The 57th Winter Nuclear & Particle Physics Conference 2020

PROGRAM & ABSTRACTS

FEBRUARY 13-16, 2020

BANFF, AB

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THE UNIVERSITY OF WINNIPEG

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SNOLAB MINING FOR KNOWLEDGE CREUSER POUR TROUVER... L'EXCELLENCE

INSTITUTE OF PARTICLE PHYSICS

57$^{\text{th}}$ WINTER NUCLEAR AND PARTICLE PHYSICS CONFERENCE

WNPPC2020

Banff, Alberta, Canada

February 13 - 16, 2020

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Hosted by University of Winnipeg and TRIUMF

Contents

Talks and Schedule

Welcome to the 57th Winter Nuclear and Particle Physics Conference. This year's conference is made possible by sponsorship from University of Winnipeg, TRIUMF, IPP, CINP, and CAP. We hope you enjoy the talks, discussions, and enjoy the crisp mountain air.

The conference is organized so that the afternoons are free to go enjoy the outdoors, and therefore there is typically a morning session that ends around noon, and then the evening session starts at 19:00. Note that Dinner will be from 17:30-19:00 just before each evening session. Lunch is after the morning sessions at 12:30, or by pre-arranged take away meals. You can find the schedule of talks in Tables 1-6.

Table 1: Feb. 13 Evening Session (19:00-20:30) **Convenor: Beatrice Franke**

N	Times	Speaker	Title
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2	19:15-19:45	David, Claire	Higgs boson physics and upgrade work with ATLAS at the Large Hadron Collider
3	19:45-20:00	Jaeger, Benjamin	Analysis of Higgs boson decays to two W bosons with the ATLAS experiment
4	20:00-20:15	Taylor, Samantha	Search for mono-Z signature dark matter with the ATLAS detector at the LHC
5	20:15-20:30	Miller, Laura	Event Reconstruction using the Global Particle Flow Algorithm for the ATLAS Experiment
	21:00-		**Conference Reception**

Table 2: Feb. 14 Morning Session (8:30-12:00) **Convenor: Alain Bellerive**

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7	9:00-9:15	Tam, Benjamin	The SNO+ Scintillator Fill
8	9:15-9:30	Chambers, Christopher	Ba Daughter Tagging as a Method for Background Rejection Technique for nEXO
9	9:30-9:45	Durnford, Daniel	The NEWS-G light Dark Matter search experiment: Current status and preparation for SNOLAB
10	9:45:10:00	Vanbergen, Sean	A novel technique for ultracold neutron transmission measurements
	10:00-10:30		**Coffee break**
11	10:30-10:45	Lavvaf, Maedeh	Environmental Magnetic Fields for the Neutron Electric Dipole Moment Experiment at TRIUMF
12	10:45-11:00	Sidhu, Steve	Decreasing the measurement time of the neutron electricdipole moment experiment at TRIUMF
13	11:00-11:15	Bell, Beryl	Simulation and Data Comparison of Ultra Cold Neutron Experiments for TUCAN Collaboration
14	11:15-11:30	O'Brien, Patrick	Radon mitigation for the NEWS-G Dark Matter Detector
15	11:30-11:45	Woodley, William	Propagation of Muons at SNOLAB
16	11:45-12:00	Pal, Sumanta	Search for dark matter and neutrinos with the Scintillating Bubble Chamber (SBC)
17	12:00-12:15	Staelens, Michael	MoEDAL-MAPP Detector Physics Performance Benchmarks

Table 3: Feb. 14 Evening Session (19:00-20:30) **Convenor: Gwen Grinyer**

N	Times	Speaker	Title
18	19:00-19:30	Siegel, Daniel	Multi-messenger astrophysics
19	19:30-19:45	Gascoine, Melanie	Development of multi-detector systems for gamma-ray coincidence measurements
20	19:45-20:00	Javaji, Abhilash	Ion transport simulations for the TITAN experiment
21	20:00-20:15	Singh, Mukhwinder	Investigation of resonance states in 11Li
	20:15-20:30		**Coffee break**
22	20:30-20:45	McLaughlin, Joe	Correcting Signal Saturation in DEAP-3600
23	20:45-21:00	Corman, Maxence	Testing exotic cosmology models with LISA
24	21:00-21:15	Bezerra, Lucas	Dark Matter Detection with SuperCDMS
25	21:15-21:30	Shillington, Trevor	The Search for CLFV at BELLE II

Table 4: Feb. 15 Morning Session (8:30-12:00) **Convenor: Russ Mammei**

N	Times	Speaker	Title
26	8:30-9:00	Diamond, Miriam	Dark Matter: Direct Detection Searches
27	9:00-9:15	Bidaman, Harris	Simulating a new complementary detector for DESCANT
28	9:15-9:30	Pal, Sumanta	Status of DEAP-3600 at SNOLAB
29	9:30-9:45	Leahy, Denis	Explosion Energies, Ages and Densities of Galactic Supernovae
30	9:45:10:00	Ismail, Nawar	Nonperturbative Extraction of the Effective Mass in Neutron Matter
	10:00-10:30		**Coffee break**
31	10:30-10:45	Usman, Ali	Charged pi-Meson Studies at Jefferson Lab
32	10:45-11:00	Kumar, Vijay	Kaon Electromagenetic Form Factor
33	11:00-11:15	Kay, Stephen	Deep Exclusive π^- Production with SoLID
34	11:15-11:30	Moore, Colin	PICO Bubble Chambers: Past, Present, and Future
35	11:30-11:45	Woosaree, Pooja	Precision Measurements on Antihydrogen using the ALPHA-g Apparatus
36	11:45-12:00	Smith, Gareth	A Cosmic Ray Veto System for the ALPHA-g Experiment
37	12:00-12:15	Evetts, Nathan	Magnetometry for Gravitational Measurements of Antihydrogen with ALPHA-g

Table 5: Feb. 15 Evening Session (19:00-21:30) **Convenor: Thomas Brunner**

N	Times	Speaker	Title
38	19:00-19:30	Williams, Matthew	Recent Studies of Astrophysical Reactions at ISAC
39	19:30-19:45	Deng, Yuqi	Primary electron drift time simulation in spherical proportional counter
40	19:45-20:00	Aslam, Muhammad Jamil	Decay of a bound muon to a bound electron
41	20:00-20:15	Reid, Parker	Applied Quantum Annealing for Track Reconstruction in HEP
	20:15-20:30		**Coffee break**
42	20:30-20:45	Palkanoglou, Georgios	From odd-even staggering to the pairing gap in neutron matter
43	20:45-21:00	De Brienne, Francois	Nuclear Recoil Calibration at TUNL
44	21:00-21:15	Coquillat, Jean-Marie	Analysis of electron drift properties and fluctuations for NEWS-G
45	21:15-21:30	Perry, Michael	Investigation of wavelength shifting materials in an active helium target

