51ST WINTER NUCLEAR & PARTICLE PHYSICS CONFERENCE

BANFF, FEBRUARY 13-16, 2014

Program

Organized by TRIUMF, the University of Manitoba, and the University of Winnipeg.

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WNPPC 2014

Welcome to WNPPC – 51st Winter Nuclear Particle Physics Conference

Location:

Kinnear Center for Learning (KC), Banff, Alberta

Accommodation:

Banff Centre (Professional Development Centre) — Check-in is at 4pm. Check-out is at 12 noon.

Your accommodation at the Banff Centre includes a conference Meal Package: three (3) Vistas breakfasts, three (3) Vistas lunches, three (3) Vistas dinners, a.m. and p.m. coffee break refreshments, parking, access to the Sally Borden Recreation Facility and wireless internet access.

Registration:

Opening day registration is on Thursday, February 13 in the Professional Development Center Foyer, directly across from the front desk in the Banff Centre. The desk will be open from 4:00 p.m. – 5:30 p.m. Registration will move to the Kinnear Learning Center BMO Financial Galleria KC200 and will open at 6:30 p.m.

Registration will open Friday, February 14 at 7:30 a.m. in the Kinnear Learning Center BMO Financial Galleria KC200.

Talks:

All presentations will be in KC203, Kinnear Learning Centre. All presenters are requested to send your completed talk to: mgericke@physics.umanitoba.ca Talks that were not received by e-mail or cannot be mailed due to file size restrictions must be supplied on a memory stick at the conference, with enough time to transfer the file to the computer used for presentation, but no later than 15 minutes prior to the start of the morning or evening sessions, whichever is relevant for your talk.

Reception:

Welcome Reception: Thursday, February 13 after the last talk (approx. 9:15 p.m.) in the Kinnear Building, room KC 105,

Banquet:

Conference Banquet: Saturday, February 15, in the Kinnear Building, Room KC 105. Dinner will be served at 7:00 p.m.

Group Photo:

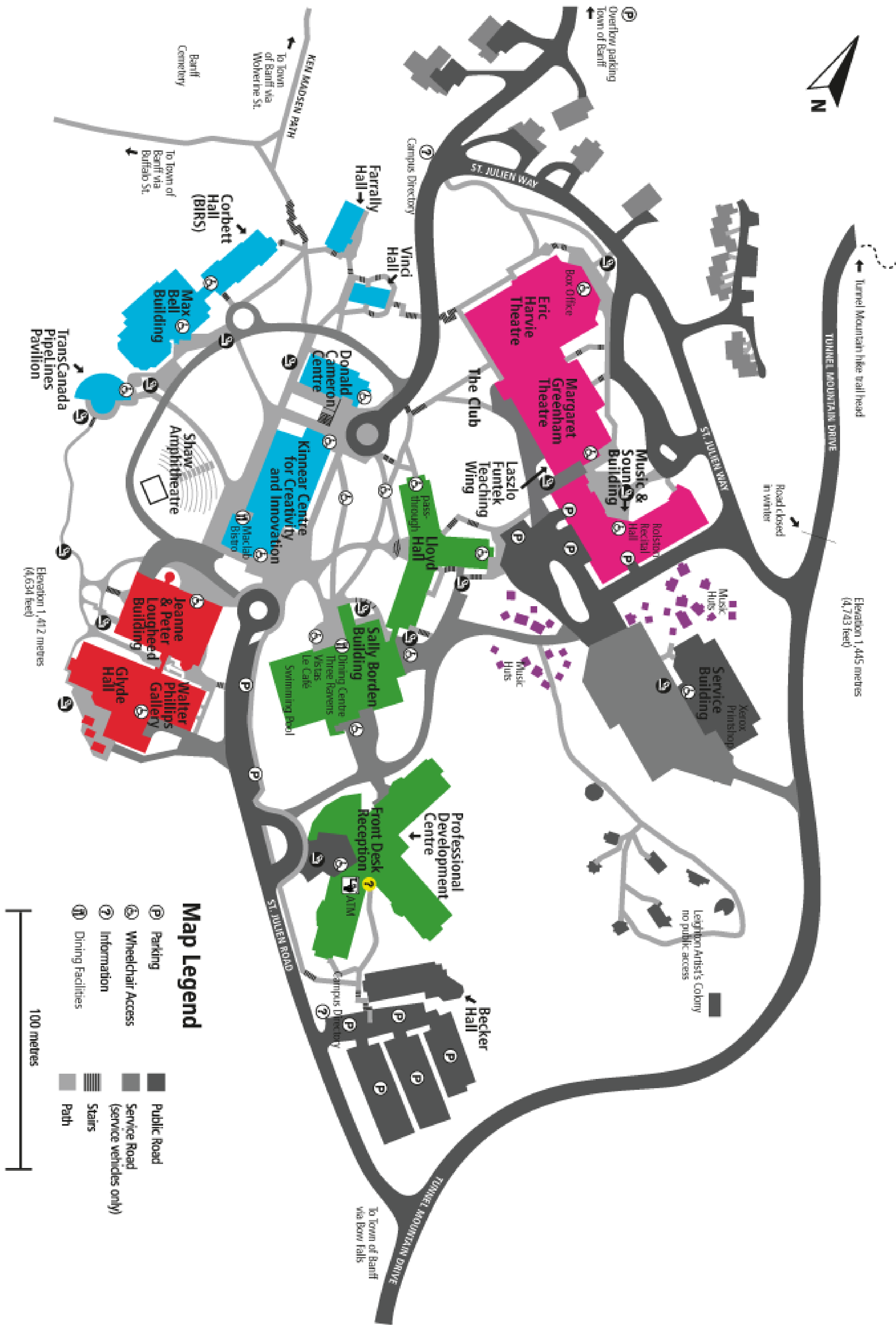
We will gather for a group photo after the Saturday a.m. coffee break, location TBD.

Meals:

The morning coffee break, Welcome Reception and Conference Banquet are included in your registration fee. Lunch is included in your room cost and for those who have paid the off-site fee you will need to use your meal card for food at Vistas.

