradual process, in the Zr isotopic chain an abrupt shape transition is observed at N=60. This dramatic onset of deformation in ^{100}Zr was recently well reproduced in the state-of-the-art Monte Carlo Shell Model calculations, which also predict that the same deformed configuration may coexist at higher excitation energies in the lighter Zr isotopes. The ^{98}Zr is of particular interest in this regard as it is a transitional nucleus which lies on the interface between both spherical and deformed nuclear phases. Thus, significant amounts of experimental and theoretical research efforts have been made to study the shape coexistence phenomena in ^{98}Zr. While they demonstrate a good overall description of the ^{98}Zr nuclear structure, the interpretation of the higher-lying shape coexisting bands is still uncertain. In particular, several discrepancies between theoretically calculated and experimentally deduced reduced transition probabilities were noted, highlighting the need for further investigations.
Based on the above, a β-decay experiment was performed at TRIUMF-ISAC facility utilising the 8π spectrometer in conjunction with auxiliary β-particle detectors to measure the branching ratios and multipolarity mixing ratios for the transitions in ^{98}Zr. The high-quality and high-statistics data obtained with this setup allowed for the determination of branching ratios for very weak transitions important for assigning band structures. Furthermore, gamma-gamma angular correlation measurements enabled both spin assignments and mixing ratio determinations. The new results will be presented, and discussed in relation to both the MCSM and recent IBM configuration mixing calculations.

Supervisor

Paul Garrett

Funding Agency

NSERC

Supervisor Email

garrettp@uoguelph.ca

Your Email

kmastako@uoguelph.ca

Primary authors: OLAIZOLA, Bruno (CERN); MASTAKOV, Konstantin (University of Guelph); Prof. GARRETT, Paul (University of Guelph)

Co-authors: DIAZ-VARELA, A. (University of Guelph); Dr RADICH, A. J. (University of Guelph); CHESTER, Aaron (Simon Fraser University); GARNSWORTHY, Adam (TRIUMF); Dr LAFFOLEY, Alex (University of Guelph); HADINA, B. (University of Guelph); SINGH, B. (McMaster University); Prof. SVENSSON, C. (University of Guelph); Prof. ANDREOIU, Corina (Simon Fraser University); Dr CROSS, D. S.; RAND, E. T. (University of Guelph); DEMAND, G. A. (University of Guelph); DENG, G. (University of Guelph); BALL, Gordon (TRIUMF); HACKMAN, Greg (TRIUMF); DAWKINS, H. (University of Guelph); Dr PARK, J. (TRIUMF); MOUKADDAM, M. (TRIUMF); RAJABALI, M. (TRIUMF); VOSS, P. (Simon Fraser University); RIZWAN, U. (Simon Fraser University); Dr BILDSTEIN, Vinzenz (University of Guelph); WANG, Z. M. (TRIUMF)

Presenter: MASTAKOV, Konstantin (University of Guelph)

Session Classification: Poster Session

Track Classification: Poster

Contribution ID: **7** Type: **Contributed Oral**

From Spin to Structure: Beam Single-Spin Asymmetry in Exclusive Pion Production

Friday, 17 February 2023 11:30 (15 minutes)

The KaonLT/PionLT Collaboration probes hadron structure by measuring deep exclusive meson production reactions at Jefferson Lab. A set of high momentum, high resolution spectrometers in Hall C allow for precision measurements of cross sections at different kinematics, from which form factors and other observables can be extracted. One possible measurement from these reactions is the beam single-spin asymmetry. This asymmetry measures the fractional difference in yield caused by an electron of positive or negative helicity, and is caused by interference between longitudinally and transversely polarized virtual photons. Measuring the asymmetry probes the Generalized Parton Distributions (GPDs) of the proton, which describe its three-dimensional parton and spin structure. In this work, the asymmetry is studied for the $p + e \rightarrow e' + \pi + n$ data from the recent KaonLT experiment. The asymmetry is calculated for a photon virtuality Q^2 in the range between 2 and 5.5 GeV^2, above the resonance region (W>2 GeV), and the dependence of the asymmetry on the four-momentum transfer to the target t is determined. These results are then compared to theoretical models to determine what information can be extracted about the GPDs of the proton.

Supervisor

Garth Huber

Funding Agency

NSERC

Supervisor Email

huberg@uregina.ca

Your Email

acp548@uregina.ca

Primary author: POSTUMA, Alicia

Presenter: POSTUMA, Alicia

Session Classification: February 17 Morning Session

Track Classification: QCD and Hadrons

Contribution ID: **8** Type: **Poster Presentation**

An investigation of the pygmy dipole resonance in 92-Sr exploiting the beta decay of 92-Rb

Situated at the low-energy tail of the Giant Dipole Resonance (GDR), which is described as an out-of-phase oscillation between protons (Z) and neutrons (N), neutron-rich nuclei exhibit a small resonance like structure of additional electric dipole strength which has been denoted as the Pygmy Dipole Resonance (PDR). The PDR is interpreted, in a geometric picture, as an out-of-phase oscillation between the neutron-skin, formed by the excess neutrons, and an isospin saturated (N≈Z) core. From this, theoretical approaches have been used to connect the neutron-skin to the symmetry term of the nuclear binding energy and the nuclear equation of state. This interpretation however, is a matter of debate. It remains unclear how nuclear shell effects contribute to the electric dipole response while other mechanisms have been proposed. What is more certain, is the impact of additional E1 strength in the region of the neutron separation energy on neutron capture rates in astrophysical calculations.
For decades, Nuclear Resonance Fluorescence (NRF) has been the workhorse for experimental studies of the PDR. However, this method preferentially probes states with strong 1-particle 1-hole components in their wavefunction while information on states with a more complex structure remains missing. Recent studies highlight that for some nuclei, beta decay can be exploited as a complementary experimental probe of the PDR. Beta decay affords greater access to more complex states and overcome some experimental limitations of NRF.
A recent study of PDR states in 92Sr populated via beta decay of 92Rb was performed at TRIUMF with the Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei spectrometer (GRIFFIN). This decay is one of the three main contributors to the antineutrino spectrum and the reactor antineutrino anomaly. The results of this study significantly extend the level scheme of 92Sr and reveal that many states in the region of the PDR exhibit rich decay fragmentation.

Supervisor

Corina Andreoiu

Funding Agency

N/A

Supervisor Email

caa12@sfu.ca

Your Email

pietro_spagnoletti@sfu.ca

Primary author: SPAGNOLETTI, Pietro (Simon Fraser University)

Presenter: SPAGNOLETTI, Pietro (Simon Fraser University)

Session Classification: Poster Session

Track Classification: Poster

Contribution ID: **9** Type: **Contributed Oral**

Constraining the 90Sr Neutron Capture Rate with the Short-Lived 91Sr Nucleus

Sunday, 19 February 2023 09:15 (15 minutes)

Recent neutron-star merger observations have provided r-process abundance constraints, which has led to significant attention towards additional neutron-capture processes such as the i-process and n-process. Working between the rates and environmental neutron densities of the r-process and s-process, their reaction pathways and abundance contributions are not yet fully characterized. Operating in densities of 10^{13} - 10^{20} neutrons/cm^3, sensitivity studies have shown these intermediate neutron-capture processes to take reaction pathways through experimentally accessible n-rich nuclei, providing opportunities to constrain the capture rates that define them.

This contribution will review the β-Oslo analysis of ^{91}Sr, taken with the SuN total absorption spectrometer at the NSCL in 2018. By measuring both γ-ray and excitation energies, a coincidence matrix was produced to perform the Oslo analysis, providing experimental information on the nuclear level density and γ-ray strength functions, two critical components in finding the neutron capture cross section. Since neutron capture rates are historically unconstrained by experimental work, this provides an opportunity to further reduce these uncertainties, better characterizing the contribution of ^{91}Sr to these exotic capture processes.

Supervisor

Carl Svensson

Funding Agency

NSERC

Supervisor Email

sven@uoguelph.ca

Your Email

bgreaves@uoguelph.ca

Primary author: GREAVES, Beau (University of Guelph)

Presenter: GREAVES, Beau (University of Guelph)

Session Classification: February 19 Morning Session

Track Classification: Nuclear Physics

Contribution ID: **10** Type: **Contributed Oral**

Update On GPD Factorization Validity Studies For Meson Production

Saturday, 18 February 2023 17:30 (15 minutes)

The development of the GPD formalism in the last 25 years is a groundbreaking advance in our understanding of the structure of the nucleon. Unifying the concepts of parton distributions and of hadronic form factors, they contain a wealth of new information about how quarks and gluons make up hadrons. For example, GPDs correlate different parton configurations in the hadron at the quantum mechanical level. A recent theorem allows the reaction amplitude to be factorized into a hard part, representing the interaction of the incident virtual photon probe with the parton, and a soft part containing the GPD, representing the response of the nucleon to this interaction. This factorization relies on several assumptions that may not be true at low four momentum transfer (Q^2) for meson production. This presentation will give the projected results of the recently completed Pion-LT experiment from Jefferson Lab Hall C. These results will test the validity of GPD factorization in the range of Q^2 = 1.45 GeV^2 to Q^2 = 8.5 GeV^2, and will have implications for several GPD extraction experiments currently planned.

Supervisor

Garth Huber

Funding Agency

NSERC

Supervisor Email

huberg@uregina.ca

Your Email

heinricn@uregina.ca

Primary author: HEINRICH, nathan (Univeristy of Regina)

Presenter: HEINRICH, nathan (Univeristy of Regina)

Session Classification: February 18 Afternoon Session

Track Classification: Nuclear Structure

Contribution ID: **11** Type: **Contributed Oral**

Decay Rates of Positronium Species

Saturday, 18 February 2023 10:00 (15 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_2) stable with respect to auto-dissociation. In 2007, the existence of Ps_2 was confirmed experimentally by David Cassidy and Allen Mills at the University of California.

I will present a determination of the radiation-less and two photon decay rates of Ps_2. 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 para-positronium (p-Ps) and positronium ion (Ps^{-1}), I will present decay rate calculation of $Ps_2 \to e^- e^+$ and $Ps_2 \to \gamma\gamma$, and demonstrate that the previously published results are incorrect.

Supervisor

Andrzej Czarnecki

Funding Agency

Supervisor

Supervisor Email

andrzejc@ualberta.ca

Your Email

mmubashe@ualberta.ca

Primary authors: Prof. CZARNECKI, Andrzej (University of Alberta); MUBASHER, Muhammad (University of Alberta)

Presenter: MUBASHER, Muhammad (University of Alberta)

Session Classification: February 18 Morning Session

Track Classification: Particle Physics

Contribution ID: **12** Type: **Contributed Oral**

Detection of Supernova Neutrinos in the SNO+ Detector

Saturday, 18 February 2023 15:15 (15 minutes)

The SNO+ experiment is a multi-phase neutrino detector located at the SNOLAB underground physics laboratory in Sudbury, Ontario, Canada. Currently, the 12 m diameter acrylic vessel (AV) is filled with 780 tonnes of the liquid scintillator, linear alkylbenzene (LAB), doped with the fluor 2,5-diphenyloxazole (PPO) to a concentration of 2.2 g/L. The detector is viewed by approximately 9400 photomultiplier tubes (PMTs) and is surrounded by an additional shielding volume of 7000 tonnes of ultra-pure water. SNO+ has a myriad of physics goals, including the search for neutrinoless double beta decay ($0\nu\beta\beta$), refined measurements of the solar neutrino flux, and the potential for observing neutrinos in the case of a supernova event in the galaxy. A supernova releases 99% of its energy in the form of neutrinos, so any nearby supernova would produce a strong neutrino signal in neutrino detectors such as SNO+. This talk will cover the detection of supernova neutrinos in SNO+ as a liquid scintillator detector, and the potential of the water shielding volume to act as a water Cherenkov detector to provide additional directional information on a supernova event.

Supervisor

Mark Chen

Funding Agency

NSERC

Supervisor Email

prof.markchen@gmail.com

Your Email

j.corning@queensu.ca

Primary author: CORNING, Jasmine (Queen's University)

Presenter: CORNING, Jasmine (Queen's University)

Session Classification: February 18 Afternoon Session

Track Classification: Neutrino Properties

Contribution ID: **13** Type: **Contributed Oral**

SuperCDMS HVeV Detectors Analysis

Friday, 17 February 2023 19:45 (15 minutes)

As part of the Dark Matter search by SuperCDMS at SNOLAB, HVeV detectors are used to provide a mechanism of detecting eV-scale energies. HVeV detectors are typically made of high-purity silicon operating with a high bias voltage at sub-K temperatures. An excitation to the silicon generates electron/hole pairs that drift due to the bias voltage. The phonons produced by the drift are expected to be quantized to the fixed voltage and distance traveled by the electron/hole pair. However, statistical randomness and impurities in the silicon add additional artifacts that need to be considered. These include detector resolution and probabilities for impact ionization and charge trapping. Additionally, LED calibrations introduce additional artifacts such as non-quantized heating. We look at some of the potential explanations for this heating, and how they may affect previous and future runs at SNOLAB.

Supervisor

Dr. Scott Oser

Funding Agency

NSERC

Supervisor Email

oser@phas.ubc.ca

Your Email

musaab@phas.ubc.ca

Primary author: AL-BAKRY, Musaab (TRIUMF/UBC)

Presenter: AL-BAKRY, Musaab (TRIUMF/UBC)

Session Classification: February 17 Evening Session

Track Classification: Dark Matter Searches

Contribution ID: **14** Type: **Contributed Oral**

New model on nucleation efficiency of bubble chamber detectors

Sunday, 19 February 2023 11:15 (15 minutes)

Bubble chambers using fluorocarbons or liquid noble gases are promising technologies for detecting low-energy nuclear recoils from weakly interacting massive particles (WIMPs), a potential candidate for dark matter. In this study, we used molecular dynamics simulations to determine the energy threshold in superheated liquids and Monte Carlo simulations with SRIM to obtain the bubble nucleation efficiency of bubble chamber detectors. We aim to construct an accurate physics model to explain the discrepancy observed between experimental results and the current theoretical model. The new model combines the Lindhard theory, resulting in improved accuracy and a better prediction of the bubble nucleation efficiency and energy threshold. Our preliminary results are promising and will be presented against experimental data from C3F8 and xenon superheated liquid detectors.