Table 6: Feb. 16 Morning Session (8:30-11:00) **Convenor: Blair Jamieson**

N	Times	Speaker	Title
46	8:30-9:00	Pavin, Matej	The Intermediate Water Cherenkov Detector for Hyper-Kamiokande
47	9:00-9:15	Sharma, Shivani	High-Precision Half-life Measurement of 14O
48	9:15-9:30	Maclean, Andrew	High-Precision Branching Ratio Measurement and Spin Assignment Implications for 62Ga Superallowed Beta Decay
49	9:30-9:45	Mubasher, Muhammad	Dipositronium annihilation into a single photon
50	9:45-10:00	Rahman Mir, Md Samiur	Single photon decay of the positronium ion
	10:00-10:30		**Coffee Break**
	10:30-11:00		Student prizes / conference close

Abstracts

Conference Opening

Feb. 13 PM
19:00-19:15

Blair Jamieson
University of Winnipeg

Higgs boson physics and upgrade work with ATLAS at the Large Hadron Collider

Feb. 13 PM
19:15-19:45

Claire David
York University/FNAL

This talk offers a tour of what is going on at the moment in collider physics with the ATLAS detector. It will cover both the data analysis side as well as detector development. For the former, the focus will be on Higgs boson physics: the latest results, their theoretical impact and what is on the menu for the incoming LHC Run 3 starting in 2021. The second part of the presentation will describe the future state-of-the-art silicon inner tracker that will equip ATLAS for the High-Luminosity program. From 2028 the LHC will deliver up to ten times the nominal luminosity to boost the discovery potential and increase the precision measurements. New design, readout materials and electronics are required to withstand the extreme radiation conditions, pushing the limits in particle detection with innovative techniques. The presentation closes with an outlook on the tools and skills collected in high energy physics and how they can be transferred to other domains and experiments, such as neutrino physics with the future DUNE detector.

Feb. 13 PM
19:45-20:00

Analysis of Higgs boson decays to two W bosons with the ATLAS experiment

Benjamin Jaeger

Simon Fraser University

After the Higgs boson discovery at the LHC in 2012, it is now of great importance to measure the properties of the Higgs boson precisely to further understand its nature. One of the most encouraging analyses is the study of H $\rightarrow$ WW decays, where the Higgs boson disintegrates into two W bosons. This channel provides the most sensitive measurements on the Higgs coupling to gauge bosons, which is crucial input to test different theories beyond the Standard Model of Particle Physics. In this presentation, I will present the analysis strategies used to measure the H $\rightarrow$ WW production cross-section in the Vector-Boson-Fusion mode. I will focus on the newly introduced Deep Learning algorithm to distinguish signal events from other collision types considered background.

Search for mono-Z signature dark matter with the ATLAS detector at the LHC

Feb. 13 PM
20:00-20:15

Samantha Taylor
University of Victoria

The ATLAS collaboration uses data collected at the LHC to search for dark matter in 13 TeV proton-proton collisions. The final state of interest in this talk is the Mono-Z channel, characterized by a single Z boson decaying into two leptons (e^+e^- or $\mu^+\mu^-$), and a dark matter pair ($\chi\overline{\chi}$) which can be inferred by measuring the missing transverse momentum of the event. Various dark matter models can be tested, including *simplified models* and the *two Higgs doublet model plus a pseudoscalar boson*. If no excess signal is detected over the Standard Model background, regions of model parameter space can be excluded. The analysis strategy will be described, with emphasis on how model parameters scans are performed.

Feb. 13 PM
20:15-20:30

Event reconstruction using the Global Particle Flow Algorithm for the ATLAS experiment

Laura Miller
Carleton University

The Large Hadron Collider (LHC) located at CERN is currently undergoing major upgrades which will result in both an increase in energy of the proton-proton collisions and a large increase in luminosity. In order to fully benefit from these upgrades, the ATLAS collaboration is also making improvements to the detector hardware and its software framework. The reconstruction algorithm that is currently in place is not optimized for these new conditions and a new method, Global Particle Flow, is being developed to better account for the energy flow of high intensity events. In future, this method can be generalized to be applicable to new experiments. This contribution will focus on the ongoing development of a method to integrate photons into this reconstruction scheme.

From quarks to neutrinos

Feb. 14 AM
8:30-9:00

Nikolina Ilic

Institute of Particle Physics

This talk presents an overview of some of the big remaining questions in high energy physics and how the ATLAS detector hopes to address them. The talk describes how the ATLAS detector works, as well as a few of its recent results. A brief overview of the remaining questions in neutrino physics is also discussed, with a short explanation of how the DUNE experiment hopes to address them.

Feb. 14 AM
9:00-9:15

The SNO+ scintillator fill

Benjamin Tam
Queen's University

The SNO+ Experiment is a versatile multipurpose neutrino detector situated at SNOLAB. SNO+ is concentrated on the search for neutrinoless double beta decay in tellurium-loaded liquid scintillator. Since 2017, SNO+ has been operating in its first phase as a water Cherenkov detector and have published results on solar neutrinos and invisible nucleon decay modes. The detector is now being filled with liquid scintillator, which will subsequently be loaded with Te for the neutrinoless double beta decay search.

The SNO+ liquid scintillator is based on linear alkylbenzene. Once filled, SNO+ will have a greatly improved light yield compared to the water Cherenkov phase. This will enable the observation of geoneutrinos, reactor antineutrinos, supernova neutrinos, and low-energy solar neutrinos. As with all low-background detectors such as SNO+, minimizing contaminants within the detector medium is of the utmost importance. Therefore, the optical properties of the scintillator and the background rates within the detector are carefully monitored during the filling process.

Ba daughter tagging as a method for background rejection technique for nEXO

Feb. 14 AM
9:15-9:30

Christopher Chambers
McGill University

Neutrinoless double beta decay is a hypothesized non standard model process in which a nucleus undergoes two simultaneous beta decays without emitting neutrinos. Observation of this decay would demonstrate that the neutrino is its own anti-particle and would violate lepton number conservation. Xenon-136 decaying to barium-136 is a candidate for observing this process. The nEXO experiment aims to search for this decay using 5 tonnes of xenon in a liquid-phase TPC located in an underground facility to reduce backgrounds that may interfere with the measurement. This talk will discuss the potential to identify (or "tag")the barium-136 daughter of the decay to provide discrimination against backgrounds not associated with double beta decay of xenon-136. This barium tagging technology would be added as a potential future upgrade for the nEXO experiment, allowing for a more sensitive search for neutrinoless double beta decay.

Feb. 14 AM
9:30-9:45

The NEWS-G light dark matter search experiment: Current status and preparation for SNOLAB

Daniel Durnford

University of Alberta

The NEWS-G direct dark matter search experiment employs spherical proportional counters (SPCs) with light noble gases as target media to search for low-mass Dark Matter (DM). The next generation of the experiment is a 140 cm diameter SPC with a new sensor design and improved shielding. This detector is expected to achieve sensitivity to single ionizations, and will profit from sensitivity to nuclear recoils on hydrogen to increase sensitivity to DM particle masses less than 100 MeV/c 2 . Making a robust claim at this new low energy frontier of particle physics technology requires precision characterization of our detector's energy response at the single-ionization regime. We report on the recent detector commissioning at the Laboratoire Souterrain de Modane in France, and on the status of installation at the SNOLAB facility in Sudbury, Ontario. Efforts to better characterize the energy response are described as well, including the formulation of a response model and empirical support from UV laser and Ar-37 calibration data.