Conference Contacts:

To contact us, please email **WNPPC@triumf.ca**


N
Overflow parking Town of Banff
Tunnel Mountain hike trail head
TUNNEL MOUNTAIN DRIVE
ST. JULIEN WAY
ST. JULIEN ROAD
KEN MADSEN PATH
To Town of Banff via Wolverine St.
Banff Cemetery
To Town of Banff via Buffalo St.
Campus Directory
Farrally Hall
Corbett Hall (BIRS)
Vinci Hall
Max Bell Building
TransCanada PipeLines Pavilion
Donald Cameron Centre
Kinnear Centre for Creativity and Innovation
MacLab Bistro
Shaw Amphitheatre
Eric Harvie Theatre
Box Office
Margaret Greenham Theatre
The Club
Music & Sound Building
Laszlo Funtek Teaching Wing
Rolston Recital Hall
Road closed in winter
Elevation 1,445 metres (4,743 feet)
Music Huts
Lloyd Hall
pass-through
Sally Borden Building
Dining Centre
Three Ravens
Vistas
Le Café
Swimming Pool
Service Building
Xerox Printshop
Elevation 1,412 metres (4,634 feet)
Jeanne & Peter Lougheed Building
Walter Phillips Gallery
Glyde Hall
Professional Development Centre
Front Desk Reception
ATM
Leighton Artist's Colony no public access
Becker Hall
To Town of Banff via Bow Falls
Map Legend
Parking
Wheelchair Access
Information
Dining Facilities
Public Road
Service Road (service vehicles only)
Stairs
Path
100 metres

Thursday

Evening		Page
R. Picker (UCN)	19:30	4
S. Cruz (Nucl. Structure)	20:00	5
M. Le Dall (High E Theory)	20:15	6
F. Doresty (UCN)	20:30	6
A. Chester (Nucl. Structure)	20:45	7
S. Henkelmann (High Energy)	21:00	7
O. Hernandez (Nucl. Theory)	21:15	8
Reception	21:30	

Friday

Morning		Page
A. Gezerlis (Nucl. Theory)	9:00	9
M. Abdallah (Nucl. Astro.)	9:30	9
A. Chuinard (High Energy)	9:45	9
N. Bernier (Nucl. Structure)	10:00	10
B. Davis-Purcell (Neutrinos)	10:15	10
Break	10:30	
Break	10:45	
R. Mammei (Accel. Sources)	11:00	11
R. Collister (Francium)	11:30	11
R. Seddon (High Energy)	11:45	11
R. Dunlop (Nucl. Structure)	12:00	12
A. Radich (Nucl. Structure)	12:15	13

Friday

Evening		Page
J. Mammei (CREX/PREX)	19:30	14
A. Gutierrez (ALPHA)	20:00	14
D. Leahy (Nucl. Astro.)	20:15	15
Break	20:30	
Break	20:45	
S. Rahman (MOLLER)	21:00	15
A. Laffoley (Beta decay)	21:15	16
R. Ueno (High Energy)	21:30	17

Saturday

Morning		Page
K. Clark (IceCube)	9:00	17
J. Dixon (SM Theory)	9:30	17
M. Gignac (High Energy)	9:45	18
Z. Papandreou (Medical)	10:00	18
M. Dunlop (Nucl. Structure)	10:15	19
Break	10:30	
Break	10:45	
P. Yevgeniy (T2K)	11:00	20
Z. Shand (Nucl. Astro.)	11:30	20
A. Ouyed (Nucl. Astro.)	11:45	21
F. Shaker (T2K)	12:00	21

Saturday

Evening		Page
Banquet	19:00	

Sunday

Morning		Page
I. Dillmann (Nucl. Structure)	9:00	22
J.L. Pore (Nucl. Structure)	9:30	22
T. McCarthy (High Energy)	9:45	23
E. Miller (UCN)	10:00	23
J. Park (Nucl. Structure)	10:15	24
Break	10:30	
Break	10:45	
R. Szafron (Muon Decay)	11:00	24
M. McCarthy (T2K)	11:15	25
M. Lang (UCN)	11:30	25
Y. Liang (Mag. Mom. Positr.)	11:45	26
W. AlTamimi (Nucl. Struct.)	12:00	26

Thursday February 13, 19:30

FUNDAMENTAL PHYSICS WITH ULTRA-COLD NEUTRONS COME TO CANADA

R. Picker[a], C. Davis, K. Katsika, A. Konaka, L. Lee, A.Miller, D. Ramsay, W. van Oers
TRIUMF

C. Bidinosti, B. Jamieson, R. Mammei, J. Martin
University of Winnipeg

J. Birchall, F. Doresty, W. Falk, M. Gericke, M. Lang, J. Mammei, S. Page,
University of Manitoba

E. Korkmaz
University of Northern British Columbia

E.Miller, T. Momose
University of British Columbia

J. Sonier
Simon Frasier University

The knowledge of fundamental properties of the neutron helps us understand many aspect of the universe. It all starts right after the Big Bang: matter wins over antimatter in the Universe, making our existence possible. The main ingredient to that, matter anti-matter asymmetry, requires major violation of another fundamental symmetry, called CP violation. This, in turn might show up in a non-zero electric dipole moment (EDM) of the neutron, making EDM measurements the flagship of fundamental neutron physics.
But, the relevance of the neutron properties continues: 100 s after the Big Bang, the neutron lifetime plays an important role in primordial nucleo synthesis, influencing, e.g., the helium abundance in the Universe significantly. If neutron lifetime results are combined with experiments determining other decay parameters of the neutron, important coupling constants of the weak interaction of fundamental particles can be determined. These are important for our understanding of solar models and tests of the Standard Model of particle physics. Owing to its neutrality and long lifetime of around 15 min, one can also look very carefully at the gravitational interaction of neutrons, thus probing the quantum mechanical features of the gravity potential; in turn, this puts constraints on non-Newtonian gravitation.
All the experiments above have in common the need for very slow neutrons, called ultra-cold neutrons. These have energies in the 100 neV region and can be stored in traps via gravitational, strong and electromagnetic interaction.
The presentation will introduce UCN, their production and some of the main experiments with special focus on the upcoming ultra-cold neutron facility at TRIUMF, Vancouver.

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Thursday February 13, 20:00

SINGLE PARTICLE STRUCTURE AND SHAPES OF EXOTIC Sr ISOTOPES[a]

S. Cruz[1b], R. Krücken[1,2], P. C. Bender[2], K. Wimmer[3], F. Ames[2], C. Andreoiu[4], C. S. Bancroft[3], T. Drake[5], R. Braid[6], T. Bruhn[2], W. Catford[7], D. S. Cross[4], A. Garnsworthy[2], G. Hackman[2], A. Knapton[7], K. Kuhn[6], J. Lassen[2], R. Laxdal[2], M. Marchetto[2], A. Matta[7], D. Miller[2], M. Moukaddam[2], N. Orr[8], A. Sanetullaev[7], C. Unsworth[2], P. J. Voss[4]

1. University of British Columbia, 2. TRIUMF, 3. Central Michigan University, 4. Simon Fraser University, 5. University of Toronto, 6. Colorado School of Mines, 7. University of Surrey, 8. LPC Caen.