Supervisor

Marie Cecile Piro

Funding Agency

University of Alberta

Supervisor Email

mariecci@ualberta.ca

Your Email

xli11@ualberta.ca

Primary author: LI, Xiang (University of Alberta)

Co-author: PIRO, Marie Cecile (University of Alberta)

Presenter: LI, Xiang (University of Alberta)

Session Classification: February 19 Morning Session

Track Classification: Dark Matter Searches

Contribution ID: **15** Type: **Contributed Oral**

AI/ML for Semi-Inclusive and Exclusive DIS Measurements

Friday, 17 February 2023 12:00 (15 minutes)

Deep Inelastic Scattering (DIS) is described by an exchange of virtual photons or, at high energies, the Z^0. The distinctive characteristic of DIS in contrast to many processes (such as pp at the LHC or pA at the RHIC) is that the kinematics are precisely computable from the leptonic (and hadronic) final state at all orders. DIS reconstruction has a strong dependence on the collision reconstruction quality and the underlying detector resolutions. The classical methods are an option for reconstruction with certain limitations, such as higher order QED radiation effects. Our approach is a neural network method for reconstruction which introduces smaller systematic errors in deep-inelastic scattering, since it has the advantage of weighting classical reconstructions and effectively utilizing information all over the available phasespace. This has been previously studied for the ZEUS experiment and applied to inclusive measurements with impressive results. The study involves using EIC simulations and collider data from ZEUS to apply the new method on the EPIC detector and extend it to exclusive measurements, which will be a novel approach.

Supervisor

Zisis Papandreou

Funding Agency

NSERC

Supervisor Email

zisis@uregina.ca

Your Email

soy062@uregina.ca

Primary author: ORESIC, Stjepan (University of Regina)

Presenter: ORESIC, Stjepan (University of Regina)

Session Classification: February 17 Morning Session

Track Classification: Particle Physics

Contribution ID: **16** Type: **Contributed Oral**

Global Analysis of the Protons Elastic Form Factors in the Space-like Region

Sunday, 19 February 2023 10:00 (15 minutes)

The response of the proton to elastic scattering events has long been known to be described via two functions of the squared momentum transfer Q^2: the Sachs electric and magnetic form factors $G_E\left(Q^2\right)$ and $G_M\left(Q^2\right)$, respectively. To understand this elastic structure of the proton there are two main observables which constrain the form factors: cross section data from elastic electron-proton scattering events, and polarization transfer measurements, which generate 'polarization ratio' data. After taking into account tree-level radiative corrections, separate fits of the form factors to these data lead to fits which disagree significantly with one another. Higher vertex corrections, especially two-photon-exchange corrections, have been assumed to play a larger role than previously thought in order to explain this discrepancy. We present our global reanalysis which takes special care to treat normalization uncertainties in a most statistically rigorous manner, with additional work done to understand how to extend certain statistical methods only defined for linear models, to non-linear models. We find only minor differences to fits when normalization uncertainty is correctly accounted for. We also present a simultaneous global fit to the two-photon-exchange corrected cross section data and polarization ratio data.

Supervisor

Dr. Peter Blunden

Funding Agency

WNPPC Graduate Student Travel Awards (Hopefully)

Supervisor Email

blunden@physics.umanitoba.ca

Your Email

mcraec3@myumanitoba.ca

Primary author: MCRAE, Craig (University of Manitoba)

Presenter: MCRAE, Craig (University of Manitoba)

Session Classification: February 19 Morning Session

Track Classification: Nuclear Physics

Contribution ID: **17** Type: **Contributed Oral**

Signal corrections using background detectors in MOLLER experiment

Thursday, 16 February 2023 20:30 (15 minutes)

Distinguishing between signal events and background events is the main issue in the integrating measurments of nuclear physics and particle physics experiments. Signal corrections can be accomplished either theoretically or experimentally. In the experimental approaches, a set of detectors called background detectors is implemented. In background detectors, the majority of particles generating the main signal are blocked and particles causing the background are detected.
The Measurement of a Lepton Lepton Electroweak Reaction (MOLLER) is an experiment that requires signal corrections to achieve precise measurements of parity-violating asymmetry (A_PV). MOLLER will measure A_PV in the scattering of longitudinally-polarized electrons from unpolarized target electrons to an accuracy of 2.4% using an 11 GeV beam in Hall A at Thomas Jefferson National Accelerator Facility (JLab). Required experimental corrections arise from background processes that are characterized by fractional dilution factors and background asymmetries. Pion dilution factors and asymmetries are a significant contribution to the experimental correction and will be measured in dedicated pion detectors optimized to maximize the signal from pions.
This talk will review the MOLLER experiment and detail the optimization processes for the pion detector system. It is followed by the verification of the results from the simulation through the cosmic test and a beam test at MAMI-B microtron at Mainz, Germany. We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC).

Supervisor

Wouter Deconinck

Funding Agency

Natural Sciences and Engineering Research Council of Canada (NSERC) MOLLER grant

Supervisor Email

wouter.deconinck@umanitoba.ca

Your Email

gorgannf@myumanitoba.ca

Primary author: Ms GORGANNEJAD, Fatemeh (University of Manitoba)

Presenter: Ms GORGANNEJAD, Fatemeh (University of Manitoba)

Session Classification: February 16 Evening Session

Track Classification: Physics Beyond the Standard Model

Contribution ID: **18** Type: **Contributed Oral**

Searches for periodic resonance signals in the e^+e^- and $\gamma\gamma$ channels at $\sqrt{s} = 13$ TeV in ATLAS

Thursday, 16 February 2023 20:00 (15 minutes)

We analyzed diphoton(e^+e^-) and dielectron($\gamma\gamma$) invariant mass spectrums in ATLAS to search for periodic resonance signals which are the decay products of clockwork gravitons predicted by the clockwork model. The clockwork model attempts to answer the hierarchy problem through a novel particle-generating mechanism. The name clockwork follows from the mechanics of obtaining a hierarchically larger field from a smaller field, which can address the hierarchical pattern of quark and lepton masses. We are interested in clockwork graviton because it also offers a solution to the naturalness problem of the electroweak scale. There are two undetermined parameters that define the theory, in addition to the graviton, which are the Higgs-curvature k, and the 5D fundamental Planck scale M_5. Monte Carlo graviton samples with different (k, M_5) are generated with *Pythia* and the detector responses to the graviton are simulated with the transfer method. We included a cascade of decay effect caused by the periodic mass feature, higher mass gravitons decays into lighter mass gravitons, and the process repeats with lighter mass gravitons forming a decay chain if kinematically allowed. A model-dependent (k, M_5) Fourier analysis is performed for the clockwork graviton signals; also a model-independent analysis is performed to search for any deviation from the standard model in the frequency domain. We have set the first exclusion limits for the phase-space (k, M_5) and are prepared to perform the unblinding studies.

Supervisor

Douglas Gingrich

Funding Agency

school / myself

Supervisor Email

gingrich@ualberta.ca

Your Email

hochun@ualberta.ca

Primary author: Prof. GINGRICH, Douglas (University of Alberta)

Co-author: LAU, Ho Chun (University of Alberta)

Presenter: LAU, Ho Chun (University of Alberta)

Session Classification: February 16 Evening Session

Track Classification: Physics Beyond the Standard Model

Contribution ID: **19** Type: **Contributed Oral**

Searching for Alpha-Cluster States in ^{126}Te

Saturday, 18 February 2023 11:15 (15 minutes)

Clustering in nuclei provides an alternative description to their nuclear structure in addition to the Nuclear Shell Model. Although alpha (^{4}He nucleus) clusters are widely accepted to be essential to the understanding of the structure of light nuclei, such as the Hoyle state in ^{12}C, it was experimentally observed in heavy nuclei only recently in ^{212}Po. The observation showed that ^{212}Po had mixed shell and cluster configurations, where the structure of ^{212}Po could be explained by an alpha cluster coupled to the doubly-magic ^{208}Pb core. In particular, the clustering structure resulted in enhanced $E1$ (electric dipole) transitions from non-natural parity states, which were measured using gamma-ray spectroscopy.

Another recent experiment at INFN Legnaro observed an excess cross section for the parasitic ^{122}Sn(^{13}C,^{9}Be)^{126}Te reaction. Because the fusion-evaporation cross section for this channel was negligible in PACE4 calculations, the ^{126}Te was likely populated through an alpha transfer reaction which suggests alpha-clustering in its structure. In this experiment gamma rays were detected with the GALILEO array which is composed of 25 Compton-suppressed HPGe detectors while charged particles with particle identification were detected in the EUCLIDES $E - \Delta E$ 4π Si-ball array. Gamma-ray spectroscopy with coincidence techniques, such as particle-particle, particle-gamma, and gamma-gamma, is underway to extract previously unobserved transitions and levels in ^{126}Te from this data set. Preliminary results from the Legnaro data, together with plans for a future experiment, will be presented and discussed.

Supervisor

Corina Andreoiu

Funding Agency

NSERC

Supervisor Email

caa12@sfu.ca

Your Email

twa73@sfu.ca

Primary authors: ANDREOIU, Corina (Simon Fraser University); WU, Frank (Tongan) (Simon Fraser University); ORTNER, Kevin (Simon Fraser University); SPAGNOLETTI, Pietro (Simon Fraser University)

Presenter: WU, Frank (Tongan) (Simon Fraser University)

Session Classification: February 18 Morning Session

Track Classification: Nuclear Structure

Contribution ID: **20** Type: **Contributed Oral**

Electromagnetic Transition Rate Studies in 28Mg

Saturday, 18 February 2023 11:45 (15 minutes)

Neutron rich Mg isotopes far from stability belong to a region known as the island of inversion where the single particle 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 matrix elements. These matrix elements can be studied through electromagnetic transition rate measurements, which allow for tests of theoretical models using the well-understood electromagnetic transition operators.

In-beam reaction experiments performed at TRIUMF, Canada's particle accelerator centre, allow for precise measurements of nuclei far from stability. Using TIGRESS in conjunction with the TIGRESS Integrated Plunger (TIP) allows for the implementation of Doppler shift techniques to measure transition rates in excited states of nuclei produced in low cross section reactions.

In June 2021, an experiment was performed using TIGRESS and TIP to measure excited state lifetimes in 28Mg using both the Doppler Shift Attenuation and Recoil Distance Methods to be sensitive to both short- and longer-lived states. ^{28}Mg nuclei were populated using the ^{12}C(^{18}O,2p) fusion-evaporation reaction, with charged particles detected using the TIP CsI(Tl) ball, and gamma rays detected using TIGRESS.

Event reconstruction using detector-specific time windows were applied to remove uncorrelated background, while particle identification of light-charged ions was performed using offline fitting of CsI(Tl) waveforms taken during data collection. The resulting spectra demonstrate the successful separation of reaction channels by particle content, essential for studying ^{28}Mg, as well as show clear evidence of the Doppler effects used to measure excited state lifetimes. The current status of data analysis and the impacts on nuclear physics will be discussed in this talk.

Supervisor

Krzysztof Starosta

Funding Agency

NSERC

Supervisor Email

starosta@sfu.ca

Your Email

matthew_martin_3@sfu.ca

Primary author: MARTIN, Matthew (Simon Fraser University)

Presenter: MARTIN, Matthew (Simon Fraser University)

Session Classification: February 18 Morning Session

Track Classification: Nuclear Structure

Contribution ID: **21** Type: **Contributed Oral**

Rapid characterization of SiPMs for nEXO and future noble liquid experiments

Saturday, 18 February 2023 15:00 (15 minutes)

Silicon photomultipliers (SiPMs) are an excellent solid-state photon detection technology that is becoming increasingly popular in the field of particle and medical physics. The features of SiPMs that make them an ideal candidate for photon detection are their compact size, lightweight, high gain, low operating voltage, low dark noise, and insensitivity to the magnetic field. The nEXO (Enriched Xenon Observatory) is a future tonne scale experiment that will be looking for neutrinoless double beta decay in the 136Xe isotope. Many large future experiments like nEXO, ARGO, etc. will be using SiPMs in their photon detection system. Newly developed vacuum ultraviolet (VUV) sensitive SiPMs will be directly used for the readout of xenon scintillation photons (λ = 175nm) in the nEXO experiment. In this research project, VUV-SiPMs from two different vendors are characterized using current-voltage (IV) and pulse-level measurements performed at TRIUMF, from room temperature to liquid xenon temperature. These data are analyzed to extract the SiPM's features like breakdown voltage, gain, dark noise rate and correlated noise probability. The results from IV and pulse analysis are compared. The method is proposed for rapid quality control of large numbers of SiPMs using IV measurements.

Supervisor

Dr. Simon Viel

Funding Agency

Arthur B. McDonald Canadian Astroparticle Physics Research Institute (Canada First Research Excellence Fund)

Supervisor Email

simonviel@cunet.carleton.ca

Your Email

bindiyachana@cmail.carleton.ca

Primary author: Ms CHANA, Bindiya (Carleton University)

Presenter: Ms CHANA, Bindiya (Carleton University)

Session Classification: February 18 Afternoon Session

Track Classification: Neutrino Properties

Contribution ID: **22** Type: **Contributed Oral**

Mirror symmetry in the f7/2 shell below 56Ni, excited states and electromagnetic transition rates in 55Ni and 55Co

Saturday, 18 February 2023 11:30 (15 minutes)

Nuclear theories often operate under the assumption that the strong nuclear force is charge independent. As a result, it is expected that mirror nuclei, which are identical under the exchange of total number of protons and neutrons, will have similar nuclear structures when Coulombic contributions are considered. Under the assumption of charge dependence, protons and neutrons are grouped together as nucleons which differ only by their isospin quantum number. However, the charge dependence of the strong nuclear force creates isospin non-conserving interactions which give rise to quantities like Mirror Energy Differences (MED) in analogous excited states for mirror nuclei which cannot be accounted for by Coulombic forces. Building a deeper understanding of isospin non-conserving interactions and how they affect nuclear structure will allow for more robust predictive powers in nuclear theories.