A novel technique for ultracold neutron transmission measurements

Feb. 14 AM
9:45:10:00

Sean Vanbergen
TRIUMF

The TRIUMF UltraCold Advanced Neutron (TUCAN) collaboration is currently working towards the installation of a next-generation ultracold neutron (UCN) source, combining a neutron spallation target with a superfluid helium cryostat. UCN have sufficiently low energy that they can experience total internal reflection through strong interactions at the surface of certain materials, allowing them to be contained for long periods of time for use in experiments such as measurements of the neutron lifetime or electric dipole moment. Transportation of ultracold neutrons from the source to these experiments is achieved using specially prepared guide tubes. To maximize the number of neutrons available for experiments it is critical to minimize the losses in transmission along the guide length. Since 2017 the TUCAN collaboration has been using a prototype source currently installed at TRIUMF to carry out tests on elements of the future source and experiments. This talk presents the development of guide transmission measurements and techniques during this period. The analysis of this data, in combination with extensive Monte Carlo simulations, enables us to determine the properties of the guides that we are capable of preparing with our current level of technology.

Feb. 14 AM
10:30-10:45

Environmental magnetic fields for the neutron electric dipole moment experiment at TRIUMF

Maedeh Lavvaf

University of Manitoba

The TRIUMF nEDM experiment employs a magnetically shielded Ramsey Resonance based EDM apparatus using ultracold neutrons (UCN). The UCN comes from the spallation based Isopure Helium-II UCN source that will be installed at TRIUMF. The experiment will be housed in a large, 4 layer magnetically shielded room (MSR) which is located in an area at TRIUMF where the background magnetic field is about 7 times the earth's field. In this environment, there is a risk that the MSR most outer layer will saturate, reducing the shielding effectiveness of the room. To this end, a detailed field mapping campaign of the area with and without the TRIUMF cyclotron field has begun. We will present the current field map results and their effect on the expected saturation of the MSR.

Decreasing the measurement time of the neutron electric dipole moment experiment at TRIUMF

Feb. 14 AM
10:45-11:00

Steve Sidhu

SFU/TRIUMF

The TRIUMF Ultra-Cold Advanced Neutron (TUCAN) collaboration is currently developing a new ultra-cold neutron (UCN) source that will supply UCN for a neutron electric dipole moment (nEDM) search experiment. Increasing the sensitivity of nEDM experiments may shed light on the Baryon-asymmetry of the universe. The collaboration's goal for this experiment is to reach a sensitivity of $1 \times 10^{-27} e \cdot cm$ within 400 measurement days.

To conduct the experiment, the neutrons must be transported to a precession chamber, be stored, and deposited into the detectors efficiently. Since neutron EDM experiments are statistically limited, they have long measurement times and a reduction of 30% in measurement time saves almost a calendar year. The presentation will describe the methods for optimising various components of the UCN source, UCN transport hardware, and the nEDM apparatus to minimise the total experimental run time by increasing the statistical sensitivity.

Feb. 14 AM
11:00-11:15

Simulation and data comparison of Ultra Cold Neutron experiments for TUCAN Collaboration

Beryl Bell

McGill University

The TRUMF Ultra-Cold Advanced Neutron (TUCAN) collaboration is currently developing a source of Ultra Cold Neutrons (UCNs) at TRIUMF. This source will supply UCN for future searches for the neutron electric dipole moment (nEDM). The existence of a nEDM could open our understanding of physics beyond the standard model.

The first analysis was done in order to quantify detector efficiencies of the two neutron detectors, a He3 gas proportional counter and a Li6 glass detector. The He3 detector is used to monitor the absolute neutron counts delivered from the beam and the Li6 detector is the main detector. The expected ratio of efficiencies of these detectors is 2:3 for the He:Li. A combination of the data and simulation of the setup using the software PENTrack allowed for a verification of this ratio. This analysis also showed an asymmetry in the rotary valve used. The energy spectrum of the neutrons produced can have an effect on the number of neutrons which survive to the detector for each TUCAN setup. Simulations were performed to compare them to previous neutron energy spectrum measurements. To match these results the material properties of the guide surfaces in the model were tuned. My presentation will give an overview of this work and how it is useful to benchmark our simulation tools for future investigations.

Radon mitigation for the NEWS-G dark matter detector

Feb. 14 AM
11:15-11:30

Patrick O'Brien
University of Alberta

Over the last few decades, Dark matter (DM) technologies have reached such unprecedented sensitivity that never-before seen background signals must be considered. In order to detect signals from DM interactions, impurities must be reduced as much as possible. In particular, radioactive contaminants such as radon constitute one of the largest backgrounds. Thus, attaining and maintaining high purity detectors is one of the most important technical constraints for DM experiments. Several experiments, like the New Experiments With Spheres - Gas (NEWS-G) require very pure gases to have the potential to directly detect Weakly Interacting Massive Particles (WIMPS), a famous candidate for DM. The challenges for removing radon from noble gases for rare event searches will be discussed along with new techniques being tested at the University of Alberta (UofA), including the development of gas concentration measurements.

Feb. 14 AM
11:30-11:45

Propagation of muons at SNOLAB

William Woodley
University of Alberta

PICO is a direct Dark Matter detection experiment installed 2 km underground at SNOLAB, searching for WIMPs (Weakly-Interacting Massive Particles) using superheated liquid technology. With this technology, a slight perturbation in the liquid (such as the deposition of energy from a recoiling nucleus) can create single or multiple bubbles, where single bubbles are the expected signal for a WIMP event. Neutrons, however, can also produce single-bubble events, which would be indistinguishable from the signals created by WIMPs. For this reason, neutrons are one of the main backgrounds for all rare event searches, including PICO, and must be well understood in order to ensure WIMP detection is feasible. One source of external neutrons is from interactions between cosmogenic muons and the rock above the detector. Understanding the expected muon spectrum underground, therefore, is fundamental to low-background experiments. This presentation will focus on the work being done to simulate the propagation of cosmogenic muons from the exosphere to the SNOLAB cavern to provide full information on the muon spectrum underground from different angles using Geant4 Monte Carlo simulations in combination with new programs for cascades and lepton propagation from high cosmic rays.

Search for dark matter and neutrinos with the Scintillating Bubble Chamber (SBC)

Feb. 14 AM
11:45-12:00

Sumanta Pal

University of Alberta

The Scintillating Bubble Chamber (SBC) experiment is a novel low-background technique used to directly detect low-mass WIMP interactions and coherent elastic neutrino nuclear scattering of reactor neutrinos (CEvNS). The detector combines the strengths of bubble chambers technology with those of scintillation detectors. By adding scintillation detection channel, the SBC detector aims to detect 100 eV nuclear recoils and significantly increase the background rejection for electron recoils compared to normal bubble chambers. The motivation of such new technology and an overview of the collaboration's plans for the SNOLAB installation/operation and the reactor CEvNS search will be presented. In addition, the current status on the ongoing construction and commissioning at Fermilab will be discussed.