Minimums in a nucleus' binding energy with respect to deformation lead to nuclear states having an identifiable "shape". Some nuclei have bound states very close in energy with very different shapes, a phenomenon called shape coexistence. A dramatic occurrence of shape coexisting states is observed in nuclei in the vicinity of Z=40, N=60 [1]. The neutron rich Sr isotopes (Z=38) in this region are known to undergo a dramatic change in shape at N=38 which serves as one of the most striking examples of shape coexistence known today [2]. The aim of the present experiment is to investigate the nature of several low lying states in ^{95}Sr through the transfer reaction ^{94}Sr(d,p)^{95}Sr. A thorough analysis of single particle states will improve our understanding of the onset of these unique structures, encouraging the ongoing theoretical discussions.
A 500 MeV proton beam was impinged on a UCx target, producing a wide range of isotopes. The isotopes were extracted from the UCx target by laser ionization and transported through a mass separater into a Charge State Booster (CSB). This enabled ^{94}Sr to be extracted and then later reaccelerated using the TRIUMF ISAC facilities. A fairly pure ionized ^{94}Sr beam at 5.5 MeV/u was delivered to the TIGRESS [3][c] and SHARC [4] [d] combined arrays. The ^{94}Sr beam impinged on the deuterated target was used to populate low energy excited states in ^{95}Sr via a (d,p) transfer reaction.
Though the analysis is still in a preliminary phase, early results using proton-gamma coincidence collected in the combined TIGRESS-SHARC arrays indicate that there are sufficient statistics to allow conventional selection techniques to be used. Thus, the reaction of interest can be extracted from the data set, which will allow the single particle structure to be studied. Preliminary results will be presented and discussed with the most up to date analysis. Moreover, the continuing direction of the analysis will be addressed.

[1] K. Heyde, J. L. Wood Rev. Mod. Phys. 83, 1467 (2011).

[2] Xiang, J. et al. Nucl. Phys. A 873 (2012).

[3] G. Hackman and C. E. Svensson, Hyper. Int. 225, 241 (2014).

[4] C Aa Diget et al 2011 JINST 6 P02005.

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[a] Work supported by the National Research Council of Canada, the Science and Technology Facilities Council of the United Kingdom and the Natural Sciences and the Engineering Research Council of Canada.

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[c] TRIUMF-ISAC Gamma Ray Escape-Suppressed Spectrometer.

[d] Silicon Highly-segmented Array for Reactions and Coulex.

Thursday February 13, 20:15

HIGGS PORTAL LEPTOGENESIS

M. Le Dall[a], A. Ritz

University of Victoria

The asymmetry between baryon and antibaryon densities in the Universe is measured relative to the photon density through the ratio $\eta = (n_B - n_{\overline{B}})/n_\gamma \sim 10^{-10}$; this number has been a puzzle for over 50 years. The Theory of Leptogenesis is a promising attempt at solving it, by using neutrino interactions in the very early Universe. We present a modification of the Standard Theory of Leptogenesis by adding portal interactions to a Dark Sector. The advantages are two-fold. Not only can we lower the energy scales of the theory to an observable, hence constrainable range, but we also open the possibility of generating Dark Matter in the process.

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Thursday February 13, 20:30

UCN DETECTOR DEVELOPMENT FOR THE TRIUMF NEUTRON EDM EXPERIMENT[a]

F. Doresty F.[b], J. Birchall, W.R. Falk, M. Gericke, M. Lang, J. Mammei, S.A. Page, W.T.H. van Oers *University of Manitoba*

J.W. Martin, C. Bidinosti, B. Jamieson, R. Mammei *University of Winnipeg*

E.Miller, T. Momose *The University of British Columbia*

C. Davis, K. Katsika, A. Konaka, L. Lee, A.Miller, D. Ramsay, W. van Oers, R. Picker *TRIUMF*

E. Korkmaz *University of Northern British Columbia*

J. Sonier *Simon Frasier University*

The measurement of the neutron Electric Dipole Moment (nEDM) is one of the prime ways to look for CP violation outside of the Kaon sector and to test CP violating Standard Model theories, which can be used to explain the observed baryon asymmetry in the universe. Neutron EDM measurements require ultra-cold neutrons (UCN) and we are currently in the process of constructing what is projected to be the highest density UCN source in the world, at TRIUMF. The planned TRIUMF nEDM experiment aims to measure the dipole moment to $d_n = 10^{-28}$ e-cm (10^{-27} first phase). To achieve this goal various significant experimental improvements have to be made, including highly efficient detection of the UCN.In this talk I will present the current status of the UCN detector design, focusing on simulations. The results will be used as a guide for the detector construction for the nEDM experiment at TRIUMF.

[a] Work supported by the Natural Sciences and Engineering Research Council of Canada.
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Thursday February 13, 20:45

DOPPLER SHIFT LIFETIME MEASUREMENTS USING THE TIGRESS INTEGRATED PLUNGER

A. Chester[a], On behalf of the TIP and TIGRESS teams

Simon Fraser University Department of Chemistry

Electromagnetic transition rate measurements serve as a fundamental probe of nuclear structure and provide a stringent test for theoretical models. Doppler shift lifetime measurements offer an opportunity to directly access information about electromagnetic transition rates and discriminate between model calculations. To take advantage of this opportunity, the TIGRESS Integrated Plunger (TIP) has been constructed at Simon Fraser University (SFU). The current TIP infrastructure supports lifetime measurements via the Doppler Shift Attenuation Method (DSAM) and the Recoil Distance Method (RDM). One advantage of Doppler shift lifetime measurements is that lifetimes can be extracted independent of the reaction mechanism. TIP has been coupled to the TIGRESS segmented Ge array at TRIUMF as part of the experimental program at ISAC-II. The initial studies using TIP employ fusion-evaporation reactions. Here, reaction channel selectivity can greatly enhance the sensitivity of the measurement. To enable channel selection, a 24-element CsI wall has been coupled to TIP for evaporated light charged-particle identification. Reaction channel selectivity has been demonstrated using the TIP infrastructure following the successful identification of the ^{28}Mg two proton evaporation channel from the ^{18}O $+^{12}$C reaction at the ^{18}O beam energies of 56 and 48 MeV. DSAM lineshapes for the 1.2(1)ps $2^+ \rightarrow 0^+$ transition and 105(35)ps $4^+ \rightarrow 2^+$ transition in ^{28}Mg have been observed. Geant4-based analysis code for TIP and TIGRESS is being developed to extract lifetimes from these experimental spectra and aid in the optimization of future experiments using this setup. The device, experimental approach, analysis, and preliminary results will be presented and discussed.

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Thursday February 13, 21:00

THE SIGNAL MODELLING IN THE SEARCH FOR THE HIGGS BOSON PRODUCED IN ASSOCIATION WITH A TOP-QUARK PAIR USING THE ATLAS EXPERIMENT AT THE LHC

Steffen Henkelmann[a],

University of British Columbia

The physics program of the ATLAS experiment pursued at the Large Hadron Collider (LHC) at CERN succeeded in the observation of a new particle in the search for the Standard Model Higgs boson. The Higgs boson production in association with a top-quark pair provides key features to further investigate the nature of the Higgs boson. Its coupling to other bosons was discovered and evidence for its coupling to fermions is given. The associated $\mathrm{t\bar{t}H}$ production with the Higgs decay, $\mathrm{H} \rightarrow \mathrm{b\bar{b}}$, provides a good opportunity to probe its coupling strength to top and bottom quarks in the production and decay, respectively.