In order to explore the charge dependence of the strong force, a stable 20Ne beam experiment to produce 55Co was conducted at TRIUMF, Canada's national particle accelerator centre, with a complimentary radioactive 21Na beam experiment proposed for production of 55Ni. These experiments are conducted using TRIUMF's TIGRESS for gamma-rays, SFU's TIGRESS Integrated Plunger (TIP) for charged particle detection, 40Ca targetry, and the Doppler-Shift Attenuation Method (DSAM). The 55Ni experiment will also utilize TRIUMF's ElectroMagnetic Mass Analyzer (EMMA) for measurement of the A, Z, and energy of residual nuclei to enhance selectivity of reaction channels.

This talk will discuss how the 55Co experiment was conducted, the preliminary analysis of the resulting data set, as well as the lessons that will be carried forward for the 55Ni experiment. In addition to investigating the charge dependence of the strong interaction, this data will be utilized to explore the f7/2 hole configurations in 56Ni and electromagnetic transition rates for excited states of 55Ni and 55Co.

Supervisor

Krzysztof Starosta

Funding Agency

NSERC

Supervisor Email

starosta@sfu.ca

Your Email

h_asch@sfu.ca

Primary author: ASCH, Heinz (Simon Fraser University)

Presenter: ASCH, Heinz (Simon Fraser University)

Session Classification: February 18 Morning Session

Track Classification: Nuclear Structure

Contribution ID: **23** Type: **Contributed Oral**

Investigating the Nuclear Shell Evolution in Neutron-Rich Calcium

Saturday, 18 February 2023 10:45 (15 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 calcium 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 subsequent beta-decay. Preliminary results from the analysis of the gamma, beta, and neutron spectra will be presented and discussed in the context of shell model calculations in neutron-rich nuclei.

Supervisor

Carl Svensson

Funding Agency

NSERC

Supervisor Email

sven@uoguelph.ca

Your Email

rcolem01@uoguelph.ca

Primary author: COLEMAN, Robin (University of Guelph)

Co-authors: SVENSSON, C. (University of Guelph); RADICH, A. J. (University of Guelph); Mr TALEBIAHER, A. (University of Regina); GARNSWORTHY, Adam (TRIUMF); LAFFOLEY, Alex (GANIL); MACLEAN, Andrew (University of Guelph); OLAIZOLA, Bruno (CERN); Dr GRIFFIN, C. (TRIUMF); Dr PAXMAN, C. (TRIUMF); Dr PORZIO, C. (LLNL); Mr NATZKE, C.R. (TRIUMF); ANDREOIU, Corina (Simon Fraser University); YATES, Daniel (TRIUMF); Dr SARAZIN, F. (Colorado School of Mines); Dr GARCIA, F.H. (LLNL); WU, Frank (Tongan) (Simon Fraser University); Ms CARPENTER, G. (TRIUMF); BALL, Gordon (TRIUMF); GRINYER, Gwen (University of Regina); BIDAMAN, Harris (University of Guelph); Mr WHITMORE, K. (Simon Fraser University); Ms HANLEY, M. (Colorado School of Mines); ROCCHINI, Marco (University of Guelph, Guelph, Canada); MARTIN, Matthew (Simon Fraser University); GARRETT, Paul (University of Guelph); Dr LUBNA, R.S. (TRIUMF); Ms BUCK, Samantha (University of Guelph); SHARMA, Shivani (University of Regina); BHATTACHARJEE, Soumendu Sekhar (TRIUMF); ZIDAR, tammy (university of guelph); Dr VEDIA, V. (TRIUMF); BILDSTEIN, Vinzenz (University of Guelph)

Presenter: COLEMAN, Robin (University of Guelph)

Session Classification: February 18 Morning Session

Track Classification: Nuclear Structure

Contribution ID: **24** Type: **Contributed Oral**

Measurement of the inelasticity distribution of neutrino interactions for 100 GeV < E⍰ < 1 TeV with IceCube DeepCore

Saturday, 18 February 2023 15:30 (15 minutes)

We present results of an analysis studying neutrino-nucleon interactions in the energy range between ~100 GeV - 1 TeV by measuring the inelasticity of these interactions with IceCube DeepCore. IceCube is a Cherenkov neutrino telescope consisting of an optical sensor array placed in ice 1.5 - 2.5 km below the geographic South Pole and covering a volume of roughly 1 km3. DeepCore is a densely instrumented sub-array inside IceCube, which allows us to detect and reconstruct neutrinos with energies from ~5 GeV to 1 TeV with greater precision. IceCube has previously reported inelasticity distribution measurement at 1 TeV- 100 TeV and this analysis extends this range to lower energies to fill in the gap with accelerator measurements of differential cross section. We use a low-background sample of fully contained muon-neutrino charged current events to fit the shape of flux-averaged inelasticity distribution. In this talk we will present an updated result taking into account contribution from neutrino induced charm production.

Supervisor

Juan Pablo Yanez

Funding Agency

NSERC

Supervisor Email

j.p.yanez@ualberta.ca

Your Email

mliubars@ualberta.ca

Primary author: LIUBARSKA, Maria (University of Alberta)

Presenter: LIUBARSKA, Maria (University of Alberta)

Session Classification: February 18 Afternoon Session

Track Classification: Neutrino Properties

Contribution ID: **25** Type: **Contributed Oral**

How to consistently use modern nuclear forces in an ab initio technique

Sunday, 19 February 2023 09:30 (15 minutes)

One of the challenges faced while studying the nuclear many-body problem is the nature of the nucleon-nucleon interaction. The full details are described by the theory of Quantum Chromodynamics (QCD), but for realistic calculations approximate models must be used. Historically these have been phenomenological potentials fit to experimental data. However, in recent decades, models for the nucleon-nucleon interaction were produced from a power counting expansion in Chiral Effective Field theory (EFT). As a result, these modern nuclear interactions have an advantage over the phenomenological potentials, since they have a connection to the symmetries of the underlying theory of QCD.

To investigate the nuclear many-body problem, we employ an ab initio approach. Quantum Monte Carlo (QMC) consists of a family of powerful stochastic methods for solving the many-body Schrodinger equation. QMC methods provide very accurate results, at the cost of being computationally expensive. In addition to their accuracy, QMC methods have the benefit that we can build the appropriate physics, such as pairing, directly into them.

Combining these two tools, QMC methods and the Chiral-EFT derived nucleon-nucleon interaction, leads to something of a contradiction. The Chiral-EFT potential is designed to be used perturbatively at the many-body level, but this is almost never the case, due to the fact that combining a non-perturbative technique (QMC) with a perturbative potential is not a trivial problem. This work attempts to remedy this inconsistency. To show this, we explore a variety of low-density neutron matter systems that have a direct application to neutron-rich systems such as the inner crust of neutron stars.

Supervisor

Alexandros Gezerlis

Funding Agency

Natural Sciences and Engineering Research Council (NSERC) and Canada Foundation for Innovation (CFI)

Supervisor Email

gezerlis@uoguelph.ca

Your Email

curry@uoguelph.ca

Primary author: CURRY, Ryan (University of Guelph)

Co-authors: Dr LYNN, Joel; Dr GEZERLIS, Alexandros (University of Guelph); Dr SCHMIDT, Kevin (Arizona State University)

Presenter: CURRY, Ryan (University of Guelph)

Session Classification: February 19 Morning Session

Track Classification: Nuclear Physics

Contribution ID: **26** Type: **Poster Presentation**

Denoising of p-type point contact (PPC) HPGe detector signals with generative adversarial networks

High-purity germanium (HPGe) detectors are used in rare event searches such as neutrinoless double-beta decay, dark matter, and other beyond Standard Model physics. An efficient signal denoising algorithm can help advance these searches by improving energy resolution and background rejection techniques and allowing for the identification of low-energy signal events.

We present a machine learning based algorithm using generative adversarial networks (GAN) to reduce electronic noise in the charge pulses from a PPC HPGe detector.

Supervisor

Ryan D. Martin

Funding Agency

Queen's University

Supervisor Email

ryan.martin@queensu.ca

Your Email

tianai.ye@queensu.ca

Primary author: YE, Tianai (Queen's University)

Presenter: YE, Tianai (Queen's University)

Session Classification: Poster Session

Track Classification: Poster

Contribution ID: **27** Type: **Contributed Oral**

Searching for a Strongly Interacting Dark Sector at MoEDAL MAPP

Friday, 17 February 2023 09:15 (15 minutes)

There is strong evidence for the existence of Dark Matter. One possible form of Dark Matter is strongly self-interacting Dark Matter, or Strongly Interacting Massive Particles (SIMP), modelled after Quantum Chromodynamics (QCD). It should also be noted that, to date, no direct detection of any kind of dark matter has been made. Direct detection of dark matter at accelerators is a high priority and is part of the program for the MoEDAL experiment located at the LHC. The MAPP extension to the MoEDAL experiment focuses on searching for Mili-Charged Particles (mCPs), and Long-Lived Particles (LLP). In this talk, we will discuss meson-like SIMP, and its potential detectability at the MoEDAL MAPP experiment. In order to model this dark matter, we construct a Lagrangian describing dark-pions using an approach inspired by Chiral Perturbation theory, an effective field theory of QCD. To couple our model to the Standard Model, we include a vector portal term which kinetically mixes our dark gauge fields with standard model gauge fields. As part of our model, we also include a Wess-Zumino-Witten term, this term is important to control the overproduction of strongly self-interacting Dark Matter in the early universe. We focus on two processes: a Drell-Yan process involving a dark gauge field, which produces a pair of dark-pions, and photofusion of two dark photons to three dark-pions. Due to kinetic mixing, these dark-pions will have an effective electric charge that is a small fraction of that of the electron.

Supervisor

Pierre-Phillippe Ouimet

Funding Agency

NSERC

Supervisor Email

pierre-philippe.ouimet@uregina.ca

Your Email

sag498@uregina.ca

Primary author: ARIFEEN, Shafakat (University of Regina)

Presenter: ARIFEEN, Shafakat (University of Regina)

Session Classification: February 17 Morning Session

Track Classification: Dark Matter Searches

Contribution ID: **28** Type: **Contributed Oral**

Compton Polarimetry at the Electron-Ion Collider

Thursday, 16 February 2023 20:45 (15 minutes)

The US-based future Electron-Ion Collider is a novel tool to address some of the unexplained physics of nucleons, including how their constituents contribute to their properties like spin, mass, etc., by colliding highly polarized electron beams with polarized beams of protons or ions. The high-energy interactions between the electrons and protons help in understanding the internal structure of the proton and one needs to know the polarization of the electron beam used. This is possible using a Compton polarimeter, facilitating Compton scattering of this electron beam with a circularly polarized laser beam. The physical quantities measured in the scattering will correlate to the degree of polarization of the electron beam. My research involves the simulation of transverse and longitudinal polarization of the electron beam with more focus on the effect of transverse beam smearing on transverse polarization measurement. I also have extended the work to evaluate beam synchrotron radiation at different locations at the interaction point in the polarimeter. In this talk, I will be presenting some of the results obtained using the Monte Carlo method in Geant4 simulations.
I acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC) for this research.

Supervisor

Dr. Wouter Deconinck

Funding Agency

Natural Sciences and Engineering Research Council of Canada (NSERC)

Supervisor Email

wouter.deconinck@umanitoba.ca

Your Email

vijaya2@myumanitoba.ca

Primary author: VIJAY, Akshaya (University Of Manitoba)

Presenter: VIJAY, Akshaya (University Of Manitoba)

Session Classification: February 16 Evening Session

Track Classification: Particle Physics

Contribution ID: **29** Type: **Contributed Oral**

Cooling Analysis of HV MAPS Detector in Vacuum

Friday, 17 February 2023 11:15 (15 minutes)

The Measurement Of a Lepton Lepton Electroweak Reaction (MOLLER) experiment anticipates new dynamics beyond the standard model. The measurements are acquired by the scattering of longitudinally polarized electrons off the unpolarized electrons using a set of detectors in Hall A at Thomas Jefferson National Accelerator Facility (JLab) in Newport News, Virginia USA. In the present study, the ability of High Voltage Monolithic Active Pixel Sensors (HVMAPS) in the Hall A's Compton polarimeter is investigated to monitor the scattered electron profile. Monolithic active pixel sensors require an in-vacuum operation to allow low-momentum particles at high rates. To prevent damage, the electronics necessitate dissipating the heat and require a cooling system. The temperature measurement of the HVMAPS in vacuum is essential to understand the thermal properties of the pixel detector and cooling needs. This talk will review the continuous efforts towards the cooling strategies, structure modification, and other changes required to achieve in-vacuum operation. We acknowledge the support of the Natural Sciences and Engineering Research Council of Canada (NSERC).