Feb. 14 AM
12:00-12:15

MoEDAL-MAPP detector physics performance benchmarks

Michael Staelens
University of Alberta

The MoEDAL (Monopole and Exotics Detector at the LHC) experiment is the 7th LHC experiment; a pioneering experiment specifically dedicated to investigating beyond The Standard Model (SM) scenarios by searching for highly ionizing particles, such as magnetic monopoles or massive pseudo-stable charged particles and multiply electrically charged particles as avatars of new physics. Currently, MoEDAL has taken data at center-of-mass energies of 8 and 13 TeV and provides the world's best laboratory constraints on monopoles with magnetic charges ranging from two to five times the Dirac charge. The MoEDAL experiment's ground-breaking physics program of over 40 scenarios complements the larger ATLAS and CMS experiments, thereby expanding the discovery reach of the LHC. During the ongoing shutdown, MoEDAL has been preparing several upgrades for RUN-3, including the new MoEDAL-MAPP (MoEDAL Apparatus for Penetrating Particles) detector which is currently being planned and constructed. The aim of the MAPP detector is to expand MoEDAL's physics program by including searches for new mini-ionizing particles (mIPs) as well as new long-lived neutrals (LLPs), both of which are predicted by many well-motivated extensions of the SM. A prototype of MAPP was placed in the UGCI gallery, adjacent to the MoEDAL region at interaction point 8, and roughly 50m away. The goal of this talk is to summarize the new MoEDAL-MAPP detector and introduce its physics program through studies of its potential reach for mIPs and LLPs during RUN-3 using two benchmarking models: mini-charged particles in dark QED and new LL scalar portals to dark matter.

Multi-messenger astrophysics

Feb. 14 PM
19:00-19:30

Daniel Siegel
Perimeter Institute for Theoretical Physics / University of Guelph

Gravitational-wave observatories are currently revolutionizing astrophysics and astronomy. Detections of neutron star mergers trigger follow-up campaigns of unprecedented scope by astronomers and astroparticle physicists worldwide. What do these new messengers — gravity, light, and particles — tell us about the Universe? One exciting fundamental question to ask in this context relates to the origin of the heavy elements in our periodic table: How does the Universe create the so-called rapid neutron-capture elements, whose cosmic origin has been a mystery for more than six decades? In this talk, I will attempt to provide an overview of some exciting recent developments at the interface of high-energy astrophysics, strong gravity, and nuclear physics.

Feb. 14 PM
19:30-19:45

Development of multi-detector systems for gamma-ray coincidence measurements

Melanie Gascoine

SFU

Gamma ray spectroscopy in the Nuclear Science Laboratory (NSL) at Simon Fraser University (SFU) is used for nuclear structure studies, neutron activation analysis, and environmental radioactivity monitoring. The current detection system is the Germanium detector for Elemental Analysis and Radioactivity Studies (GEARS), and consists of a single high purity germanium (HPGe) detector which is housed in a lead box for passive shielding. Sensitivity is limited especially at low energies due to background radiation and Compton scattering. The detection capabilities of the NSL can be improved through the use of Compton suppression and time coincidence measurements. The time coincidence method allows for the possibility of gamma-gamma, beta-gamma, and alpha-gamma measurements that will help distinguish between events of interest, and background radiation or events caused by contaminant induced reactions. However a multi-detector system is required to take advantage of this method. For this purpose, the 8-Pi spectrometer, recently acquired by SFU from the ISAC-1 facility at TRIUMF, is being rebuilt to its original design, consisting of 20 HPGe Compton suppressed spectrometers (CSS). Operation of the 8-Pi requires a 352 channel data acquisition (DAQ) system which is under development, based on the TIG-10 and VF-48 digitizers. In the interim, a subset of six of the 8-Pi CSS has been arranged in a cubic array, operating on a NIM/CAMAC-based DAQ system. The development and application of the cubic array will be presented and discussed.

Ion transport simulations for the TITAN experiment

Feb. 14 PM
19:45-20:00

Abhilash Javaji
TRIUMF

A useful experimental method for probing nuclear structure is high precision mass spectroscopy. TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN) is an experimental setup consisting of multiple ion traps designed to perform high precision mass measurements with radioactive ion beams provided by ISAC. While measurements on nuclei further from stability are less known and hence more interesting, they come at a cost of low production yields. Transport efficiency therefore becomes a vital factor for TITAN. This presentation will discuss the latest ion transport simulations performed using SIMION and its geometries, with the intent of minimizing transport loses. The work also explores the feasibility and need of installing additional diagnostics to improve ion transport at TITAN.

Feb. 14 PM
20:00-20:15

Investigation of resonance states in ^{11}Li

Mukhwinder Singh
Saint Mary's University

Understanding the structure of complex many-body nuclei is one of the central challenges in nuclear physics. The conventional shell model is capable of explaining the structure of stable nuclei, but it starts to shatter towards the driplines or rare isotopes. To explain the new trends in the shell model at the driplines, it is essential to study these exotic nuclei. Halo nuclei are prime examples of some of the unusual characteristics of rare isotopes. The development in the radioactive ion beam facilities made it possible to explore different aspects of halo nuclei. ^{11}Li is a two-neutron halo with a ^{9}Li core. In this study, the excited states of the ^{11}Li have been investigated through the deuteron scattering off an ^{11}Li. The experiment was performed at the IRIS facility at TRIUMF with an ^{11}Li beam accelerated to 7.3A MeV. The scattered deuterons were detected using a silicon and CsI(Tl) detector. The missing-mass technique was used to obtain the excitation spectrum. The observed resonance spectrum from inelastic scattering and the ground state of ^{11}Li from elastic scattering will be presented.

Correcting signal saturation in DEAP-3600

Feb. 14 PM
20:30-20:45

Joe McLaughlin
Royal Holloway University of London/TRIUMF

DEAP-3600 is a tonne-scale, liquid argon (LAr) experiment searching for Weakly Interacting Massive Particles (WIMPs), which are a leading candidate for dark matter. The detector is located at SNOLAB in Sudbury, Ontario, and contains 3279 kg of LAr as a scintillating medium, viewed by 255 photomultiplier tubes (PMTs). While DEAP is optimized for detecting WIMPs at recoil kinetic energies on the order of 10 keV, vital background analyses probe higher energy regimes—up to a few MeV, where signal saturation in the PMTs and digitizers are important systematic effects. In this presentation, a novel approach to correcting such non-linear behaviour is discussed, with the goal of decoupling saturation effects in different components, particularly digitizers and PMTs. A physics-driven model for PMT saturation has been developed and applied to re-linearize the PMT response. This talk will report on the development of this technique and its validation in data using alpha decays in the LAr bulk of the DEAP-3600 detector. The impact of this work on the dark matter search is to improve the understanding of surface backgrounds from Rn chain daughters, particularly Po-210.