In order to improve the signal sensitivity of the search, multivariate analysis techniques are used to enhance the background and signal separation power relying on persuasive signal and background models. Therefore, dedicated studies of the $\mathrm{t\bar{t}H}$ signal predictions by various Monte Carlo generators at different orders in QCD perturbation theory including differing features and the evaluation of systematic uncertainties assessed to the signal model are presented.

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Thursday February 13, 21:15

UNDERSTANDING THE PROTON RADIUS PUZZLE: "NUCLEAR POLARIZABILITY CORRECTIONS IN μD "

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In 2010 the accuracy of the rms proton radius was improved ten-fold [1] by new spectroscopic measurements of the Lamb shift [2] in muonic hydrogen, where a proton is surrounded by a muon instead of an electron. However, this new value differed by 7σ from what was previously determined in ordinary hydrogen [3]. This large discrepancy was coined the "proton radius puzzle" and challenges our understanding of physics based on the standard model. New high-precision measurements on various muonic atoms are planned at PSI to study whether this discrepancy persists or varies with mass and charge numbers. In particular, the CREMA collaboration [4] plans to measure the Lamb shift and isotope shifts in several light muonic atoms, such as muonic deuterium (μD) and muonic helium. The accuracy of the nuclear charge radii determination from their data is limited by the uncertainty in the nuclear polarizability corrections. For μD, these nuclear corrections have been most recently calculated by Pachucki with the AV18 nuclear potential [5]. In this contribution I would like to show how we complement Pachuki's pioneering work by performing ab-initio calculations in μD with state-of-the-art nuclear potentials from chiral effective field theory. We take into account multipole corrections, Coulomb, relativistic and finite-nucleon-size corrections. We found small but non-negligible differences between our results and Pachuki's for the the relativistic corrections that may have an impact on improving the accuracy of the experimental program. Furthermore, performing a systematic study in chiral effective field theory will allow us to better assess the theoretical error associated to the polarizability calculations.

[1] R. Pohl *et al.*, Nature **466**, 213 (2010).
[2] W. E. Lamb and R. C. Rutherford, Phys. Rev. **72**, 241 (1947).
[3] A. Antognini *et al.*., Science **339** (6118): 417 (2013).
[4] A. Antognini *et al.*, Can. J. Phys. **89**, 47 (2011).
[5] K. Pachuki, Phys. Rev. Lett. **106** 193007 (2011).

[a] *E-mail:* javierh@triumf.ca

Friday February 14, 9:00

MICROSCOPIC SIMULATIONS IN NUCLEAR PHYSICS: FROM QCD TO EFT AND FROM THERE TO QMC[a]

Alexandros Gezerlis[b]

Department of Physics, University of Guelph

I will first go over the status of modern nuclear theory, especially in connection with first-principles studies of strongly interacting nucleons. After some general points on the underlying theory of Quantum Chromodynamics (QCD), I will go over the efforts toward connecting QCD with many-nucleon studies (via chiral Effective Field Theory [EFT]). I will then introduce a recent local reformulation of chiral EFT, which makes it possible to use such modern potentials within the framework of Quantum Monte Carlo (an essentially exact type of microscopic simulation method).

[a]Work supported by the Natural Sciences and Engineering Research Council of Canada.
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Friday February 14, 9:30

SPECTRAL STUDY OF X-RAY BINARY HERCULES X-1/HZ HERCULES

Mohammed H. Abdallah[a], Denis Leahy

University of Calgary

Hercules X-1 is a well know eclipsing binary X-ray pulsar. The system contain a 1.24 second period pulsar Her X-1 in a 1.7 day circular orbit with its optical companion Hz Her. In addition, the system display a longer 35-day on/off cycle in which a Main-High state and a Short-High state, lasting about 11 and 8 days each respectively, occure once per 35-day and separated by 8 days long Low state. The system was observed by the proportional Counter Array on board of the Rossi X-ray Timing Explorer (RXTE/PCA) between 1996, July and 2009, February covering a wide range of 35-day phase and a large amount of data during eclipses including (ingresses/egresses). This large set of data enables the spectral study of of the binary X-ray Pulsar which will be presented in this talk.

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Friday February 14, 9:45

DIFFRACTION STUDIES AT HIGH ENERGIES USING THE ATLAS DETECTOR

A. Chuinard[a]

McGill University

Diffraction is an important part of the studies performed in experiments involving interacting hadrons. At the LHC, both theoretical and experimental aspects of possible diffractive measurements are studied. The mechanisms of soft and hard diffraction, including those involving multiple Pomeron exchanges, will be presented. Opportunities to probe the QCD dynamics at play in diffractive processes using data recorded by the ATLAS detector will be explored.

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Friday February 14, 10:00

STUDY OF THE PHOTOPRODUCTION OF ^{8}Li WITH THE REACTION $^{9}Be(\gamma,p)^{8}Li$[a]

N. Bernier[b], P. Bricault
TRIUMF and Laval University

R. Roy
Laval University

The TRIUMF laboratory is a world leader in the production of rare radioactive ion beams. Its ARIEL project consists of the construction of a superconducting linac capable of delivering 10 mA electron beam at 50 MeV. In the first phase the electron intensity and energy will be limited to 4 mA and 25 MeV. This is enough energy to start a program producing ^{8}Li for material science. The ^{8}Li is produced via the photo detachment of a proton from the ^{9}Be nucleus, $^{9}Be(\gamma,p)^{8}Li$. The photons are produced by the interaction of the electron passing through a high Z material placed immediately before the production target. The ^{9}Be is imbedded in a beryllium oxide compound, manufactured at TRIUMF and designed following specifications of ALTO Orsay where the preliminary tests are conducted, with their 10 μA, 50 MeV electron linac, while the ARIEL linac is being constructed. Both the power deposition and rare isotope production rates were calculated using the Monte Carlo simulation package FLUKA. This presentation will focus on the fabrication of the target and the comparison of previous experiment results obtained at ALTO to the FLUKA calculations for simulating photofission with an electron beam.

[a]Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
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Friday February 14, 10:15

NECK OPTICS TUNING OF THE SNO+ EXPERIMENT

Ben Davis-Purcell[a]
TRIUMF

SNO+ is a liquid scintillator-based neutrino experiment located approximately 2 km underground at SNOLab near Sudbury, Ontario in VALE's Creighton mine. SNO+ will be searching for various types of neutrinos, including low-energy solar neutrinos, reactor neutrinos, geo-neutrinos, supernovae neutrinos, and will also include a special phase to search for neutrino-less double beta decay. Neutrino interactions occur inside a 12 m diameter acrylic vessel filled with 780 t of linear alkyl benzene. Scintillation light from these interactions is observed by a sphere of approximately 9000 photo-multiplier tubes surrounding the acrylic sphere. The vessel has a 7 m long neck extending upwards from the top of the sphere, which allows calibration sources to enter the vessel. One aspect of detector response that has not been examined until now is the optics of the neck. While the acrylic of the vessel is transparent, the neck acrylic is made of a darker, partially opaque material. The optical properties of this material change are not accounted for in any simulation software. If the properties of the neck were better known, the energies of events passing through the neck would be able to be reconstructed with much higher accuracy, thereby reducing the systematic error of the experiment. This talk will examine the difference in detector response caused by the change of material and present results obtained from data and simulations that answer the question: What is the percent attenuation of light through the acrylic vessel neck?