Supervisor

Dr. Wouter Deconinck

Funding Agency

NSERC

Supervisor Email

wouter.deconinck@umanitoba.ca

Your Email

prabhak2@myumanitoba.ca

Primary authors: Ms SHEFALI, Shefali (University of Manitoba); Dr DECONINCK, Wouter (University of Manitoba)

Presenter: Ms SHEFALI, Shefali (University of Manitoba)

Session Classification: February 17 Morning Session

Track Classification: Particle Physics

Contribution ID: **30** Type: **Contributed Oral**

Fluorescent Properties of Clevios For Use As Electrodes In DarkSide-20K

Friday, 17 February 2023 09:30 (15 minutes)

Many particle and rare-event search detectors use liquid scintillators as the detection method. A popular candidate for scintillation fluids are noble elements such as Liquid Argon (LAr). LAr detectors typically store their scintillators inside an acrylic vessel, which can be coated with various materials. A common coating is 1,1,4,4-tetraphenyl-1,3-butadiene (TPB) which is a wavelength shifter that converts the ultraviolet (UV) scintillation into visible wavelengths that are detectable by the photodetectors, such as photomultiplier tubes. In the DarkSide-20K experiment clevios is an another coating on the acrylic, and will act as the electrodes. Acrylic is known to fluoresce in visible wavelengths when excited by UV light, and previous studies indicate that the clevios will also fluoresce under similar conditions, both of which could be a source of background in the experiment. The amount of light received by the photodetectors from the fluorescence can be compared to TPB when they are excited by the same wavelength and intensity of UV light. This comparison produces the relative light yield of acrylic or clevios to TPB. The fluorescence properties of these materials are measured at various temperatures between 300K and 4K. This includes all of the operating temperatures of noble liquids, with particular interest in 87K as that is the operating temperature of LAr, which is the liquid scintillator used in DarkSide-20k. The fluorescence properties are determined by exciting the acrylic using external UV sources to mimic scintillation events. We present the status of the study to determine the fluorescence of clevios, comparing it to standard materials used in liquid scintillators, such as TPB. These results will show how much clevios will contribute to background signals that are found in future liquid scintillator detectors.

Supervisor

Philippe Di Stefano

Funding Agency

NSERC

Supervisor Email

distefan@queensu.ca

Your Email

21nes8@queensu.ca

Primary author: SWIDINSKY, Nicholas (Queen's University)

Co-authors: Ms ELLINGWOOD, Emma (Queen's University); Mr HUCKER, Jonathan (Queen's University); Dr SKENSVED, Peter (Queen's University); Prof. DI STEFANO, Philippe (Queen's University)

Presenter: SWIDINSKY, Nicholas (Queen's University)

Session Classification: February 17 Morning Session

Track Classification: Dark Matter Searches

Contribution ID: **31** Type: **Contributed Oral**

Mitigating Cosmogenic Backgrounds in nEXO

Saturday, 18 February 2023 14:45 (15 minutes)

The nEXO experiment is a proposed neutrinoless double beta decay ($0\nu\beta\beta$) search in the isotope ^{136}Xe. $0\nu\beta\beta$ is a lepton number violating process, and a positive observation of this decay mode in any isotope would be a direct observation of physics beyond the standard model. Anticipated to be located 2 km underground at SNOLAB, nEXO aims to discover the Majorana nature of neutrinos with a half-life sensitivity to $0\nu\beta\beta$ exceeding 10^{28} years at the 90% confidence level. To reach this sensitivity goal, nEXO employs 5 tonnes of liquid xenon in a time projection chamber (TPC), and performs a multi-parameter fit to the dataset including event-level information on: the total energy deposited in the xenon, the position of energy deposits, and the topology of detected ionization clouds.

Stringent radiopurity requirements necessitate a 1.5 kilotonne water shield in order to reduce background contributions from ambient external radiation entering the TPC. Photomultiplier tubes (PMTs) instrumented inside the water shield tank will measure the Cherenkov light from passing atmospheric muons and other secondary particles to allow the vetoing of so-called cosmogenic backgrounds from the $0\nu\beta\beta$ dataset; this active shield is referred to as the Outer Detector.

This talk will overview nEXO's Outer Detector, cosmogenic background mitigation strategies, and introduce a GPU-accelerated ray-tracing software (Chroma) to simulate Cherenkov photons in the water and optimize nEXO's muon veto.

Supervisor

Thomas Brunner

Funding Agency

NSERC

Supervisor Email

thomas.brunner@mcgill.ca

Your Email

soud.alkharusi@mail.mcgill.ca

Primary author: AL KHARUSI, Soud (McGill University)

Co-authors: CADEN, Erica (SNOLAB); BRUNNER, Thomas (McGill/TRIUMF); COLLABORATION, nEXO

Presenter: AL KHARUSI, Soud (McGill University)

Session Classification: February 18 Afternoon Session

Track Classification: Neutrino Properties

Contribution ID: **32** Type: **Poster Presentation**

Delayed Charged Particle Spectroscopy with GRIFFIN

Naturally occurring explosive astrophysical events including x-ray bursts, supernovae, and neutron-star mergers are responsible for the synthesis of the majority of heavy elements in the universe. Short-lived rare isotopes, produced in the initial blast, will decay back to stability through β-decay and other modes of radioactivity. The properties of these exotic nuclei can be investigated in the lab with highly efficient detection instrumentation and intense beams of rare isotopes, available at TRIUMF's Isotope Separator and Accelerator (ISAC) facility. A new radiation detector array, consisting of six double-sided silicon strip detectors, is presently being developed by the nuclear physics group at the University of Regina that will be coupled with the GRIFFIN spectrometer at TRIUMF. This state-of-the-art detection system will allow new studies of exotic decay modes close to the proton drip line including α-decay and β-delayed charged-particle emission (βp, β2p, $\beta\alpha$p). An overview of the design and construction of the array will be presented.

Supervisor

Gwen Grinyer

Funding Agency

NSERC

Supervisor Email

Gwen.Grinyer@uregina.ca

Your Email

dsi491@uregina.ca

Primary author: SHAH, Dhruval (University of Regina)

Presenter: SHAH, Dhruval (University of Regina)

Session Classification: Poster Session

Track Classification: Poster

Contribution ID: **33** Type: **Contributed Oral**

Investigation of States Populated in the 102Ru(p,t)100Ru Two Neutron Transfer Reaction

Saturday, 18 February 2023 17:45 (15 minutes)

One of the foremost goals of nuclear physics is to provide an understanding of how nuclei are assembled from the basic constituent building blocks of protons and neutrons. Preceding studies have attempted to achieve this by observing the excitation's of nuclei under fine-tuned experimental conditions with the most advanced detectors available on the planet. Nevertheless, this initiative continues to present as extraordinarily non-trivial in nature, as these complex nucleic systems exhibit unique characteristics and trends in different areas of the chart of nuclides, many of which are yet to be fully understood and parameterized. A prime example of one such characteristic is the behaviour of collective states within the context of the shell model, and how this feature evolves in different Z areas of the chart of nuclides. With Z = 44 and N = 56, 100Ru lies near the middle of the Z = 40 − 50 shell, and ergo investigation into the excited states of this nucleus stands to offer an increased understanding of the evolution of collectivity in the Z = 40 − 50 region. The experiment under discussion herein focuses on the study of 100Ru via a two-neutron transfer reaction experiment that was performed using the Q3D magnetic spectrograph at the Maier-Leibnitz Laboratory, in Garching, Germany, in 2019. The experimental procedure employed the use of a 102Ru target which was bombarded with protons in order to effectively pick-up two neutrons from the target, resulting in the production of 100Ru. Removing a pair of particles from the system enables the study of the neutron-pair properties of the states observed in the reaction, which in turn renders a more robust understanding of the structure of 100Ru. Results of the analysis of this experiment will be discussed and their future significance will be highlighted.

Supervisor

Dr. Paul Garrett

Funding Agency

NSERC

Supervisor Email

garrettp@uoguelph.ca

Your Email

sbuck@uoguelph.ca

Primary author: BUCK, Samantha (University of Guelph)

Co-authors: RADICH, A. J. (University of Guelph); GREAVES, Beau (University of Guelph); SVENSSON, C. (University of Guelph); BURBADGE, Christina (University of Guelph); WIRTH, H.-F.; BIDAMAN, Harris (University of Guelph); ROCCHINI, Marco (University of Guelph, Guelph, Canada); GARRETT, Paul (University of Guelph); HERTENBERGER, R.; COLEMAN, Robin (University of Guelph); FAESTERMANN, T; BILDSTEIN, Vinzenz (University of Guelph); ZIDAR, tammy (university of guelph)

Presenter: BUCK, Samantha (University of Guelph)

Session Classification: February 18 Afternoon Session

Track Classification: Nuclear Structure

Contribution ID: **34** Type: **Contributed Oral**

Decay spectroscopy around neutron-rich 33Mg to probe the ”island of inversion”

Saturday, 18 February 2023 11:00 (15 minutes)

The term 'island of inversion'is used to refer to a region of the nuclear landscape in which deformed intruder configurations dominate nuclear ground states over the spherical configurations naively expected from the shell model. Theoretical models of the inversion mechanism can be tested through detailed studies of the nuclear structure of transitional nuclei, in which the normal and intruder configurations compete. One such transition occurs along the N = 20 isotones, where neutron-rich ^{32}Mg is known to have a deformed ground-state configuration, while ^{34}Si displays a normal ground state configuration. Previous studies of the intermediate N = 20 isotone ^{33}Al have yielded conflicting results regarding its structure. In the present work, ^{33}Al was studied through the β-decay of ^{33}Mg to clarify these discrepancies. A low-energy radioactive beam of ^{33}Mg was delivered at a rate of 10e3 ions/s by the Isotope Separator and Accelerator (ISAC-I) facility at TRIUMF. Data were collected with the GRIFFIN high-purity germanium γ-ray spectrometer coupled with the SCEPTAR plastic scintillator array and the ZDS (zero degree) β particle detectors. The high efficiency of the GRIFFIN detector provided new γ-γ coincidences to elucidate the excited state structure of ^{33}Al, and the capability of GRIFFIN to detect weak transitions has provided more complete β-decay branching ratios for the decay chain. Results following the β-decay of neutron-rich ^{33}Mg are presented. Approximately 10^8 γ-γ coincidences were used to build level schemes for ^{33}Al and ^{32}Al. γ-gated time spectra were fit to calculate half-lives of ^{33}Mg, ^{32,33}Al and ^{33}Si. β counts were used to calculate β-feeding to the levels of the scheme of ^{33}Al, including the ground state. Clarification of ^{33}Al level scheme, and expansion of ^{32}Al are presented.

Supervisor

Dr. Carl E. Svensson

Funding Agency

NSERC, Canada Foundation for Innovation, National Research Council Canada and Department Of Energy grant DE-SC0016988

Supervisor Email

sven@uoguelph.ca

Your Email

tzidar@uoguelph.ca

Primary author: ZIDAR, tammy (university of guelph)

Co-authors: GARNSWORTHY, Adam (TRIUMF); LAFFOLEY, Alex (GANIL); OLAIZOLA, Bruno (CERN); GRIFFIN, C. (TRIUMF); PAXMAN, C. (TRIUMF); PORZIO, C. (LLNL); SVENSSON, C. (University of Guelph); NATZKE, C.R. (TRIUMF); CARPENTER, G. (TRIUMF); BALL, Gordon (TRIUMF); HACKMAN, Greg (TRIUMF); DILLMANN, Iris (TRIUMF); WHITMORE, K. (Simon Fraser University); RAJABALI, M. (TRIUMF); LUBNA, R.S. (TRIUMF); KANUNGO, Rituparna (Saint Mary's University); BHATTACHARJEE, Soumendu Sekhar (TRIUMF); VEDIA, V. (TRIUMF); BILDSTEIN, Vinzenz (University of Guelph); SAITO, Yukiya (The University of British Columbia / TRIUMF)

Presenter: ZIDAR, tammy (university of guelph)

Session Classification: February 18 Morning Session

Track Classification: Nuclear Structure

Contribution ID: **35** Type: **Contributed Oral**

High Precision Half Life Measurement of 26Na with GRIFFIN

Saturday, 18 February 2023 17:15 (15 minutes)

A high-precision half-life measurement for the radioactive isotope, 26Na, was performed at TRIUMF's Isotope Separator and Accelerator (ISAC) facility. This is the first experimental test of the high-efficiency Gamma-Ray Infrastructure for Fundamental Investigations of Nuclei (GRIFFIN) spectrometer for performing high precision (± 0.05% or better) half-life measurements [1]. In this talk, I will discuss new results of the half-life obtained from gating on 1809-keV γ-ray photopeaks that include corrections for pile-up and deadtime losses. The results obtained from these techniques will be compared to a previous high-precision measurement of the that employed direct β counting [2].
KEYWORDS: **radioactive isotope, half-life, deadtime, pile-up**

References

1. A. B. Garnsworthy *et al., Nucl. Instrum. Methods Phys. Res. A*, vol. **918**, 0168-9002, (2019).
2. G. F. Grinyer *et al., Phys. Rev. C.* vol. **71**, 044309, (2005).