Feb. 14 PM
20:45-21:00

Testing exotic cosmology models with LISA

Maxence Corman
Perimeter Institute / UW

We investigate that the acceleration of the universe could be the consequence of gravitational leakage into extra dimensions on cosmological scales rather than the result of a non-zero cosmological constant. LISA will observe massive black hole binary merger events and help optical surveys identify an electromagnetic counterpart. In theories that include additional non-compact spacetime dimensions, the gravitational leakage intro extra dimensions leads to a reduction in the amplitude of observed gravitational waves and thereby a systematic error in the inferred distance to gravitational wave source. We investigate the capability of LISA to probe this modified gravity on large scales. We find that the extent to which LISA will be able to place limits on the number of spacetime dimensions and other cosmological parameters characterizing modified gravity will strongly depend on the actual number and redshift distribution of sources together with uncertainty on the GW measurements. A relatively small number of sources and high uncertainties would strongly challenge the ability of LISA to place meaningful constraints on the parameters in cosmological scenarios where gravity is only five-dimensional and modified at scales larger than about four times the Hubble radius. Conversely, if the number of sources observed amounts to a four-year average of 27, then in the most favourable cosmological scenarios LISA has the potential to place meaningful constraints on the cosmological parameters with a precision of approximately 1 % on the number of dimensions and 7.5 % on the scale beyond which gravity is modified.

Dark matter detection with SuperCDMS

Feb. 14 PM
21:00-21:15

Lucas Bezerra
UBC

The Super Cryogenic Dark Matter Search (SuperCDMS) uses millikelvin cryogenic germanium and silicon detectors to obtain exceptional sensitivity to low-energy dark matter-nucleus scattering. Interactions within the detectors generate phonons and ionization, which are measured by superconducting Transition Edge Sensors. These signals are then processed to generate ultra-low energy (<10 GeV/c^2) thresholds, allowing the experiment to specialize in searches for light dark matter candidates. SuperCDMS operated a generation of detectors at the Soudan Underground Laboratory in Minnesota. The collaboration is currently installing new detectors and infrastructure at SNOLAB in Sudbury, Ontario as its next step in development. This new installation will have greater shielding against high energy cosmic rays and radioactive decay byproducts, which will reduce background and refine the search for dark matter particles. The collaboration's most recent analysis of electron recoils in cryogenic germanium sets new constraints on dark photons and axion-like particles in the mass range from 40 eV/c^2 to 500 keV/c^2.

Feb. 14 PM
21:15-21:30

The search for CLFV at BELLE II

Trevor Shillington
McGill University

Charged lepton flavour violation (CLFV) has been searched for since the discovery of the muon in the 1940s. It has not been found through any channel thus far. Many extensions of the Standard Model expect an enhancement in CLFV. Particularly, many of the proposed extensions to the Standard Model to account for the observed B-anomalies, like R(D*) and R(K), predict a significant increase in CLFV. In this talk, I discuss the search for CLFV at Belle II through the decay B $\rightarrow$ Kτl (l = e, μ). A brief overview of the theoretical aspects of CLFV and how they relate to the decay B $\rightarrow$ Kτl (l = e, μ) will also be discussed. In addition, a review of the similar analysis performed by the BaBar experiment, which set the current upper limits on B $\rightarrow$ Kτl (l = e, μ), will be presented, as well as a discussion on how Belle II will improve the existing limit.

Dark matter: Direct detection searches

Feb. 15 AM
8:30-9:00

Miriam Diamond
University of Toronto

The predictions of the Standard Model have been confirmed by decades of tests in experimental particle physics, yet we know it is incomplete. A sister branch of inquiry, astrophysics, provides us with convincing evidence that the Standard Model describes only about 5% of the universe; approximately a quarter of the universe consists of something whose gravitational effects can be seen in a variety of astrophysical phenomena but which we have been unable to detect and identify in the laboratory. We label it "dark matter" (DM) because it does not give off light – in fact, it does not directly interact through any of the known forces except gravity. Most physicists agree that DM consists of new subatomic particle(s); the quest to discover its exact nature is among the foremost missions in modern physics and the greatest treasure hunts in history. This talk will introduce the basic principles, current status, and recent results of DM direct detection searches. These experiments encompass multiple detection channels – phonons, heat, charge, and light – and a wide variety of technologies, including cryogenic bolometers, scintillators, semiconductor crystals, liquid noble gases, and time projection chambers. A brief preview of the next generation of direct detection experiments will then be provided. As they seek to improve sensitivity and reduce backgrounds ever further, these searches continue to push the boundaries of engineering as well as analysis techniques, to finally shed some light on a wide range of DM particle candidates.

Feb. 15 AM
9:00-9:15

Simulating a new complementary detector for DESCANT

Harris Bidaman
University of Guelph

The study of neutron rich nuclei far from the valley of stability has become an increasingly important field of research within nuclear physics. One of the decay mechanisms that opens when the decay Q value becomes sufficiently large is that of beta-delayed neutron emission. This decay mode is important when studying the astrophysical r-process as it can have a direct effect on theoretical solar abundance calculations. The utilization of large scale neutron detector arrays in future experiments is therefore imperative in order to study these beta-delayed neutron emitters and better understand these processes.

The deuterated scintillator array, DESCANT, was designed to be coupled with the large-scale gamma-spectrometers GRIFFIN and TIGRESS at the TRIUMF ISAC-I and ISAC-II facilities, respectively. However, DESCANT was originally intended to be a neutron-tagging array and a precise measurement of the neutron energy was not considered a priority. This limitation could be overcome through the use of thin plastic scintillators, possibly including their positioning in front of the DESCANT detectors. The energy of the neutrons can then be determined via the time-of-flight technique. To investigate the viability of this augmentation, GEANT4 will be used to simulate and optimize the experimental design, the progress of which will be discussed.

Status of DEAP-3600 at SNOLAB

Feb. 15 AM
9:15-9:30

Sumanta Pal
University of Alberta

DEAP-3600 is a single-phase liquid argon (LAr) direct-detection dark matter experiment, operating 2 km underground at SNOLAB (Sudbury, Canada). The detector consists of 3279 kg of LAr contained in a spherical acrylic vessel. Analysis results from 758 tonne-day exposure taken over a period of 231 live-days during the first year of operation are already published last year. I am going to discuss the current detector status, proposed hardware change to decrease alpha backgrounds from the neck region of the detector and update on WIMP-search analysis.

Feb. 15 AM
9:30-9:45

Explosion energies, ages and densities of galactic supernovae

Denis Leahy
University of Calgary

A number of recent studies using 21 cm HI line and 13CO line observations in the Galaxy have resulted in new distances for Galactic supernova remnants (SNRs). 58 of those remnants have observed X-ray spectra, for which shocked-gas temperatures and emission measures are measured. Here we apply spherically symmetric SNR evolution models to these 58 remnants to obtain estimates for ages, explosion energies, circumstellar medium densities and profiles (uniform or wind-type). From the distribution of ages we obtain a supernova birth rate and estimate incompleteness. The energies and densities can be well with log-normal distributions. The distribution of explosion energies is very similar to that of SNRs in the Large Magellanic Cloud (LMC), suggesting SN explosions in the LMC and in the Galaxy are very similar. The density distribution has higher mean density for Galactic SNRs than for LMC SNRs.