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Friday February 14, 11:00

ELECTRON GUN SOURCES FOR THE PARTICLE ACCELERATORS OF TOMORROW [a]

R. Mammei [b], *University of Winnipeg*

Accelerated electrons provide a clean probe to study matter from the micron to the sub-femtometer scale. Such examples include the relatively low KeV energy electron beams used in scanning electron microscopes to the high energy GeV electron beams used at the Thomas Jefferson National Accelerator Facility (Jefferson Lab) or the proposed International Linear Collider (ILC). In addition to using the electrons as the probe themselves, accelerated electrons can be manipulated to generate light, which has given rise to many light source facilities around the world. These facilities are being used to study matter at an unprecedented scale in space and time, illuminating many biological and materials science processes. Usually, when you want to create a high-current source of electrons, you start by simply boiling them out of a metal, i.e. by heating a filament much like the one in an incandescent light bulb. However the most demanding electron accelerator facilities require electron beams generated using the photoelectric effect, where a carefully prepared photocathode material is illuminated with a high-power laser of a particular wavelength. This kind of electron source provides a tightly bunched, in space and time, electron beam for use in the most advanced electron accelerators. I will provide an overview of current and future accelerator applications for these electron sources and some recent results of photocathode R&D performed at Jefferson Lab.

[a] Work supported by the United States Department of Energy.
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Friday February 14, 11:30

ISOTOPE SHIFTS IN FRANCIUM ISOTOPES 206-213FR AND 221FR [a]

R. Collister [b], *University of Manitoba*

We present isotope shift measurements for the 7S1/2 to 7P1/2 transition in francium isotopes 206-213 with respect to 221. The measurements were performed in the Francium Trapping Facility at TRIUMF by radiofrequency sideband spectroscopy on atoms collected in a magneto-optical trap. While isotope shifts in heavy elements are dominated by the field shift, caused by a change in charge radius, our new measurements are aimed at benchmarking calculations of another important, and highly non-trivial contribution, the specific mass shift, which is sensitive to electron correlations. Applications include the calculation of isotopic ratios in stellar abundances or fundamental symmetry tests, such as time and space dependences of the fine structure constant alpha or atomic parity violation.

[a] Work supported by the Natural Sciences and Engineering Research Council of Canada.
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Friday February 14, 11:45

SEARCH FOR THE RARE $B^- \to \Lambda\bar{P}\nu\bar{\nu}$ DECAY AT THE BABAR EXPERIMENT

R. Seddon [a], *McGill University*

We present preliminary results from our analysis of the decay $B^- \to \Lambda\bar{p}\nu\bar{\nu}$. $B^- \to \Lambda\bar{p}\nu\bar{\nu}$ is a semileptonic, flavour-changing-neutral-current decay which proceeds exclusively through one-loop box and penguin diagrams. It is therefore expected to be heavily suppressed ("rare") within the context of the Standard Model (SM) with a predicted branching fraction of $(7.9 \pm 1.9) \times 10^{-7}$. This suppression, combined with the possibility of contributions in loops containing new physics particles, makes the decay particularly sensitive to beyond-SM physics as any deviation from the predicted decay processes will lead to a large change in the branching fraction. The aim of this analysis is to establish the first experimentally measured branching fraction of this decay. This analysis uses data from the BABAR detector based at SLAC National Accelerator Laboratory in California.

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Friday February 14, 12:00

$A \geq 62$ SUPERALLOWED FERMI β-DECAYS AND FUTURE PROSPECTS WITH GRIFFIN

R. Dunlop[a], S. Chagnon-Lessard, P. Finlay, P.E. Garrett, B. Hadinia, K.G. Leach, E.T. Rand, C.E. Svensson, J. Wong

Department of Physics, University of Guelph, Guelph, Ontario, N1G 2W1, Canada

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High-precision measurements of superallowed Fermi β decays allow for the extraction of the weak-vector coupling strength, and provide stringent tests of the electro-weak Standard Model. Superallowed decays of $A \geq 62$ nuclei are of particular interest as the nucleus dependent isospin-symmetry-breaking corrections are relatively large in these nuclei. The magnitudes of these corrections are a topic of great current interest, making the $A \geq 62$ superallowed decays an ideal test for these corrections. The measurement of superallowed β decay rates requires the Q_{EC}-value, superallowed branching ratio, and half-life for the decay. The branching ratio measurement for the $A \geq 62$ decays include a unique challenge as they are far from stability. This implies a large Q_{EC} and, hence, a large level density of available states for the parent nucleus to decay into, resulting in the Pandemonium effect. The weak feeding distributed over this large number of states is very difficult to observe and limits the precision of the branching ratio measurements. Therefore, very-high efficiency detectors are of paramount importance in determining the branching ratio for these decays.

Recently, the 8π γ-ray spectrometer was decommissioned at TRIUMF's Isotope Separator and Accelerator (ISAC). The 8π has served the field of γ-ray spectroscopy for over 30 years, and had continued to provide competitive results in decay spectroscopy, including the achievement of world-record precision of $A \geq 62$ superallowed branching ratios. Later this year, the GRIFFIN detector array will be installed in place of the 8π spectrometer. GRIFFIN boasts a γ-ray efficiency increase by a factor of 17 compared to the 8π array efficiency for γ-rays of 1 MeV, and larger gains for the higher energy γ rays of particular importance in the Pandemonium effect. In this talk, the importance of one of these results from the 8π — the high-precision measurement of the branching ratio measurement for the superallowed Fermi β-decay of ^{74}Rb — will be discussed, as well as the importance of GRIFFIN for future superallowed β decay studies at ISAC.