Supervisor

Gwen Grinyer

Funding Agency

NSERC & University of Regina

Supervisor Email

gwen.grinyer@uregina.ca

Your Email

ericgyabeng2012@gmail.com

Primary authors: FUAKYE, Eric Gyabeng (University of Regina); GRINYER, Gwen (University of Regina)

Co-authors: RADICH, A. J. (University of Guelph); GARNSWORTHY, Adam (TRIUMF); DIAZ VARELA, Alejandra (University of Guelph); LAFFOLEY, Alex (GANIL); Dr TALEBITAHER, Alireza (University of Regina); MACLEAN, Andrew (University of Guelph); JIGMEDDORJ, Badamsambuu (University of Guelph); OLAIZOLA, Bruno (CERN); SVENSSON, C. (University of Guelph); NATZKE, C.R. (TRIUMF); BURBADGE, Christina (University of Guelph); ANDREOIU, Corina (Simon Fraser University); ALI, Fuad (Univerity of Guelph); BALL, Gordon (TRIUMF); GARTH, Huber (University of

Regina); Dr LONG, J. (University of Notre Dame); LESLIE, James R. (Queen's University); SMALLCOMBE, James (TRIUMF); WHITMORE, K. (Simon Fraser University); KAPOOR, Kushal (University of Regina); LEACH, Kyle (Colorado School of Mines); DUNLOP, Michelle (University of Guelph); SAEI, Nastaran (University of Regina); BERNIER, Nikita (TRIUMF/UBC); COLEMAN, Robin (University of Guelph); CABALLERO-FOLCH, Roger (TRIUMF); DUNLOP, Ryan (University of Guelph); SHARMA, Shivani (University of Regina); BHATTACHARJEE, Soumendu Sekhar (TRIUMF); ZIDAR, Tammy (University of Guelph); BILDSTEIN, Vinzenz (University of Guelph)

Presenter: FUAKYE, Eric Gyabeng (University of Regina)

Session Classification: February 18 Afternoon Session

Track Classification: Nuclear Physics

Contribution ID: **36** Type: **Contributed Oral**

Laser Calibration Studies Using the ALPHA-g Detector

Saturday, 18 February 2023 09:15 (15 minutes)

ALPHA-g has completed a successful run in 2022 in the pursuit of measuring the gravitational mass of antihydrogen. This apparatus was designed to test 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 uses electrically neutral antihydrogen atoms produced in a vertical Penning-Malmberg trap and trapped in a magnetic minimum trap. By measuring the antihydrogen annihilation positions after a controlled magnetic release of the atoms the gravitational mass of antihydrogen can be determined. Annihilation positions are reconstructed with a radial time projection chamber (rTPC) surrounding the trapping volume.
To accurately determine vertical annihilation positions, precise detector calibrations are needed. A laser calibration system was developed and used to gather drift time data in the rTPC, which results in vertical position information, and can be used to monitor changes in pressure, temperature, and magnetic field. In particular, we can calculate the Lorentz angle using the drift time, which is then used in reconstruction to accurately determine the annihilation positions. This results in precise measurements for the gravitational mass of antihydrogen.
In this talk I will discuss the laser calibration system for the rTPC and the results of the drift time data taken over the course of the 2022 run period. I will further discuss how these results are used in the reconstruction of antihydrogen annihilations.

Supervisor

Timothy Friesen

Funding Agency

NSERC, CFI

Supervisor Email

timothy.friesen@ucalgary.ca

Your Email

pooja.woosaree@ucalgary.ca

Primary author: WOOSAREE, Pooja (University of Calgary)

Presenter: WOOSAREE, Pooja (University of Calgary)

Session Classification: February 18 Morning Session

Track Classification: Particle Physics

Contribution ID: **37** Type: **Contributed Oral**

An Auxiliary ATLAS Detector to Enhance the Detection of Long Lived Particles

Thursday, 16 February 2023 19:45 (15 minutes)

Several models that provide solutions to the Standard Model's open problems allow for the possibility of long lived particles (LLPs) with lifetimes, in some cases, in excess of 10^3 seconds. It is proposed that charged LLPs produced at the Large Hadron Collider could interact with the ATLAS detector, eventually coming to rest and decaying. Other LLPs, such as neutral particles, may also exit ATLAS and decay in flight just outside the detector. We propose a low cost scintillating detector to be placed above the ATLAS detector to measure LLP signals as they decay within ATLAS during technical stops and other "beam off"times, thus minimizing Standard Model background. The same detector would provide a decay volume outside of ATLAS to detect LLP decays in flight during normal operation. To illustrate the efficacy of the proposed detector we simulate the production, interaction, and decay of long lived particles within select models.

Supervisor

James Pinfold

Funding Agency

NSERC

Supervisor Email

jpinfold@ualberta.ca

Your Email

jmkelly1@ualberta.ca

Primary author: KELLY, Joseph Mitchell (University of Alberta)

Presenter: KELLY, Joseph Mitchell (University of Alberta)

Session Classification: February 16 Evening Session

Track Classification: Physics Beyond the Standard Model

Contribution ID: **39** Type: **Contributed Oral**

Anti-Hydrogen Detection and Background Rejection for ALPHA-g

Saturday, 18 February 2023 09:30 (15 minutes)

Antimatter lies at the heart of many of the universe's unanswered questions, but direct study of antimatter structures is technically difficult. ALPHA-g promises the first direct free-fall observation of the Earth's gravitational force acting on anti-atoms, by precisely recording the annihilation positions of anti-hydrogen atoms after a controlled release from a magnetic trap. Reconstructing these annihilations is a unique challenge requiring a specialized detector system. Furthermore, due to low antihydrogen yield and the slow release timescale, the cosmic ray background provides a an additional obstacle which requires a secondary detector system to overcome. I describe the implementation of the ALPHA-g time projection chamber and "barrel scintillator"cosmic ray veto, and showcase their ability to meet these goals.

Supervisor

Makoto Fujiwara

Funding Agency

NSERC

Supervisor Email

fujiwara@triumf.ca

Your Email

gsmith@triumf.ca

Primary author: SMITH, Gareth (UBC/TRIUMF)

Presenter: SMITH, Gareth (UBC/TRIUMF)

Session Classification: February 18 Morning Session

Track Classification: Particle Physics

Contribution ID: **40** Type: **Contributed Oral**

Status of NEWS-G3 Experiment and Muon Veto System

Friday, 17 February 2023 10:00 (15 minutes)

The NEWS-G experiment searches for low-mass dark matter candidates at SNOLAB in Sudbury, Ontario. The direct dark matter search is performed using a spherical proportional counter (SPC) filled with light atomic mass gases. NEWS-G3 is a proposed experiment that employs the same technology as the NEWS-G experiment to search for coherent elastic neutrino-nucleus scattering (CEνNS) at a nuclear reactor. NEWS-G3 will consist of a 60-cm high purity copper SPC implemented in a compact shield consisting of many different layers of material. One layer of shielding is an active muon veto system consisting of plastic scintillators coupled with a photomultiplier tube (PMT). In this presentation, I will present the current status of the NEWS-G3 experiment at Queen's University and the commissioning of the muon veto system.

Supervisor

Guillaume Giroux

Funding Agency

CERC, CFI, NSERC, MI

Supervisor Email

ggiroux@owl.phy.queensu.ca

Your Email

hayden.meadows@queensu.ca

Primary author: MEADOWS, Hayden (Queen's University)

Presenter: MEADOWS, Hayden (Queen's University)

Session Classification: February 17 Morning Session

Track Classification: Dark Matter Searches

Contribution ID: **42** Type: **Contributed Oral**

Measurement of kaon-carbon forward scattering with EMPHATIC spectrometer

Saturday, 18 February 2023 17:00 (15 minutes)

The precision measurements of neutrino oscillation parameters and neutrino-nucleus scattering and also unprecedented sensitivity to physics beyond the Standard Model are the goals of the next generation of long-baseline neutrino experiments. To achieve this high precision and sensitivity, these experiments need a reduction of the uncertainties in neutrino flux calculations. New measurements of hadron-nucleus interaction cross sections are needed to reduce uncertainties of neutrino fluxes. 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 aims to measure hadron scattering and production cross sections that are relevant for neutrino flux predictions. In my presentation, I will show measurements of the differential cross-section as a function of scattering angle for kaon-carbon interactions with a single charged particle in the final state at beam momenta of 30 GeV/c. These results can be used in current and future long-baseline neutrino experiments, and demonstrate the feasibility of future measurements by the EMPHATIC spectrometer.

Supervisor

Nikolay Kolev

Funding Agency

NSERC

Supervisor Email

Nikolay.Kolev@uregina.ca

Your Email

b.ferrazzi@gmail.com

Primary author: Mr FERRAZZI, Bruno (University of Regina)

Presenter: Mr FERRAZZI, Bruno (University of Regina)

Session Classification: February 18 Afternoon Session

Track Classification: Nuclear Physics

Contribution ID: **43** Type: **Contributed Oral**

MUTE: A Modern Calculation for Deep Underground and Underwater Muons

Sunday, 19 February 2023 11:00 (15 minutes)

I present a new, open-source, pure Python program, MUTE (MUon inTensity codE) (A. Fedynitch, W. Woodley, M.-C. Piro 2022 ApJ 928 27). MUTE combines the state-of-the-art codes MCEq (Matrix Cascade Equation) and PROPOSAL (PRopagator with Optimal Precision and Optimised Speed for All Leptons) to compute cosmic ray cascades in the atmosphere and the propagation of muons through matter in separate steps. It is efficient, precise, and flexible, as the most recent theoretical models can be changed in the code independently of each other. Using these tools, MUTE provides forward predictions for muon intensities in mines or under mountains deep underground and underwater laboratories, accurately characterising the uncertainties arising from hadron production models. MUTE can also provide full information about muon energy and angular spectra underground. The control of theoretical uncertainties allows us to accurately predict the total muon rates and their seasonal variations to calculate muon-induced backgrounds in underground Dark Matter and neutrino detectors.

Supervisor

Marie-Cécile Piro

Funding Agency

McDonald Institute

Supervisor Email

mariecci@ualberta.ca

Your Email

wwoodley@ualberta.ca

Primary author: WOODLEY, William (University of Alberta)

Co-author: PIRO, Marie Cecile (University of Alberta)

Presenter: WOODLEY, William (University of Alberta)

Session Classification: February 19 Morning Session

Track Classification: Dark Matter Searches

Contribution ID: **44** Type: **Contributed Oral**

Adiabatic transport of ultracold polarized neutrons for the TUCAN EDM experiment

Friday, 17 February 2023 21:15 (15 minutes)

The TUCAN EDM experiment at TRIUMF will use polarized, ultracold neutrons (UCNs) to search for the neutron electric dipole moment (nEDM). The discovery of a permanent nEDM would indicate the violation of time reversal symmetry, and thus charge-parity symmetry (given the CPT theorem). This would point to physics beyond the Standard Model of Particle Physics. To achieve the projected sensitivity of the experiment of $1 \cdot 10^{-27} e$cm, a stable and homogeneous magnetic field is required in the inner most experiment region. This is mainly achieved with the use of a magnetically shielded room (MSR). To preserve the polarization of the neutrons between the UCN source and the MSR, magnetic guiding fields must be applied throughout the neutron guides between these two sections. Any losses in neutron polarization will directly affect the statistical sensitivity of the nEDM search. In this presentation I will outline the requirements of the guiding fields based on adiabatic spin transport theory and show my current work towards designing and prototyping this critical subsystem.

Supervisor

Beatrice Franke

Funding Agency

NSERC

Supervisor Email

bfranke@triumf.ca

Your Email

eklemets@triumf.ca

Primary author: KLEMETS, Emma (TRIUMF)

Presenter: KLEMETS, Emma (TRIUMF)

Session Classification: February 17 Evening Session

Track Classification: Particle Physics

Contribution ID: **45** Type: **Poster Presentation**

Thereshold Aerogel Cherenkov detectors of Water Cherenkov Test Experiment (WCTE)

Aerogel threshold Cherenkov detectors are supposed to be used, in combination with time of flight detectors, as part of the particle identification system of Water Cherenkov Test Experiment (WCTE). In this work, the characteristics and design of these aerogel threshold Cherenkov detectors are given, and with the aide of Monte Carlo simulations, the effects of several parameters on improvement of light collection efficiency are studied.

Supervisor

Dr. Nikolay Kolev

Funding Agency

Hyper-Kamiokande

Supervisor Email

Nikolay.Kolev@uregina.ca

Your Email

syn920@uregina.ca

Primary author: YOUSEFNEJAD, Sirous (Universit of Regina)

Presenter: YOUSEFNEJAD, Sirous (Universit of Regina)

Session Classification: Poster Session

Track Classification: Poster

Contribution ID: **46** Type: **Contributed Oral**

New results from the NEWS-G dark matter experiment

Friday, 17 February 2023 20:00 (15 minutes)

In the Fall of 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. Having the sphere filled with pure methane, hydrogen was used as the target to produce new limits on the spin-dependent cross-section around masses of 1 GeV.
This talk will first describe the commissioning at the LSM with the shielding used, the SPC detection principle and the new multi-anode sensor. It will then focus on the energy calibration using a UV laser and argon-37, as well as the background discrimination methods to remove alpha-induced events and electronic spike signals. The talk will conclude with a presentation of recent results from NEWS-G and the status of the current commissioning of the detector at SNOLAB.

Supervisor

Guillaume Giroux

Funding Agency

Arthur B. McDonald Canadian Astroparticle Physics Research Institute

Supervisor Email

ggiroux@owl.phy.queensu.ca

Your Email

jeanmarie.coquillat@queensu.ca

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

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

Session Classification: February 17 Evening Session

Track Classification: Dark Matter Searches

Contribution ID: **47** Type: **Contributed Oral**

Machine Learning for Noise Removal in NEWS-G

Friday, 17 February 2023 20:15 (15 minutes)

In this talk I will present preliminary results regarding the application of machine learning techniques for noise removal on signals from spherical proportional counters (SPCs) with the NEWS-G experiment. In SPC detectors, a primary ionization, created by a particle interacting with the gas, drifts towards a central anode. When ions approach the anode, the electric field becomes strong enough to trigger secondary ionizations, resulting in an amplified detector signal. 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.

Supervisor

Guillaume Giroux

Funding Agency

Arthur B. McDonald Institute, Canada Excellence Research Chairs, Natural Sciences and Engineering Research Council of Canada, and CFI

Supervisor Email

ggiroux@owl.phy.queensu.ca

Your Email

noah.rowe@queensu.ca

Primary author: ROWE, Noah (Queen's University)

Presenter: ROWE, Noah (Queen's University)

Session Classification: February 17 Evening Session

Track Classification: Dark Matter Searches

Contribution ID: **48** Type: **Poster Presentation**

Decay γ-spectroscopy of neutron-rich Ge - Br isotopes around A ~ 90 - 100

Nuclear data calculated by theoretical models play a large role in our understanding of the r-process due to the experimental difficulties in producing these very neutron-rich nuclei directly. In turn, experimental data are crucial in validating and constraining these models with the focus often on nuclear masses, half-lives and neutron emission probabilities. Nuclear structure also plays a key role and cutting-edge nuclear models have shown decay properties such as half-lives and P_n values to exhibit significant sensitivity to both nuclear shape and the competition between allowed Gamow-Teller (GT) and first-forbidden (FF) β-transitions. This sensitivity is particularly evident around shell closures and the mid-shell region. However, little to no γ-spectroscopy data exist for neutron-rich isotopes in the N ~ 60, A ~ 90 - 100 region.