Nonperturbative extraction of the effective mass in neutron matter

Feb. 15 AM
9:45-10:00

Ismail Nawar

University of Guelph

We carry out nonperturbative calculations of the single-particle excitation spectrum in strongly interacting neutron matter. These are microscopic quantum Monte Carlo computations of many-neutron energies at different densities as well as several distinct excited states. As input, we employ both phenomenological and chiral two- and three-nucleon interactions. We use the single-particle spectrum to extract the effective mass in neutron matter. With a view to systematizing the error involved in this extraction, we carefully assess the impact of finite-size effects on the quasiparticle dispersion relation. We find an effective-mass ratio that drops from 1 as the density is increased. We conclude by connecting our results with the physics of ultracold gases as well as with energy-density functional theories of nuclei and neutron-star matter.

Feb. 15 AM
10:30-10:45

Charged pi-meson studies at Jefferson Lab

Ali Usman

University of Regina

It is experimentally proven that the mass of the hadron is significantly larger than the combined mass of its constituents (quarks and gluons). The reason for this lies in the inner structure of hadrons and the interactions between the constituent quarks and gluons. Quantum Chromodynamics (QCD) is the theory that explains the interaction of hadrons, but it does not provide a clear picture of their inner structure. The pion is a simple system, consisting only of two valence quarks (up and down), making it an ideal candidate to study in order to understand hadronic structure. Experimentally, the inner structure of hadrons can be studied in detail by scattering electrons off nuclei. One of the easiest and most abundant exclusive reactions after such scattering produces charged pions (i.e. p(e,e',π")n). The cross-section for this reaction largely depends on the exchange of a virtual photon between an incident electron and the target nucleon. This cross-section then allows us to extract the pion form factor, a key parameter in the understanding of pion sub-structure, which indicates the momentum and spatial distribution of constituent particles. These studies are being conducted at the Thomas Jefferson National Accelerator Facility (JLab) in Newport News, VA, USA. JLab has recently undergone a major upgrade; our pion structure studies are one of the flagship experiments enabled by this upgrade. In this talk, I will outline the physics motivation behind these studies, as well as providing an outline of the experimental facility. Preliminary results from the analysis of experimental data and a future outlook will also be presented.

Kaon electromagenetic form factor

Feb. 15 AM
10:45-11:00

Vijay Kumar
University of Regina

It is well understood that hadrons are composed of smaller, more fundamental particles, quarks and gluons. The internal structure of hadrons is determined by the interaction between these constituent quarks and gluons. The simplest hadronic systems we can analyse to understand this internal structure are the pion and kaon. The electromagnetic form factor of pions and kaons plays a unique role in understanding of their internal structure. Experimental measurements of the LT (longitudinal and transverse) cross sections for the kaon and pion have been carried out at the Thomas Jefferson National Accelerator Facility (Jlab) in Newport News, Virginia, USA. Data for the reactions p(e, e'K +)Λ and p(e, e'K +)Σ 0 have been measured at various kinematic points. The precision measurements of LT separated cross-sections are of particular interest. They allow us to extract the form factor which is a measure of the spatial distribution of the mesons' constituents. The Rosenbluth separation technique is used to separate the longitudinal and transverse cross sections from the experimental measurements. In this talk, I will outline some of the experimental details, including the detector systems in use and the Rosenbluth separation technique. I will also briefly outline how the data will be used to extract the kaon electromagnetic form factor.

Feb. 15 AM
11:00-11:15

Deep exclusive $\pi-$ production with SoLID

Stephen Kay
University of Regina

SoLID (Solenoidal Large Intensity Device) is an upcoming high acceptance detector at Jefferson Lab. SoLID will utilise the latest detector technology to allow for accurate measurements at higher luminosities than currently possible for other large acceptance detectors currently available at Jefferson Lab. The proposed measurement of deep exclusive $\pi-$ production from the neutron in a polarised helium-3 target using SoLID makes full use of these capabilities; in particular to measure several key single-spin asymmetries. These polarisation observables open a window into novel aspects of nucleon structure, and also play a role in the reliable extraction of the charged pion form factor from pion electroproduction measurements. These measurements are highly complementary to other experiments carried out at Jefferson Lab. In this talk, I will outline the experimental proposal as well as the capabilities and parameters of the SoLID.

PICO bubble chambers: Past, present, and future

Feb. 15 AM
11:15-11:30

Colin Moore
Queen's University

Bubble chambers are a historically important tool for detecting high energy particles, both from the atmosphere and near particle accelerators, but have been largely superseded by modern detectors for their original purpose. However, these sensitive detectors have seen a resurgence in the last 15 years in the field of dark matter direct detection. PICO-60 was one such bubble chamber, which produced a world-leading limit on the WIMP-proton cross section. Its successor, PICO-40L, which uses an alternative "right-side up" design to reduce backgrounds is currently being commissioned at SNOLAB in Sudbury, Ontario. This talk will discuss the results from the complete exposure of PICO-60, as well as the physics goals for PICO-40L.

Feb. 15 AM
11:30-11:45

Precision measurements on antihydrogen using the ALPHA-g apparatus

Pooja Woosaree*
University of Calgary

The ALPHA (Antihydrogen Laser PHysics Apparatus) experiment aims to provide a possible solution to the baryonic asymmetry problem by testing CPT (charge conjugation, parity reversal, time reversal) theory and observing whether antimatter follows Einstein's Weak Equivalence Principle (WEP), where the acceleration due to gravity that a body experiences is independent of its structure or composition. A measurement of this nature has never been done before, as previous experiments used charged particles which meant the experiments were dominated by electromagnetic forces. The ALPHA-g apparatus will use electrically neutral antihydrogen produced in a vertical Penning-Malmberg trap and hold the antihydrogen in a magnetic well. Once the antihydrogen is released, the position of the resulting annihilation can be reconstructed with a radial TPC (time projection chamber) surrounding the trapping volume [1]. This data will be used to measure the gravitational mass of antihydrogen, making this a crucial step in testing the fundamental symmetry of matter and antimatter.

The ALPHA-g apparatus is currently being commissioned at CERN, and the first gravitational measurements of antihydrogen are expected to begin in April 2021. I will be presenting some key components of the ALPHA-g apparatus and their functions, then proceed to discuss the future of the ALPHA-g apparatus.

*On behalf of the ALPHA collaboration

[1] Capra, A. *et al.* "Design of a Radial TPC for Antihydrogen Gravity Measurement with ALPHA-g." Proceedings of the 12th International Conference on Low Energy Antiproton Physics (LEAP2016).

A cosmic ray veto system for the ALPHA-g experiment

Feb. 15 AM
11:45-12:00

Gareth Smith
UBC/TRIUMF

The Weak Equivalence Principle, a foundation of general relativity, implies that the gravitational acceleration of matter and antimatter in an external field must be the same. The ALPHA-g experiment at CERN aims to perform the first precision test of this principle using antihydrogen, the simplest neutral atom. Antihydrogen is produced in a vertical trap and released such that it falls due to the Earth's gravitational field. The annihilation positions of the atoms are then studied using a time projection chamber (TPC) to discern the strength of their gravitational acceleration.

The largest background in the TPC is due to cosmic rays. To reject these background events during analysis, a cosmic ray veto has been implemented, which is composed of a "barrel" of plastic scintillator bars surrounding the TPC. I will describe the design and implementation of this cosmic ray veto system. Following this, I will describe the methods which will be used to discriminate cosmic ray background from annihilation events, and finally present the ongoing analysis work to implement this procedure.