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Friday February 14, 12:15

NUCLEAR STRUCTURE OF ^{124}Xe STUDIED WITH β^+/EC-DECAY[a]

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The Xe and Te nuclei show a smooth evolution of collectivity, with increasingly ill-defined nuclear structure away from shell closures. To better characterize collective properties of nuclei in this region, an experimental program using β^+/EC-decay was proposed at the ISAC facility at TRIUMF. The first nucleus studied in this program was ^{124}Xe.
A beam of 9.8x10^7 ions/s ^{124}Cs (J$^\pi$=1$^+$, t$_{1/2}$=30.8s) and 2.6x10^6 ions/s ^{124m}Cs (J$^\pi$=7$^+$, t$_{1/2}$=6s) was implanted at the center of the 8π spectrometer−a spherically symmetric array of 20 Compton-suppressed High-Purity Germanium (HPGe) detectors−where it underwent β^+/EC-decay into stable ^{124}Xe. High-statistics γ-γ coincidence measurements have been analyzed to add to the level scheme of ^{124}Xe, which has been extended considerably with the addition of over 200 new transitions. The high statistics data set has also revealed a new decay branch from a ^{124}Cs high-spin isomer.
Two particular low-spin transitions−360-keV ($2^+_3 \rightarrow 0^+_2$) and 289-keV ($2^+_4 \rightarrow 0^+_3$)−were clearly observed with β-decay but unobserved in a previous Coulomb excitation experiment at Gammaphere (^{12}C(^{124}Xe,^{124}Xe*))[c]. The matrix elements for these in-band transitions were hypothesized based on γ-ray yields of other decay branches observed in the Coulex experiment. In this work, the branching ratios and B(E2) transition strengths were measured with greater precision to be 5.5(2)% and 77(15) Weisskopf units for the 360-keV transition, and 0.79(9)% and 54(12) Weisskopf units for the 289-keV transition, respectively. The high collectivity of these transitions will be discussed in this presentation.

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[a]Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
[b]*E-mail:* aradich@uoguelph.ca
[c]G. Rainovski et al. Physics Letters B 683 (2010) 11

Friday February 14, 19:30

THE LEAD RADIUS AND CALCIUM RADIUS EXPERIMENTS (PREX AND CREX) AT JEFFERSON LAB[a]

J. Mammei[b]
University of Manitoba

For the PREX and CREX Collaborations

The PREX and CREX collaborations will measure the parity-violating asymmetry in elastic electron-nucleus scattering on lead and calcium, respectively. The Z^0 boson couples mainly to neutrons, so the asymmetry provides a clean measurement of the neutron skin, the difference in the extent of the neutron and proton density distributions in a nucleus. Lead and calcium are both neutron rich nuclei and are doubly-magic, making it easier to correct for strong interaction uncertainties. The neutron skins in the two nuclei are predicted to be correlated, so measuring both will provide a test of nuclear theory. Lead more closely approximates infinite nuclear matter, such as in a neutron star, while three nucleon forces can be calculated with ab initio models in calcium. Both experiments have recieved approval of the Jefferson Lab PAC to run after the completion of the 12 GeV Upgrade. PREX and CREX will use 1.0 GeV and 2.2 GeV electron beams, respectively. The low scattering angles required, 5° and 4°, respectively, require the use of a septum magnet in addition to the standard Hall A magnetic spectrometers. Together they will provide input to nuclear theory, affecting a wide range of areas from neutron star structure, atomic parity violation and more.

[a]Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
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Friday February 14, 20:00

ANTIPROTON CLOUD RADIAL COMPRESSION IN THE ALPHA APPARATUS AT CERN[a]

Andrea Gutierrez[b]
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ALPHA Collaboration [c]

The ALPHA experiment aims to study trapped antihydrogen. Based at CERN's Antiproton Decelerator (AD), ALPHA successfully trapped antihydrogen in 2010 [1] and, in 2012, performed the first measurement on the internal structure of the antihydrogen system with microwave radiation [2]. Antiproton cloud compression is crucial for the production of trappable antihydrogen. Antiproton clouds can be radially compressed using a rotating dipolar electric field, also called the rotating wall technique. Antiprotons have previously been indirectly compressed by applying a rotating wall to a dense electron plasma co-located with the antiprotons [3]. In this talk, I will present new results obtained in the ALPHA apparatus at CERN, in which antiproton clouds are directly compressed, with a diffuse electron cloud providing a cooling mechanism.

[1] G. B. Andresen *et al.*, Nature **468**, 673 (2010).
[2] C. Amole *et al.*, Nature **483**, 439 (2012).
[3] G. B. Andresen *et al.*, Phys. Rev. Lett **100**, 203401 (2008).

[a]This work was supported by: CNPq, FINEP/RENAFAE (Brazil); ISF (Israel); FNU (Denmark); VR (Sweden); NSERC, NRC/TRIUMF, AITF, FQRNT (Canada); DOE, NSF, LBNL-LDRD (USA); and EPSRC, the Royal Society and the Leverhulme Trust (UK).
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Friday February 14, 20:15

A DECADE OF RXTE X-RAY OBSERVATIONS OF HERCULES X-1: WHAT WE HAVE LEARNED.[a]

D. Leahy[b],

University of Calgary

The Rossi X-ray Timing Explorer (RXTE) data archive includes a large set of observations of Hercules X-1 obtained over a 15 year period. Derived products from this data set include: orbital light curves, 35-day cycle light curves, pulse shapes and their variations, Anomalous Low State observations, observations of over 350 dips, 21 eclipse ingresses and egresses, and spectra for all of these. High-lights of the analysis of this data set are given here. This includes the derived mass and radius for the neutron star (one of the most accurate radii yet determined), the derived disk geometry, the accretion disk corona properties, and the newly-determined companion star radius and evolutionary state.

[a]Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
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Friday February 14, 21:00

SPECTROMETER SENSITIVITY STUDIES FOR THE MOLLER EXPERIMENT

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University of Manitoba

The MOLLER experiment at Jefferson Laboratory proposes to measure the parity-violating asymmetry A_{PV} in polarized electron-electron (Møller) scattering. The measurement will be carried out in Hall A at Jefferson Laboratory, where a longitudinally polarized electron beam will be incident on a liquid hydrogen target and the resulting fractional difference in the probability of electrons with opposite polarizations scattering off atomic electrons in the target will be observed. The asymmetry is proportional to the weak charge of the electron, which in turn is a function of the electroweak mixing angle. Møller electrons in the full range of azimuth and spanning a specific polar angular range, will be separated from background. These selected electrons will be brought to a ring focus downstream of the target by a spectrometer system consisting of a pair of toroidal magnet assemblies and precision collimators. The Møller ring will be intercepted by a system of quartz detectors. We simulate this process in $GEANT4$ using different magnetic field maps generated in $TOSCA$ with respect to different radial, z, T, roll, pitch and yaw offsets of the individual coils in the downstream hybrid toroid. For these preliminary results, we only concentrated on offsets in one coil in the downstream toroid in order to determine the uncertainty in the electroweak mixing angle due to the different kinds of offsets. This will give us an initial idea about the engineering precision required in the design of the toroidal system for the experiment.