Installed at RIKEN Nishina Center's RIBF facility since 2016, the BRIKEN collaboration has significantly extended the envelope of known decay data for β-delayed neutron emitters between A = 70 and 170, contributing hundreds of new and more precise β-decay half-lives and neutron emission probabilities. In addition to the silicon implantation detector AIDA and the array of ^{3}He neutron counters, the BRIKEN array also includes two HPGe clovers to allow coincident γ-ray spectroscopy.

Presented here is the first look at γ-spectroscopy data obtained using the BRIKEN detector in neutron-rich Ge, As, Se and Br isotopes around N ~ 60 and A ~ 100. This region shows a mini-peak in observed r-process abundance distribution, most likely originating from nuclear structure effects like strong deformation. However, despite a similar potential production mechanism, this area has so far received much less attention from the r-process community than the rare-earth peak at A ~ 160. This analysis offers a first look into the decay patterns of the most neutron-rich Ge, As, Se and Br isotopes.

Supervisor

I. Dillmann

Funding Agency

NSERC

Supervisor Email

dillmann@triumf.ca

Your Email

cgriffin@triumf.ca

Primary authors: GRIFFIN, Chris (TRIUMF); DILLMANN, Iris (TRIUMF); CABALLERO-FOLCH, Roger (TRIUMF); Mr SEXTON, Lewis (TRIUMF); CARPENTER, G. (TRIUMF); RYKACZEWSKI, KP

(Oak Ridge National Laboratory); TAIN, Jose-Luis (IFIC Valencia); GRZYWACZ, RK (Oak Ridge National Laboratory); NISHIMURA, Shunji (RIKEN Nishina Center)

Presenter: GRIFFIN, Chris (TRIUMF)

Session Classification: Poster Session

Track Classification: Poster

Contribution ID: **49** Type: **Contributed Oral**

Overview and New Results from the PICO Dark Matter Search Experiment

Friday, 17 February 2023 09:45 (15 minutes)

The PICO collaboration aims to use superheated bubble chambers for the direct detection of dark matter, particularly in the spin-dependent WIMP-proton regime. PICO-40L is the current generation dark matter detector that is currently in the final stages of construction 2km underground at SNOLAB. It will be anticipating first commissioning results and early physics results early next year. The results from PICO-40L are expected to lead to a new world leading limit or discovery of dark matter. They will also inform the design and operation of a much larger next generation detector, PICO-500, currently in the design & fabrication phase. This presentation will be a brief overview on the current status of the PICO experiment and the first physics results.

Supervisor

Tony Noble

Funding Agency

NSERC

Supervisor Email

noblet@queensu.ca

Your Email

minya.bai@queensu.ca

Primary author: BAI, Minya (Queen's University)

Presenter: BAI, Minya (Queen's University)

Session Classification: February 17 Morning Session

Track Classification: Dark Matter Searches

Contribution ID: **50** Type: **Contributed Oral**

Commissioning of a Paul trap for Collinear Laser Spectroscopy of Exotic Radionuclides performed in a 30 keV MR-ToF device

Friday, 17 February 2023 21:30 (15 minutes)

The Multi-Ion Reflection Apparatus for Collinear Laser Spectroscopy (MIRACLS) is a novel approach in performing high-resolution collinear laser spectroscopy (CLS) in a multi-reflection time-of-flight (MR-ToF) device. By trapping a 30-keV ion beam in-between the MR-ToF's electrostatic mirrors and revolving it around a few thousand times through an optical detection region (ODR), significant gains in experimental sensitivity can be achieved compared to a single passage in conventional CLS. This increase will allow for studying exotic radionuclides that are produced with low yields at radioactive ion beam facilities such as ISOLDE at CERN or ISAC and ARIEL at TRIUMF, thus opening a new region of the nuclear chart to CLS experiments.

In order to fully benefit from the MIRACLS approach, the MR-ToF device requires cooled ion bunches with strict emittance requirements. This necessitates the use of a dedicated Paul trap tailored to match ion-bunch properties to the MR-ToF requirements.

In this presentation we will describe the MIRACLS concept, its science goals, and its current status with an emphasis on the recent commissioning of its Paul trap. Experimentally, the Paul trap is shown to provide ion bunches with temporal widths of 123 ns (FWHM), well matched to perform highly sensitive CLS of exotic radionuclides in the MIRACLS MR-ToF device.

Supervisor

Stephan Malbrunot-Ettenauer

Funding Agency

NSERC

Supervisor Email

sette@triumf.ca

Your Email

lcroquette@triumf.ca

Primary author: CROQUETTE, Louis (McGill University)

Co-authors: Mr BUCHINGER, Fritz (McGill University); Mr MALBRUNOT-ETTENAUER, Stephan (TRIUMF, University of Toronto)

Presenter: CROQUETTE, Louis (McGill University)

Session Classification: February 17 Evening Session

Track Classification: Particle Physics

Contribution ID: **51** Type: **Contributed Oral**

An Introduction to the TUCAN EDM Measurement

Friday, 17 February 2023 21:00 (15 minutes)

The TUCAN collaboration aims to make a measurement of the neutron electric dipole moment (nEDM) with a precision of 10⁻²⁷ e cm, an order of magnitude improvement over the current best limit. A non-zero nEDM would be explicit evidence for CP violation in the Standard Model. This, in turn, contributes to solving the longstanding baryon asymmetry problem. Such a measurement requires an immense effort with careful coordination between many different subsystems. This talk will introduce how the nEDM measurement is conducted, the challenges involved, how these subsystems work together to overcome these challenges, and the current state of these systems at TRIUMF.

Supervisor

Beatrice Franke

Funding Agency

NSERC

Supervisor Email

bfranke@triumf.ca

Your Email

dfujimoto@triumf.ca

Primary author: FUJIMOTO, Derek (TRIUMF)

Presenter: FUJIMOTO, Derek (TRIUMF)

Session Classification: February 17 Evening Session

Track Classification: Particle Physics

Contribution ID: **52** Type: **Contributed Oral**

Magnetic Fields During Gravitational Experiments with Antihydrogen

Saturday, 18 February 2023 09:45 (15 minutes)

The Antihydrogen Laser Physics Apparatus (ALPHA) collaboration uses low energy antiprotons to produce, trap, and study the bound state of an antiproton and positron, antihydrogen. Hydrogen has been studied extensively through history and has many physical properties known to a high precision experimentally and theoretically. Therefore, comparisons between hydrogen and its antimatter equivalent offer highly sensitive tests of many fundamental symmetries. In a new venture, ALPHAg, the collaboration is attempting to observe the effect of Earth's gravity on antihydrogen through a controlled magnetic release.

ALPHAg will store low field seeking antihydrogen in a vertical magnetic minima trap, two short solenoids providing vertical confinement will then be slowly ramped down. Due to the difference in height between the two solenoids the trapping potential is different at each end by $mg\Delta h$, given this potential difference antihydrogen will "fall"in a direction biased by g and annihilate. Since this potential difference is equivalent to a ~ 4.5 Gauss magnetic field variation, and with a background field changing from 17000 Gauss to 10000 Gauss during release, it is clear this is only achievable through careful design, control, and measurement of magnetic fields.

I will introduce a technique developed in ALPHA that determines the in situ magnetic fields by measuring the cyclotron frequency of an electron plasma. I will then lay out the necessary steps to display control and understanding of the magnetic environment by showing results of extensive mapping of the on-axis field of several magnets, and characterisations of field drifts in the experiment. Finally, I will discuss the prospects and challenges related to making a measurement in a dynamic magnetic field in preparation for a gravity measurement.

Supervisor

Dr Timothy Friesen

Funding Agency

University of Calgary, Canadian Institute of Nuclear Physics

Supervisor Email

timothy.friesen@ucalgary.ca

Your Email

adam.powell1@ucalgary.ca

Primary author: POWELL, Adam (University of Calgary)

Presenter: POWELL, Adam (University of Calgary)

Session Classification: February 18 Morning Session

Track Classification: Particle Physics

Contribution ID: **53** Type: **Contributed Oral**

Bound-state beta-decay of Thallium-205 to constrain s-process predictions for the early Solar System

Saturday, 18 February 2023 16:15 (15 minutes)

Bound-state β-decay (β_b^--decay) is a radically transformative decay mode that can change the stability of a nucleus and generate temperature- and density-dependent decay rates. In this decay mode the β-electron is created directly in a bound atomic orbital of the daughter nucleus instead of being emitted into the continuum, so the decay channel is only significant in almost fully stripped ions during extreme astrophysical conditions. The β_b^--decay of $^{205}Tl^{81+}$ could influence our understanding of the production of ^{205}Pb, a short-lived radioactive (SLR) nucleus that is fully produced by the s-process in stars. In the context of the early Solar system, SLRs are defined by half-lives of 0.1-100 My and their abundance in meteorites can be used to constrain the formation of the Solar System [1]. Historically, it has been noted that thermal population of the 2.3 keV state of ^{205}Pb in stellar conditions could dramatically reduce the abundance of s-process ^{205}Pb by speeding up the EC-decay to ^{205}Tl. This destruction of ^{205}Pb is potentially balanced by the β_b^--decay of $^{205}Tl^{81+}$ [2]. Currently, a theoretical prediction for the half-life of fully stripped ^{205}Tl is used in stellar models, but given the importance of the $^{205}Pb/^{205}Pb$ chronometer, a measurement of the β_b^--decay for $^{205}Tl^{81+}$ was conducted at the GSI Heavy Ion Facility in March 2020. A $^{205}Tl^{81+}$ beam was stored in the Experimental Storage Ring, and the growth of $^{205}Pb^{81+}$ daughters with storage time was directly attributable to the β_b^--decay channel. The authors will report a preliminary measured half-life and detail how this half-life can be used to more accurately predict the ^{205}Pb abundance in the early Solar System.

[1] M. Lugaro, et al. Progress in Particle and Nuclear Physics, 102:1–47, 2018.
[2] K. Yokoi, et al. Astronomy and Astrophysics, 145:339–346, 1985.

Supervisor

Iris Dillmann

Funding Agency

NSERC

Supervisor Email

dillmann@triumf.ca

Your Email

gleckenby@triumf.ca

Primary authors: LECKENBY, Guy (TRIUMF); Dr CHEN, Rui Jiu (GSI Helmholtzzentrum für Schwerionenforschung GmbH); SIDHU, Ragandeep Singh (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI)); Dr MANCINO, Riccardo (GSI Helmholtzzentrum für Schwerionenforschung GmbH); Prof. LITVINOV, Yuri (GSI Helmholtzzentrum für Schwerionenforschung GmbH); Prof. TAKAHASHI, Kohji (GSI Helmholtzzentrum für Schwerionenforschung GmbH); GLORIUS, Jan (GSI Helmholtz Center Darmstadt); Prof. MARTINEZ PINEDO, Gabriel (GSI Helmholtzzentrum für Schwerionenforschung GmbH); Dr WEICK, Helmut (GSI Helmholtzzentrum für Schwerionenforschung GmbH); DILLMANN, Iris (TRIUMF); GRIFFIN, Chris (TRIUMF); Dr PIGNATARI, Marco (Konkoly Observatory); Dr LUGARO, Maria (Konkoly Observatory); Dr BATTINO, Umberto (University of Hull); Ms KAUR, Tejpreet (Panjab University Chandigarh); Dr CRISTALLO, Sergio (National Institute of Astrophysics INAF, Abruzzo Observatory); Dr VESCOVI, Diego (Goethe University Frankfurt); Dr FAESTERMANN, Thomas (Technische Universitat Munchen); Dr GERNHAUSER, Roman (Technische Universitat Munchen)

Presenter: LECKENBY, Guy (TRIUMF)

Session Classification: February 18 Afternoon Session

Track Classification: Nuclear Physics

Contribution ID: **55** Type: **Contributed Oral**

Mass measurements of neutron-deficient strontium–implications for the rp-process and isospin symmetry

Saturday, 18 February 2023 16:30 (15 minutes)

Precision mass measurements of neutron-deficient fp-shell nuclei near N=Z are of interest to the nuclear physics community because they are relevant to several research areas. First is that these nuclei are situated along the reaction path of the rapid proton capture process (rp-process) which powers type I X-ray bursts. Precision mass values are required for the calculation of astrophysical reaction rates which constrain uncertainty of the mass flow, the burst light curve, and the burst ashes produced. Precision mass measurements in this region are also valued as probes for studying the properties of isospin-symmetry breaking in nuclei via the isobaric mass multiplet equation (IMME). Experimental data on IMME b and c coefficients are used to construct isospin non-conserving shell model Hamiltonians which provide a grounds for investigating isospin non-conserving interactions and also provide a baseline for mass extrapolations. Experimental data presently only enables evaluations of the c coefficients up to the mid-fp-shell at A=60. We report on precision mass measurements of neutron-deficient, upper-fp-shell nuclei $^{74-76}$Sr performed at TRIUMF with TITAN's multi-reflection time-of-flight mass spectrometer. This mass measurement campaign constitutes a first-time direct measurement of ^{74}Sr, a first-time measurement of ^{75}Sr, and improved mass precision of ^{76}Sr. We give preliminary results on the effects that the new mass data have on the rp-process flow, type I X-ray burst ashes, and the IMME b and c coefficients.