Feb. 15 AM
12:00-12:15

Magnetometry for gravitational measurements of antihydrogen with ALPHA-g

Nathan Evetts

UBC

The Einstein equivalence principle (EEP) has never been directly examined with an antimatter test body. To address this, the ALPHA Collaboration is constructing a new apparatus (ALPHA-g) which can test the EEP using magnetically trapped antihydrogen atoms. I will discuss motivations for these experiments, as well as the methods we intend to employ. In particular, magnetic field characterization will be an essential component of the experimental methodology. The antiatom gravitational energy difference between the top and bottom of our trap is about a factor of 104 smaller than the magnetic confinement energies involved. This necessitates the use of precision magnetometers that will allow us to distinguish between the effects of magnetic and gravitational fields on antihydrogen trajectories. We will accomplish the required magnetometry using techniques drawn from the fields of nuclear magnetic resonance and non-neutral plasmas. I will overview these in the context of the greater experiment.

Recent studies of astrophysical reactions at ISAC

Feb. 15 PM
19:00-19:30

Matthew Williams*
TRIUMF

Experimental studies of nuclear reaction rates play a pivotal role in our understanding of how the elements came to be synthesized in the quantities we observe in nature. From hydrostatic burning to explosive environments, specific reactions are identified as important in that uncertainties in their thermonuclear rates can measurably influence astrophysical observables, such as elemental abundances and light curves for example. Once identified, some of these reactions are feasible to study either directly or indirectly in the laboratory. However, the experimental challenges behind studies of astrophysical reactions are considerable, characterised by low cross sections and high background. In addition, many interesting astrophysical processes involve reactions on unstable isotopes, which present significant difficulties related to beam production and background suppression. The TRIUMF-ISAC facility has for the past 20 years been a world leader in the study of astrophysical reactions, providing intense stable and radioactive ion beams accelerated to energies relevant for astrophysical processes. This legacy is set to continue with the first experimental campaign of the new recoil mass spectrometer EMMA, which commenced last year after successful integration with the TIGRESS gamma-ray spectrometer. This talk will present a selection of recent results obtained with both the DRAGON facility and the recently commissioned EMMA spectrometer.

*On behalf of the EMMA, TIGRESS and DRAGON collaborations

Feb. 15 PM
19:30-19:45

Primary electron drift time simulation in spherical proportional counter

Yuqi Deng

University of Alberta

New Experiments With Spheres-Gas (NEWS-G) is a direct dark matter search experiment using Spherical Proportional Counters (SPCs) to search for low-mass Weakly Interacting Massive Particles (WIMPs). Including WIMPs, particles interacting within detector can ionize gas molecules that produce primary electrons/ions. Under electric field, electrons will drift toward the center of the SPC where a sensor is located for charge collection. The final detected voltage signal is proportional to the initial ionization produced. The primary electrons generated at the same starting point can arrive to the sensor at different times due to diffusion so that we can observe a "rise time" in the produced waveform. Since rise time of different events will vary with different starting positions, it can be used to discriminate a large proportion of background events introduced by radioactive contamination on inner surface of the spherical detector. Different tools are used to simulate the electric field inside the detector and to generate the drift velocities and diffusion coefficients. This presentation will focus on the work done to obtain the simulation of the electron drifting in the detector and how we compare with real data in order to understand the detector response.

Decay of a bound muon to a bound electron

Feb. 15 PM
19:45-20:00

Muhammad Jamil Aslam
University of Alberta

Two major experiments are about to start searching for the muon-electron conversion near a nucleus: Mu2e in Fermilab and COMET in J-PARC, Japan. We have analysed the main Standard Model background for these searches: the decay of a muon bound in an atom. Here we report our results for the case when the daughter electron remains bound in the atom as well. We find that a previous study neglected important contributions. We also provide an intuitive interpretation of our new results.

Feb. 15 PM
20:00-20:15

Applied quantum annealing for track reconstruction in HEP

Parker Reid

Simon Fraser University

The upgrade for the High-Luminosity Large Hadron Collider (HL-LHC) is approaching, with the first run scheduled for 2027. The HL-LHC is designed to reach a maximum instantaneous luminosity a factor of five greater than Run 3. Increased CPU resources are a necessary requirement for fast event reconstruction in the denser environment, particularly for the computationally expensive particle track reconstruction algorithms. ATLAS tracking procedures use hit information (electrical signals) from different detector layers to reconstruct particle tracks. The coordinates of the hits are used in a combinatorial reconstruction algorithm, adapted from the ATLAS track seeding algorithm. This new annealing based reconstruction technique generates a multi-dimensional objective function, which is minimized using an annealer. This function is represented as a Hamiltonian, which can be adiabatically introduced into a quantum annealer. Using a previously designed algorithm (HEPQPR) fit for a D-Wave quantum annealer[1], it is possible to directly test a track reconstruction algorithm on the TrackML dataset from the Kaggle challenge of 2019. This presentation will highlight ongoing developments and performance optimizations with respect to this dataset, including penalty parameter optimization, and dataset slicing.

[1] Frederic Bapst *et.al.,* A Pattern Recognition Algorithm for Quantum Annealers. Computing and Software for Big Science, 4(1). https://doi.org/10.1007/s41781-019-0032-5. (2019)

From odd-even staggering to the pairing gap in neutron matter

Feb. 15 PM
20:15-20:30

Georgios Palkanoglou
TRIUMF

The properties of neutron matter are integral to the correct description of neutron stars and the extraction of their observables as well as the description of neutron-rich nuclei. One key property of neutron matter is its superfluid behaviour in a range of densities relevant to the inner crust of neutron stars. This talk will be centered around the Finite Size Effects in the pairing gap of a pure neutron matter superfluid system at densities found in the inner crust of cold neutron stars. The BCS (Bardeen-Cooper-Schrieffer) treatment of superfluidity gives rise to the mean-field pairing gap while a projection after variation leads to beyond-mean-field pairing gap through an odd-even staggering formula. While these two pairing gap results should agree in the thermodynamic limit, we will show that this is the case for systems far from the thermodynamic limit as well. This aims in taking the first step towards a model-independent extraction of the pairing gap in neutron matter.

Feb. 15 PM
20:45-21:00

Nuclear recoil calibration at TUNL

Francois De Brienne
Université De Montréal

The Super Cryogenic Dark Matter Search (SuperCDMS) uses millikelvin cryogenic germanium and silicon detectors to obtain exceptional sensitivity to low-energy dark matter-nucleus interactions. When a particle interacts with the detector, phonons and electron-hole pairs are produced and detected. The proportion of energy deposited as phonons versus as electron-hole pairs changes with the energy of the event and with the type of scattering, either nuclear recoil or electron recoil. The detector sensitivity to ionization can also be modulated using a voltage bias across the detector and the Neganov-Trofimov-Luke effect. Ionization Measurement with Phonons At Cryogenic Temperatures (IMPACT) uses a small silicon SuperCDMS HV-style detector to measure the ionization yield of nuclear recoils. To do so, we used a beam of 55.7keV neutrons at the Triangle University Nuclear Laboratory (TUNL) and measured the scattering of this beam though the detector into 29 liquid scintillator cells placed at various angles to the beam. By comparing the scattering angle to the signal measured in the detector at various detector biases, the ionization yield can be determined. This calibration allows us to measure ionization yield for nuclear recoil energy < 1keV, for which no present results exist.