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HIGH-PRECISION HALF-LIFE MEASUREMENTS FOR THE SUPERALLOWED β^+ EMITTER ^{18}NE[a]

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J. R. Leslie

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High-precision measurements of the ft values for superallowed Fermi β decays—decays between 0^+ isobaric analog states—have provided invaluable probes of the Standard Model description of the electroweak interaction. These measurements have been used to test the conserved vector current (CVC) hypothesis, set limits on the existence of scalar and right-handed currents in the electroweak interaction, and search for other possible extensions of the Standard Model.The current precision of the ^{18}Ne half-life, although recently improved, and branching ratio are still not at the required level of precision to be included in the calculation of the world average corrected $\mathcal{F}t$ value for superallowed Fermi β emitters. A high-precision branching ratio measurement for ^{18}Ne was recently performed at GANIL and is in the final stages of the analysis; it is this development which has prompted us to improve the precision of the ^{18}Ne half-life at TRIUMF. Using the 8π γ-ray Spectrometer—a spherically symmetric array consisting of 20 Compton suppressed High-Purity Germanium (HPGe) detectors—and the ancillary Zero-Degree Scintillator (ZDS)—a fast plastic scintillator placed behind the tape transport system within the 8π—as well as a 4π proportional continuous-flow gas counter, two direct β counting measurements for the half-life of ^{18}Ne were performed. Each of these two measurements is a factor of 2 times more precise than the previous world average data, resulting in an improved precision for the half-life of ^{18}Ne by a factor of approximately 3, to $\pm 0.025\%$, which is comparable to the other most precisely known superallowed β emitters. A new thick-tape transport system (T-Tape) was recently constructed and used in conjunction with the 4π proportional gas counting station at TRIUMF. The system was designed to be thick enough to prevent any diffusion when using gaseous samples; this ^{18}Ne half-life experiment was the first commissioning experiment of the T-Tape system and successfully demonstrated its use with a noble gas. This presentation will discuss the half-life results for ^{18}Ne as well as the newly commissioned T-Tape system.

[a] Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
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Friday February 14, 21:30

SEARCHES FOR ELECTROWEAK SUSY SIGNATURES WITH TWO LEPTONS AND MISSING ENERGY WITH THE ATLAS DETECTOR

Rick (Ryuichi) Ueno[a], on behalf of the ATLAS Collaboration

Carleton University

With the strong limit on squark and gluino masses resulting from the early LHC results, electroweak supersymmetry scenarios are becoming more favourable. A search for supersymmetric direct gaugino and direct slepton production is performed in pp collisions with the ATLAS detector. This analysis focuses on these models by searching for final states involving exactly two leptons (e or μ) and missing transverse momentum. The overview of the analysis, as well as results using data with integrated luminosity of 20.3 fb^{-1} at $\sqrt{s} = 8$ TeV are presented.

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Saturday February 15, 9:00

NEUTRINOS ON ICE[a]

K. Clark[b]

University of Toronto

For several years the IceCube detector has been taking data at the South Pole, studying many aspects of neutrino (and non-neutrino) physics. Designed to search out energetic events (of order PeV), IceCube has recently published the detection of the highest energy events ever recorded. At the same time, however, preliminary investigations are ongoing into the possible study of events with six orders of magnitude less energy. This talk will present the recent high energy results while introducing the IceCube extension DeepCore and potential further enhancement PINGU. These additions are focused on lowering the detection energy threshold and possibly determining the neutrino mass hierarchy.

[a] Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
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Saturday February 15, 9:30

DOES SUSY REALLY NEED TO BE BROKEN?

J. Dixon[a]

(University of Alberta)

It is notorious that SUSY breaking leads to phenomenological and theoretical nightmares. In this talk, I examine the possibility that these problems can be circumvented, by using the fact that the BRST Cohomology of SUSY appears to contain a mechanism for splitting and mixing up the supermultiplet masses, while conserving SUSY. The mechanism also seems to give a reason for the existence of three flavours of quarks and leptons.

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Saturday February 15, 9:45

SEARCH FOR CHARGINO AND NEUTRALINO PRODUCTION IN FINAL STATES WITH ONE LEPTON, TWO B-JETS CONSISTENT WITH A HIGGS BOSON AND MISSING TRANSVERSE MOMENTUM WITH THE ATLAS DETECTOR IN 20.3 FB^{-1} OF $\sqrt{S}$ = 8 TEV PP COLLISIONS

M. Gignac[a]
TRIUMF/UBC

The Standard Model (SM) of particle physics provides a theoretical framework to understand fundamental particle interactions. Despite its extraordinary success, the SM leave a number of open questions: What is the nature of Dark Matter? Why is the SM Higgs boson so light? Supersymmetry (SUSY) is an extension of the SM of particle physics which predicts a super-partner for each of the SM particles which differs by one-half unit of spin. In R-parity conserving SUSY models, the lightest supersymmetric particle (LSP) is stable, neutral and weakly interacting, providing a promising candidate to explain Dark Matter. In addition, SUSY provides a solution to the Hierarchy problem of the SM and allows for the unification of forces at the GUT scale. This talk focuses on the first search for the direct production of charginos and neutralinos in final states with one lepton, two b-jets consistent with a SM Higgs boson and large missing transverse momentum. The analysis utilizes 20.3 fb^{-1} of data collected by the ATLAS detector at $\sqrt{s}$ = 8 TeV during Run 1 of the LHC. The signal region selection and optimization along with the estimation of the SM background will be discussed. No excess above the Standard Model predictions is observed. Limits are set in the context of simplified SUSY models.

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Saturday February 15, 10:00

MULTI PIXEL PHOTON COUNTERS FOR PET IMAGING IN PLANTS AND PERSONAL RADIATION DETECTION[a]

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Multi Pixel Photon Counters (MPPCs) are photo detectors that have shown great potential for many applications ranging from subatomic physics to the health and safety sectors. Our group has recently embarked into the development of modular and flexible detector solutions for Positron Emission Tomography (PET) detection arising from radioisotope uptake in plants, as well as development of compact, inexpensive personal radiation detectors for first responders. The understanding of the gain and other performance characteristics of MPPCs as a function of temperature is an essential element of these applications. Measurements of the associated temperature coefficient will be presented together with the conceptual design of the above systems.

[a] Work supported by the Natural Sciences and Engineering Research Council of Canada and the Sylvia Fedoruk Canadian Centre for Nuclear Innovation.
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Saturday February 15, 10:15

HIGH-PRECISION HALF-LIFE MEASUREMENTS FOR THE SUPERALLOWED β^+ EMITTER ^{10}C [a]

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High precision measurements of superallowed Fermi beta transitions between 0^+ isobaric analogue states allow for stringent tests of the electroweak interaction described by the Standard Model. Particularly, these transitions provide an experimental probe of the unitary of the Cabibbo-Kobayashi-Maskawa (CKM) matrix, the Conserved-Vector-Current (CVC) hypothesis, as well as set limits on the existence of scalar currents in the weak interaction. Half-life measurements for the lightest of the superallowed emitters are of particular interest as it is the low-Z superallowed decays that are most sensitive to a possible scalar current contribution.

There are two methods for measuring the superallowed β decay half-life of ^{10}C: via directly counting the β particles or measuring the γ-ray activity following β decay. Previous results for the ^{10}C half-life measured via these two methods differ at the 2.7σ level, prompting simultaneous and independent measurements of the ^{10}C half-life using both techniques. Since ^{10}C is the lightest nucleus for which superallowed β decay is possible, a high precision measurement of its half-life is essential for obtaining an upper limit on the presence of scalar currents in the weak interaction.