Supervisor

Thomas Brunner

Funding Agency

NSERC

Supervisor Email

thomas.brunner@mcgill.ca

Your Email

zachary.hockenbery@mail.mcgill.ca

Primary authors: KWIATKOWSKI, Anna (TRIUMF); Mr SCHATZ, Hendrik (Michigan State University, National Superconducting Cyclotron Laboratory); BRUNNER, Thomas (McGill/TRIUMF); Mr MURBOECK, Tobias (University of Giessen); HOCKENBERY, Zachary (McGill)

Presenter: HOCKENBERY, Zachary (McGill)

Session Classification: February 18 Afternoon Session

Track Classification: Nuclear Physics

Contribution ID: **56** Type: **Contributed Oral**

SuperCDMS Background Explorer Functionality and Validation

Friday, 17 February 2023 19:30 (15 minutes)

The SuperCDMS SNOLAB experiment is a next-generation direct detection dark matter search experiment with an anticipated world-leading sensitivity to particles with masses $\leq$ 10 GeV/c^2. The experiment is currently under construction at SNOLAB in Sudbury, Ontario. The unique facility, located 2 km underground, offers abundant shielding against cosmic rays. The SuperCDMS experiment requires a low background environment. All materials surrounding the experiment are assayed as they could contain impurities that can decay radioactively and cause an interaction within the detectors. As a result, various isotopes in these enveloping materials will have their expected background simulated and estimated. Furthermore, contributions from neutrinos and cosmic rays whose spectra are calculated analytically can be taken into account. Background Explorer is a python/web toolkit used for book-keeping background estimations for the SuperCDMS experiment as well as other experiments, including the Cryogenic Underground TEst facility (CUTE) at SNOLAB and the Deep Underground Neutrino Experiment (DUNE). Background Explorer takes an input of components, simulation datasets, and assay data to construct background spectra and display results in a user-friendly web interface. This presentation will demonstrate the functionality of Background Explorer V2 and its validation against the previously estimated backgrounds for SuperCDMS.

Supervisor

Dr. Miriam Diamond and Dr. Ziqing Hong

Funding Agency

University of Toronto

Supervisor Email

mdiamond@physics.utoronto.ca and zqhong@physics.utoronto.ca

Your Email

tj.martin@mail.utoronto.ca

Primary author: MARTIN, Tyler (University of Toronto)

Presenter: MARTIN, Tyler (University of Toronto)

Session Classification: February 17 Evening Session

Track Classification: Dark Matter Searches

Contribution ID: **57** Type: **Contributed Oral**

Development of the Detector Array for Energy Measurement of Neutrons (DAEMON)

Sunday, 19 February 2023 09:45 (15 minutes)

As one moves away from stable isotopes and deeper into the neutron-rich region, the likelihood of β-delayed neutron (βn) emission decay increases. The ability to understand the neutron emission probabilities and the neutron energy spectrum can reveal highly sensitive detail of the nuclear structure that a conventional β-decay study using only γ-ray detection cannot. We propose to build the Detector Array for Energy Measurements of Neutrons (DAEMON) that will employ the time-of-flight technique to enable high-resolution energy measurements of the neutrons emitted following βn emission. The initial trials, performed at the University of Guelph, testing the rudimentary geometries of EJ200 plastic scintillators and various electronic parameters of silicon photomultiplier (SiPM) arrays for the foundation of DAEMON will be presented. Upon successful comparison of tests with gamma sources with simulations data, the DAEMON prototype will be tested with the monoenergetic neutron beam at the University of Kentucky Accelerator Laboratory. Used in conjunction with the GRIFFIN Decay Station at TRIUMF in Vancouver, BC, DAEMON will establish a frontier for βn studies currently non-existent at the facility and therefore initiating a road to strong international collaborations. From shaping the abundance curve of the astrophysical rapid neutron capture process, as well as controlling the neutron induced fission in nuclear reactions, the building of a neutron detector will address a broad arena of physics.

Supervisor

Dr. Paul Garrett

Funding Agency

NSERC

Supervisor Email

garrettp@uoguelph.ca

Your Email

zarin@uoguelph.ca

Primary author: AHMED, Zarin Tasnim (University of Guelph)

Co-authors: GARNSWORTHY, Adam (TRIUMF); Ms RADICH, Allison (University of Guelph); BIDAMAN, Harris (University of Guelph); DILLMANN, Iris (TRIUMF); MASTAKOV, Konstantin (University of Guelph); GARRETT, Paul (University of Guelph); BILDSTEIN, Vinzenz (University of Guelph)

Presenter: AHMED, Zarin Tasnim (University of Guelph)

Session Classification: February 19 Morning Session

Track Classification: Nuclear Physics

Contribution ID: **64** Type: **Contributed Oral**

Singlet and triplet pairing in nuclear and cold atomic systems

Saturday, 18 February 2023 16:45 (15 minutes)

Nuclear pairing, i.e., the tendency of nucleons to form pairs, has important consequences to the physics of neutron star crusts and heavy nuclei. The usual pairing found in nuclei happens between identical nucleons and in singlet states, while recent investigations have shown that certain heavy nuclei might exhibit triplet and mixed-spin pairing correlations in their ground states. In this talk, I will present new investigations on the effect of nuclear deformation on these novel superfluids. Signatures of these pairing effects can be directly seen in nuclear experiments on spectroscopic quantities and two-particle transfer direct reaction cross sections. Indirectly, pairing correlations of nuclear superfluidity can be probed in cold-atomic experiments utilizing Feshbach resonances. On that note, preliminary results on phenomenological investigations of s- and p-wave pairing in cold-atomic gases will also be discussed.

Supervisor

Alexandros Gezerlis

Funding Agency

NSERC and CFI

Supervisor Email

gezerlis@uoguelph.ca

Your Email

gpalkano@uoguelph.ca

Primary author: PALKANOGLOU, Georgios (University of Guelph)

Co-authors: GEZERLIS, Alex (University of Guelph); Mr HICKS, Caleb (Michigan State University); Prof. LEE, Dean (Michigan State University); Mr GIVEN, Gabriel (Michigan State University); Prof. SCHMIDT, Kevin (Arizona State University); Dr GANDOLFI, Stefano (Los Alamos National Lab)

Presenter: PALKANOGLOU, Georgios (University of Guelph)

Session Classification: February 18 Afternoon Session

Track Classification: Nuclear Physics

Contribution ID: **66** Type: **Contributed Oral**

Background simulations on Charged-Lepton Flavour Violation (CLFV) in the Leptoquark framework at the EIC

Thursday, 16 February 2023 20:15 (15 minutes)

The discovery of neutrino oscillations provided evidence of lepton flavour vi- olation. In this work, we carry out the background simulations in the leptoquark framework. Leptoquarks are bosons which carry lepton and baryon numbers, coupling leptons to quarks and mediating charged lepton flavour violation pro- cesses at tree-level. The goal of this work is to study charged lepton flavour violations at the EIC based on the real detector simulations concentrating on three main background events, Charged Current Deep Inelastic Scattering (CC DIS), Neutral Current Deep Inelastic Scattering (NC DIS) and Photoproduc- tion. The plan is to simulate higher statistics of these background events by using the Djangoh MC event generator for neutral and charged currents and Pythia8 for photoproduction while applying selection criteria on higher statis- tical input events compared to what was done before with ECCE.

Supervisor

Wouter Deconinck

Funding Agency

University of Manitoba

Supervisor Email

wouter.deconinck@umanitoba.ca

Your Email

qunib@myumanitoba.ca

Primary authors: QUNI, Bardh (Uni); DECONINCK, Wouter (University of Manitoba)

Presenter: QUNI, Bardh (Uni)

Session Classification: February 16 Evening Session

Track Classification: Physics Beyond the Standard Model

Contribution ID: **67** Type: **Contributed Oral**

Study of W Boson Production in Association with Two Jets using Boosted Decision Trees on Data Collected by the ATLAS Detector.

Sunday, 19 February 2023 10:30 (15 minutes)

As a fundamental interaction of the Standard Model, the electroweak production of a W boson in association with two jets in proton-proton collisions is of particular interest due to its sensitivity to vector boson fusion, a topic of high interest at the Large Hadron Collider as it's study can yield valuable information about the anomalous triple gauge couplings. By employing a machine learning network using boosted decision trees,high dimensional data collected by the ATLAS detector at CERN can be reduced to a single dimension. Applying an extended likelihood fit to this reduced dimension will yield a total fiducial cross section measurement, providing additional information towards our goal of improved understanding of the triple gauge couplings.

Supervisor

Alain Bellerive

Funding Agency

NSERC

Supervisor Email

alainb@physics.carleton.ca

Your Email

Matthewsmith12@cmail.carleton.ca

Primary author: SMITH, Matthew (Carleton)

Presenter: SMITH, Matthew (Carleton)

Session Classification: February 19 Morning Session

Track Classification: Particle Physics

Contribution ID: **68** Type: **Contributed Oral**

Core-collapse Supernova Constraint on the Origin of Sterile Neutrino Dark Matter via Neutrino Self-interactions

Sunday, 19 February 2023 10:45 (15 minutes)

I will present a constraint on the sterile-neutrino dark matter through neutrino self-interaction inside a core-collapse supernova. The environment inside a core-collapse supernova has similar features as the early universe era where the sterile-neutrino dark matter is dominantly produced. I will start by showing how a massive scalar mediated neutrino self-interaction can affect the cooling rate of a core-collapse supernova. Then I will present the effect on the cooling luminosity, including the contributions to the thermal potential in the presence of non-zero chemical potentials from the plasma species. We will see that the supernova cooling argument can set a useful constraint on the neutrino self-interaction parameter space.

Supervisor

Yue Zhang

Funding Agency

Arthur B. McDonald Canadian Astroparticle Physics Research Institute

Supervisor Email

yzhang@physics.carleton.ca

Your Email

yumingchen@cmail.carleton.ca

Primary authors: Dr TUCKLER, Douglas (Carleton University); Dr SEN, Manibrata (Max Planck Institute for Nuclear Physics); Prof. TANGARIFE, Walter (Loyola University); CHEN, Yu-Ming (Carleton University); Prof. ZHANG, Yue (Carleton University)

Presenter: CHEN, Yu-Ming (Carleton University)

Session Classification: February 19 Morning Session

Track Classification: Physics Beyond the Standard Model

Contribution ID: **71** Type: **Poster Presentation**

Experiment with neutron-rich Cs beams at TRIUMF and DESCANT detector maintenance

Nuclear structure properties of many isotopes in the neutron-rich region are still unknown. Detection systems that focus on this region are an important part of nuclear physics studies. At TRIUMF, the gamma-decay spectroscopy GRIFFIN facility, and its ancillary detectors, such as the neutron-tagging DESCANT detector, allows the study of many of these nuclei. From these studies, we can learn about the r-process nucleosynthesis and better understand the nuclear structure of exotic isotopes.

This poster will show the current maintenance process of DESCANT. This work is important to preserve the performance of the 70 detectors that make up the array and its future experiments. In addition, the status of the analysis of a GRIFFIN experiment aiming to determine 148-150Ba properties using Cs beams will be reported.

Supervisor

Roger Caballero-Folch

Funding Agency

TRIUMF NSERC

Supervisor Email

rcaballero-folch@triumf.ca

Your Email

mberube@triumf.ca

Primary author: BERUBE, Madeleine (TRIUMF/University of Waterloo)

Presenter: BERUBE, Madeleine (TRIUMF/University of Waterloo)

Session Classification: Poster Session

Track Classification: Poster

Contribution ID: **72** Type: **Poster Presentation**

Design and evaluation of laser ion source in TITAN to measure 222Rn progeny product abundances

Radon is a radioactive gas that arises from the radioactive decay of uranium and thorium minerals. It emerges from the ground and can enter homes, where it can decay and attach to dust particles, both of which can be inhaled. The alpha emissions from radon decay can cause DNA damage in lung tissue, increasing the risk of lung cancer [1,2]. Assessing radon exposure is important as it is the leading cause of lung cancer for Canadians who do not smoke. Canadian national action thresholds for unacceptable radon exposure are 200 Bq/m3, with any levels at or above 100 Bq/m3 showing statistically significant increase in lung cancer risk [3]. A practical tool to assess lifetime radon exposure is being developed using the Multiple Reflection Time-Of-Flight Mass Spectrometer (MR-TOF-MS) at TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN) to measure the low amounts of 210Pb in biological samples [4].
This project aims to design and build a laser ablation ion source that will be coupled with MR-TOF-MS system to measure the abundance of long-lived and stable isotopes. It uses a UV laser that generates ions from different materials, the laser beam is focused on the sample surface with a spot size of tens of micrometers, and the sample is scanned using a motorized mirror. The ions produced are then directed to a quadrupole bender that bends the ion beam 90 degrees and then to an Einzel lens which focuses the beam into MR-TOF-MS for isotope abundance measurement.
The experiment uses isotope abundance ratio measurement, specifically the ratio of 210Pb to 208Pb, to calculate the abundance of 210Pb. The method involves independent measurement of lead stable isotopes using ICP-MS and MR-TOF-MS. The measurement error is reduced by this method and systematic bias is assessed by using standard reference material [5]. The goal is to develop a personalized radon bio-dosimeter by measuring the number of accumulated atoms in a person's biological tissue.