Analysis of electron drift properties and fluctuations for NEWS-G

Feb. 15 PM
21:00-21:15

Jean-Marie Coquillat*

Queen's University

As part of the ongoing search for dark matter, the NEWS-G collaboration uses a spherical proportional counter to detect WIMP interaction. The detector consists of a grounded spherical vessel filled with gas. A positive voltage is applied on a central anode, inducing a radial electric field. Energy deposited by a WIMP can cause ionization. Under the influence of the electric field, primary electrons drift towards the central anode. Within a few hundred μm around the anode, where the electric field is strong enough, primary electrons acquire sufficient kinetic energy to ionize other gas atoms, producing a large quantity of secondary ion-electron pairs by Townsend avalanche. However, the time taken for the primary electrons to drift from the sphere's volume to the central anode varies significantly depending on the field conditions. Moreover, it has been found to fluctuate substantially with time and is strongly correlated to other events happening inside the sphere that modify the charges distribution and the electric field. The purpose of this talk is to discuss causes and consequences of these fluctuations of the drift time, how it can influence the pulse formations and the overall data analysis as well as how problems arising from this effect can be mitigated.

*On behalf of the NEWS-G collaboration

Feb. 15 PM
21:30-21:45

Investigation of wavelength shifting materials in an active helium target

Michael Perry
Mount Allison University

The strong nuclear force has proven challenging to study experimentally. Asymptotic freedom allows the strong force to be studied and tested effectively at high energies, however in medium to low energy regimes, it is not well understood. One way of gaining insight into the strong force at this energy is to study neutron scalar polarisabilities, fundamental structure constants akin to charge or mass. In an effort to determine these values to a high order of precision, the A2 Collaboration in Mainz, Germany is implementing an active helium target. One of the main motivations for using this target is that it allows for the collection of scintillation light after a Compton event, which may be used to more accurately identify such events in the analysis. However, the silicon photomultipliers in the active volume are unable to detect the vacuum ultraviolet light emitted by the helium gas, and thus a wavelength shifting material is required. One such material, popular in other scintillating noble gas targets, is an organic compound called Tetraphenyl Butadiene. This material is promising because of its particular ability to shift light from the vacuum ultraviolet to the visible spectrum, where the photomultipliers are most sensitive. This compound was tested in various conditions, and promising preliminary results support further study of this material in the active helium target.

The intermediate water Cherenkov detector for Hyper-Kamiokande

Feb. 16 AM
8:30-9:00

Matej Pavin
TRIUMF

Hyper-Kamiokande is a new long-baseline neutrino and nucleon decay experiment, currently being constructed in Japan. It will use Cherenkov radiation in water to detect charged particles produced in neutrino interactions. Due to its enormous size, Hyper-Kamiokande will allow us to collect an unprecedented number of neutrino events and probe the CP violation in the lepton sector.

However, the measurements will be limited by systematic uncertainties, mostly caused by neutrino-nucleus cross-section modeling and detector systematics. To reduce systematic uncertainties, the HyperK Canada group is working on an Intermediate Water Cherenkov Detector (IWCD), which will perform reference measurements for HyperK. The proposed detector will use a novel ν-prism technique to measure neutrino-nucleus cross-sections at different energies. Additionally, the IWCD will feature multi-PMT modules for improved Cherenkov light detection and particle identification, which are currently being developed at TRIUMF.

In this talk, I will discuss the physics case for the IWCD and show recent progress on the construction of the multi-PMT module at TRIUMF.

Feb. 16 AM
9:00-9:15

High-precision half-life measurement of ^{14}O

Shivani Sharma
University of Regina

Precision measurements of the *ft* values for Superallowed Fermi beta decays between nuclear isobaric analogue states of spin-parity $J\pi = 0+$ provide fundamental tests of the electroweak interaction. These transitions are used to constrain the conserved vector current (CVC) hypothesis and they provide the most precise value of Vud, the up-down element of the Cabibbo-Kobayashi-Maskawa (CKM) quark-mixing matrix. A high precision half-life measurement for ^{14}O, one of these superallowed emitters, has recently been performed at the Isotope Separator and Accelerator (ISAC) facility at TRIUMF. The half-life of 14O was deduced using a 4π gas-filled proportional counter and fast tape transport system. This analysis has led to a new result that is 2 times more precise than the world average, T1/2(^{14}O)= 70.619(11) s, obtained from 10 previous measurements of this quantity. Details of this new measurement and its impact on the *ft* value for ^{14}O will be presented.

High-precision branching ratio measurement and spin assignment implications for ^{62}Ga superallowed beta decay

Feb. 16 AM
9:15-9:30

Andrew MacLean
University of Guelph

A high-statistics beta decay experiment for the superallowed Fermi beta emitter 62Ga was performed at the Isotope Separator and Accelerator (ISAC) radioactive ion beam facility at TRIUMF with the high-efficiency Gamma-Ray Infrastructure for Fundamental Investigations of Nuclei (GRIFFIN) spectrometer. The high coincidence efficiency of the GRIFFIN spectrometer allowed for an expansion of the level scheme contributing further knowledge to the structure of the daughter nucleus ^{62}Zn, in addition to a new measurement of the super-allowed branching ratio with a precision of +/-0.002%. For one particularly important cascade, sufficient statistics were obtained to perform a gamma-gamma angular correlation measurement. This allowed the assignment of the spin of the 2.34 MeV excited state in ^{62}Zn to be resolved from previous discrepant measurements and definitively assigned a spin of $J\pi = 0+$. The assignment of the spin of this state has important implications for the isospin symmetry breaking correction, δC1, changing the central value by almost a factor of two. Results on this analysis will be discussed.

Feb. 16 AM
9:30-9:45

Dipositronium annihilation into a single photon

Muhammad Mubasher
University of Alberta

It has been known for many years that an electron and its antiparticle, the positron, may together form a metastable hydrogenlike atom, known as positronium or Ps. In 1946, Wheeler speculated that two Ps atoms may combine to form the dipositronium molecule (Ps_2) stable with respect to auto-dissociation. In 2007 existence of Ps_2 was confirmed experimentally. I will present a determination of the Ps_2 decay rate into a single photon and an electron-positron pair. We employ a simple method (described in the proposed talk by Md Samiur Rahman Mir) and demonstrate that the previously published result is incorrect.

I will also briefly mention that studies of multi-positronium systems are motivated by a longterm goal of generating coherent gamma radiation and could one day facilitate fusion power generation.

Single photon decay of the positronium ion

Feb. 16 AM
9:45-10:00

Md Samiur Rahman Mir
University of Alberta

Positronium ion Ps^- is a bound state of two electrons and a positron. Thanks to a new method developed by Yasuyuki Nagashima it can be copiously produced. Precise knowledge of its properties is important. Here I will report a new determination of the rate of Ps^- annihilation into a single photon and an electron. Our result agrees with previous literature, but our approach is intuitive and much simpler. It can also be applied to more complicated systems such as the positronium-hydrogen and dipositronium bound states.