Supervisor

Dr. Michael Wieser

Funding Agency

University of Calgary

Supervisor Email

mwieser@ucalgary.ca

Your Email

behnam.ashrafkhan1@ucalgary.ca

Primary author: Mr ASHRAFKHANI LIMOUDEHI, Behnam (University of Calgary)

Co-authors: Dr GOODARZI, Aaron (University of Calgary); KWIATKOWSKI, Anna (TRIUMF); Dr CHAMBERS, Chris (TRIUMF); Dr PEARSON, Dustin (University of Calgary); Dr MILLER, Kerri (University of Calgary); Dr WIESER, Michael (University of Calgary); Prof. IAN THOMPSON, Robert (University of Calgary)

Presenter: Mr ASHRAFKHANI LIMOUDEHI, Behnam (University of Calgary)

Session Classification: Poster Session

Track Classification: Poster

Contribution ID: **73** Type: **Contributed Oral**

The Experimental Study of Shape Coexistence in 114Sn Using the GRIFFIN Spectrometer

Saturday, 18 February 2023 12:00 (15 minutes)

The nucleus, made up of protons and neutrons, exhibits a shell-like structure consisting of orbitals described by quantum mechanics. This has been demonstrated by extensive experimental observables, which reveal that nuclei possessing specific "magic numbers" of neutrons or protons exhibit particular characteristics well described in the nuclear shell model. The tin isotopes, with a closed proton shell at Z=50, are an ideal testing ground for shell model calculations as the isotopic range extends from the doubly-magic 100Sn through 132Sn. The singly-magic nucleus 114Sn, with N=64, is situated in the neutron mid-shell between the N=50 and N=82 magic numbers. The known even-even isotopes of tin are described as possessing a spherical shape in their ground state, however, those isotopes situated in the neutron mid-shell gap also exhibit excited states with properties characteristic of deformed shapes. This phenomenon is also known as shape coexistence. Here the deformed shape arises via 2-particle 2-hole excitation across the Z=50 proton shell gap. This deformed shape gives rise to rotational intruder-bands identified by excited 0+ states presenting at low excitation energies. A recent experimental study of 116Sn suggested a reevaluation of the properties of these intruder bands, while key information on 114Sn remains missing. To investigate the characteristics of these intruder bands, the competing beta-decay and electron capture of 114Sb was exploited to populate excited states in 114Sn at TRIUMF's ISAC facility in 2019. The decay to excited states and subsequent decays by gamma-ray emission were measured using the GRIFFIN spectrometer and its suite of ancillary detectors. The experiment pursued a more in-depth understanding of the intruder configurations and their band-heads in 114Sn with an intention to draw parallels to the recent findings in the other mid-shell even-even tin isotopes. Here, the current state of analysis and recent findings will be presented.

Supervisor

Dr. Corina Andreoiu

Funding Agency

NSERC

Supervisor Email

corina_andreoiu@sfu.ca

Your Email

dannen@sfu.ca

Primary author: ANNEN, Dominic (Simon Fraser University)

Co-authors: Dr ANDREOIU, Corina (Simon Fraser University); Dr SPAGNOLETTI, Pietro (Simon Fraser University)

Presenter: ANNEN, Dominic (Simon Fraser University)

Session Classification: February 18 Morning Session

Track Classification: Nuclear Structure

Contribution ID: **74** Type: **Poster Presentation**

SiRop: latest implementations

r-process nucleosynthesis is responsible for about half of the heavy elements observed in the universe, possibly happening in explosive environments like supernovas and neutron star mergers. The r-process outputs in the literature are not easy to replicate and vary across studies because of different nuclear mass models or initial conditions (seed nuclei); hence there is yet knowledge to be exploited. SiRoP is a software that calculates the r-process for different astrophysical conditions. It also has a modulus to evaluate the sensitivity of the results to changes in nuclear properties. This work is about the new implementations of SiRoP that includes the alpha process to build up the initial conditions of the r-process, inclusion on different mass models, and neutrino physics, which take into account the effect of neutrino capture of heavy nuclei

Supervisor

Rachid Ouyed

Funding Agency

Supervisor grant - CINP

Supervisor Email

rouyed@ucalgary.ca

Your Email

jose.trujillo@ucalgary.ca

Primary author: TRUJILLO, JOSE (UNIVERSITY OF CALGARY)

Presenter: TRUJILLO, JOSE (UNIVERSITY OF CALGARY)

Session Classification: Poster Session

Track Classification: Poster

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

Opening Remarks

Thursday, 16 February 2023 19:00 (15 minutes)

Session Classification: February 16 Evening Session

Contribution ID: **78** Type: **not specified**

Welcome & notes

Friday, 17 February 2023 08:30 (15 minutes)

Session Classification: February 17 Morning Session

Contribution ID: **81** Type: **not specified**

Welcome & Notes

Saturday, 18 February 2023 08:30 (15 minutes)

Session Classification: February 18 Morning Session

Contribution ID: **85** Type: **Invited Oral**

A holistic view of pseudo-Dirac dark matter

Friday, 17 February 2023 08:45 (30 minutes)

I will give an overview of pseudo-Dirac dark matter, a scenario where a small Majorana mass splits charged Dirac dark matter into two nearly degenerate states. A longtime favourite of model-builders, this dark matter candidate has a rich phenomenology that still has yet to be fully characterized. I will discuss a few mechanisms for producing this kind of dark matter in the early universe, and will show various ways in which this candidate will manifest itself in the subsequent cosmology, astrophysical systems, and terrestrial experiments.

Supervisor

Funding Agency

Supervisor Email

Your Email

Primary author: SCHUTZ, Katelin (McGill University)

Presenter: SCHUTZ, Katelin (McGill University)

Session Classification: February 17 Morning Session

Track Classification: Dark Matter Searches

Contribution ID: **86** Type: **Invited Oral**

Precision measurement of neutrino oscillations with Hyper-Kamiokande

Saturday, 18 February 2023 14:15 (30 minutes)

Ever since the first measurements were made of these ghostly particles, neutrinos have been a constant fascination for physicists due to their unusual properties. One such peculiarity is that neutrinos can seemingly change flavours as they propagate —a phenomenon known as neutrino oscillation. The oscillation probabilities are determined by a set of fundamental parameters in the Standard Model. Decades of neutrino experiments designed to probe these parameters have narrowed down much of the phase space, yet many unanswered questions remain: Is there CP-violation in the lepton sector? Which neutrino is the lightest? Are there neutrinos beyond the three generations? The answers to these questions may hold the key to discovering physics beyond the Standard Model and understanding our universe, but answering them requires detectors much more powerful than those currently in operation. The successor of the T2K and Super-Kamiokande experiments, Hyper-Kamiokande, is a next generation experiment with a 260 kiloton water Cherenkov far detector, a more powerful neutrino beam and more capable near detectors. It has a broad and ambitious physics program which includes probing the last unknown neutrino oscillation parameters and the precision measurement of neutrino mixing. In this talk, I will begin with a brief introduction of neutrino oscillations and the history of discoveries. I will then describe the Hyper-Kamiokande experiment, its current progress and its physics potentials, and the challenges that must be overcome in order to realize them.

Supervisor

Funding Agency

Supervisor Email

Your Email

Primary author: LI, Xiaoyue (TRIUMF)

Presenter: LI, Xiaoyue (TRIUMF)

Session Classification: February 18 Afternoon Session

Track Classification: Neutrino Properties

Contribution ID: **87** Type: **Invited Oral**

The Cosmology and Astrophysics of Dark Complexity

Thursday, 16 February 2023 19:15 (30 minutes)

Simple hidden sector theories can give rise to interacting dark matter involving multiple particle species and long-range interactions, such as atomic dark matter. These scenarios are highly plausible in their own right, but can be particularly motivated by modern solutions to the Hierarchy Problem such as the Twin Higgs. These dark matter models feature dissipative dynamics and bound state formation, giving rise to complex dynamics at all scales which is only now being explored in detail. I will outline the variety of exciting new astrophysical and cosmological signals that could be generated by such scenarios: formation of mirror stars and their signals in optical, X-ray, gravitational lensing or gravitational wave observations; direct detection of atomic dark matter with dark plasma screening effects in terrestrial experiments or stellar cooling; signals in precision cosmological observables; and combining full MHD N-body simulations of atomic dark matter with measurements of galactic structure to determine the forces active in the dark sector.

Supervisor

Funding Agency

Supervisor Email

Your Email

Primary author: Dr CURTIN, David (University of Toronto)

Presenter: Dr CURTIN, David (University of Toronto)

Session Classification: February 16 Evening Session

Track Classification: Physics Beyond the Standard Model

Contribution ID: **88** Type: **Invited Oral**

Opportunities at SNOLAB

Friday, 17 February 2023 19:00 (30 minutes)

SNOLAB is an epicenter of global astroparticle physics and underground science discovery and research. As one of the deepest, cleanest underground laboratory in the world, with first-rate scientists and staff, it is a location of choice for cutting edge experiments. In this talk I will highlight some of the exciting research conducted at SNOLAB and discuss potential future research directions.

Supervisor

Funding Agency

Supervisor Email

Your Email

Primary author: COOLEY, Jodi (SMU)

Presenter: COOLEY, Jodi (SMU)

Session Classification: February 17 Evening Session

Track Classification: Neutrino Properties

Contribution ID: **89** Type: **Invited Oral**

Using Neutrons for Material Research

Sunday, 19 February 2023 08:30 (30 minutes)

Neutrons are subatomic particles with no net electric charge, which means that they generally can penetrate deeper into matter than other subatomic particles. The interaction between neutrons and matter can be used to gather information about bulk characteristics of materials by evaluating the scattered neutrons. This opens a whole assortment of possible physics knowledge that can be acquired from studying neutron-matter interactions. This technique can be applied to a variety of materials but is particularly well suited for studying lighter elements such as hydrogen-rich materials. Neutron scattering is versatile and is used both for studying structures as well as dynamics on different lengths and time scales. The neutron scattering response can be inelastic, quasi-elastic, or elastic depending on the finite energy transfer between the neutrons and the material. The inelastic signal can probe the periodic motions of the molecules in the sample with a finite energy transfer, while the elastic signal is suitable for acquiring structural information. The Quasi-elastic neutron scattering is well suited to gather quantitative information about the correlation times and length scales of the diffuse motion occurring in hydrogenous materials in different geometries.

Supervisor

Funding Agency

Supervisor Email

Your Email

Primary author: Dr BERG, Marcella (University of Regina)

Presenter: Dr BERG, Marcella (University of Regina)

Session Classification: February 19 Morning Session

Track Classification: Nuclear Physics

Contribution ID: **90** Type: **Invited Oral**

The ALPHA-g antihydrogen gravity experiment

Saturday, 18 February 2023 08:45 (30 minutes)

The symmetry between matter and antimatter is one of the great unresolved questions in fundamental physics, as it underscores the discrepancies between the Standard Model and cosmological observations. Many experiments have been performed to compare the properties of antimatter to matter at great precision. However, gravitation has so far eluded these efforts due to the difficulty measuring such a tenuous force acting on energetic anti-particles. The advent of cryogenic, trapped antihydrogen atoms, first produced by the ALPHA experiment, has opened a new possibility.

The ALPHA-g experiment at CERN, which has just completed its first year of physics campaign in 2022, is designed to precisely measure the gravitational mass of antihydrogen atoms. The anti-atoms are confined in a vertical magnetic minimum trap, and released through precisely controlled openings in the field, at the trap's bottom and top. Anti-atoms preferentially escape through the opening with the lowest potential energy, which is a sum of magnetic and gravitational potentials. By observing the magnetic field at which anti-atoms escape equally through both openings, their gravitational mass can be deduced.

Precise measurement of antihydrogen gravity hinges on controlling the trap field. For a 1% precision in gravity measurement, the field need to be controlled to within 1e-5 T in a O(1 T)-deep trap. Extensive effort is therefore expended in magnet design, construction and magnetometry to achieve such precision.

This talk will give an overview of ALPHA-g's physics methodology, magnetic trap design and simulation results which predict the precision achievable in ALPHA-g.

Supervisor

Funding Agency

Supervisor Email

Your Email

Primary author: SO, Chukman (TRIUMF)

Presenter: SO, Chukman (TRIUMF)

Session Classification: February 18 Morning Session

Track Classification: Particle Physics

Contribution ID: **91** Type: **Poster Presentation**

Analysis of H -> WW Decay in ggF and VBF Production Modes

The Higgs boson is a fundamental particle in the Standard Model of particle physics, but its properties are not well-constrained experimentally. This analysis aims to improve our understanding of the Higgs boson through measurements of the H → WW decay channel in gluon-gluon fusion (ggF) and vector boson fusion (VBF) production modes. The ggF channel is the dominant production mechanism for Higgs bosons at the Large Hadron Collider (LHC), while the VBF channel is a subdominant but important process that can provide additional information about the properties of the Higgs boson. The analysis uses data collected by the ATLAS experiment at the LHC, and utilizes deep neural networks to identify and measure these Higgs boson processes. The results of the analysis will provide new constraints on the Higgs boson's couplings to W bosons and can be used to improve our understanding of the Higgs boson in the Standard Model and beyond.

Supervisor

Bernd Stelzer

Funding Agency

Simon Fraser University

Supervisor Email

stelzer@sfu.ca

Your Email

mmarr@sfu.ca

Primary author: MARR, Metea (Simon Fraser University)

Presenter: MARR, Metea (Simon Fraser University)

Session Classification: Poster Session

Track Classification: Poster

Contribution ID: **92** Type: **Poster Presentation**

Table top neutron scattering experiment

The scattering of neutrons was observed in a table top experiment with an AmBe source. It is a crucial step towards quenching factor measurement in gases with a neutron beam for the NEWS-G experiment. Before conducting the upcoming in-beam experiments, it is important to do a systematic investigation to study the effects of different gas mixtures, pressures, sphere sizes, and ionization voltages. It is also very important to establish the DAQ and analysis-related tools in the lab. The current work make use of one of the diagnostic for doing various studies. It is to plot the drift time vs rise time of electrons generated due to the scattering of neutrons in the gas, which has a unique correlation. This correlation is independent of the energy of the neutrons, therefore the current work was done in the lab using a neutron source. The diffusion and drift are related and dependent on the gas. Various factors affecting the drift and diffusion were explicitly studied in this work. A good agreement was observed with the MagBoltz simulations.

Supervisor

Levente Balogh & Guillaume Giroux

Funding Agency

Queen's University

Supervisor Email

levente.balogh@queensu.ca & ggiroux@owl.phy.queensu.ca

Your Email

np72@queensu.ca

Primary author: Dr PANCHAL, Neha (Postdoctoral Fellow)

Presenter: Dr PANCHAL, Neha (Postdoctoral Fellow)

Session Classification: Poster Session

Track Classification: Poster