In October 2013, ^{10}C half-life measurements via both gamma-ray photo-peak and direct beta counting were performed at TRIUMF's Isotope Separator and Accelerator (ISAC) facility using the 8π spectrometer and a 4π gas proportional β counter at the ISAC General Purpose Station. The 8π γ-ray spectrometer consists of 20 High Purity Germanium (HPGe) detectors as well as the Zero Degree β detector, a fast plastic scintillator located at the end of the beam line within the 8π. This presentation will highlight the importance of these measurements and preliminary half-life results for ^{10}C will be presented.

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Saturday February 15, 11:00

SUMMARY OF THE LATEST RESULTS FROM THE T2K EXPERIMENT

Yevgeniy Petrov[a],
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For the T2K Collaboration

Measurements of the neutrino oscillation parameters play an important role for development of the physics theory beyond the standard model and potentially for our understanding of matter-antimatter asymmetry. The T2K experiment located in Japan is designed to study oscillations of muon neutrinos. It utilizes a long baseline approach. J-PARC accelerator produces a beam of 30GeV protons that hit a target and convert into a beam of muon neutrinos peaked at 0.6 GeV. After travelling 295 km, neutrinos are detected by Super-Kamiokande water Cherenkov detector. The near detector complex (ND280) located at 280 m from the target provides information about un-oscillated neutrino flux, direction and interaction cross-sections. T2K observed electron neutrino appearance with the significance of 7.3σ and measured the associated oscillation parameter θ_{13} for both normal and inverted hierarchies. In addition, by looking at muon neutrino disappearance T2K provided better measurements of θ_{23} parameter and Δm^2_{32}. The results of these measurements are presented, as well as the results of neutrino cross section measurements.

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Saturday February 15, 11:30

INVESTIGATION OF THE FEASABILITY OF THE HIGH ENTROPY WIND OF A SUPERNOVA AS AN R-PROCESS SITE

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University of Calgary

The bulk of elements heavier than iron present in the universe today are understood to be a product of the r-process. The r-process occurs in a neutron rich environment where neutrons are rapidly captured by heavier nuclei to produce elements from iron up to uranium. This requires a high energy astrophysical event which is rich in free neutrons. Historically, supernovae have been the most promising location suspected of producing the heavy elements we see in our galaxy today; however, there are now competitive theories which take advantage of other high energy astrophysical events like neutron star mergers or quark novae. In a type II supernova, there is a heavy iron core which, after core bounce, is photodisintegrated into nucleons which are left behind as a neutron star. These free nucleons are the proposed source of the free neutrons we require for the r-process. Although qualitatively simple, this mechanism – when modelled – has difficulty reproducing the r-process elements as we observe them in our galaxy. Using the program r-Java 2.0, [b] the r-process in the high entropy wind was examined using the theoretical predictions of the Hartree-Fock-Bogoliubov mass model.
The results of these simulations using different initial conditions have a range of final abundance distributions. Given sufficient free neutrons, neutron rich nuclei near the neutron drip line and superheavy nuclei (that is, fissile nuclei of masses much greater than uranium) are predicted to be produced. Simulations which had in excess of 100 neutrons for each other nucleus best matched the high mass wing of the r-process distribution. These results are interesting when contrasted against observational data which show that the r-process elements are always produced in the same relative abundances. This suggests that both neutron rich nuclei near the neutron drip line and superheavy elements are produced in nature; however, the relative number of free neutrons required in this case is unsupported by the results from hydrodynamic simulations of supernovae. This means that either supernovae do not produce all of the r-process elements, or there is some new physics buried in the problem to be discovered.

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[b]r-Java 2.0 is free-use software soon to be available at quarknova.ucalgary.ca

Saturday February 15, 11:45

A NEW FRAGMENTATION MODEL FOR THE PRODUCTION OF $56 < A < 130$ ELEMENTS AND P-NUCLEI[a]

Amir Ouyed[b], Rachid Ouyed, Denis Leahy

University of Calgary

It's assumed that the bulk $A > 90$ isotopes in the universe is produced by rapid neutron capture (r-process). Yet, current r-process site candidates either fail to trigger the environment necessary for the r-process or are only capable of creating very heavy $A > 120$ isotopes, the latter which leave a gap in $90 < A < 120$ unexplained. Furthermore, the p-nuclei, which are 35 specific proton rich isotopes, are not completely reproduced by current models. We argue that the reason why sites that can trigger the r-process can only create heavy $A > 120$ isotopes, is because the models are incomplete: they require a spallation process to fragment $A > 120$ nuclei into $A < 120$ isotopes. We locate this spallation process in the explosive phase transition of a Neutron Star into a Quark Star, the Quark Nova (QN). Finally, this QN spallation also conveniently produce the p-nuclei without the deficiencies characteristic of many p-process models.

[a]Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
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Saturday February 15, 12:00

UPGRADING THE TOKAI TO KAMIOKA TIME PROJECTION CHAMBER DATA CONCENTRATOR CARD

F. Shaker[a], B. Jamieson

University of Winnipeg

T2K is a long baseline neutrino oscillation experiment in Japan, that is making precision measurements of the θ_{13} and θ_{23} mixing parameters. Neutrino oscillations arise from a mixture between the flavor and mass eigenstates of neutrinos. The three neutrino flavor states that interact with the charged leptons in weak interactions (ν_α, with $\alpha = e, \mu, \tau$) are each a superposition of the three neutrino mass states (ν_k with $k = 1, 2, 3$). The neutrino flavor and mass eigenstates are linked by the Maki-Nakagawa-Sakata (MNS) matrix.

In this talk I will present an electronics upgade for the T2K experiment, namely the near detector Time Projection Chamber (TPC) Data Concentration Card (DCC). I will explain the role of the DCC and how improving the DCC leads to a better measurement of track x-coordinates. This improvement is also expected to make the TPC time calibration much simpler.

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Sunday February 16, 9:00

INVESTIGATION OF β-DELAYED NEUTRON EMITTERS FOR ASTROPHYSICS[a]

Iris Dillmann[b], *TRIUMF*

Beta-delayed neutron (βn) emitters play an important, two-fold role in the stellar nucleosynthesis of heavy elements in the "rapid neutron-capture process" (r process). On one hand they lead to a detour of the material β-decaying back to stability. On the other hand, the released neutrons increase the neutron-to-seed ratio, and are re-captured during the freeze-out phase and thus influence the final solar r-abundance curve. A large fraction of the isotopes for r-process nucleosynthesis are not yet experimentally accessible and are located in the "terra incognita". Presently, about 600 one-neutron emitter are identified, but only for a third of them experimental data is available. With the next generation of fragmentation and ISOL facilities presently being built the main motivation of all projects is the investigation of very neutron-rich isotopes. However, reaching more neutron-rich isotopes means also that multiple neutron-emission becomes the dominant decay mechanism. About 460 β-delayed two-, three- or four-neutron emitters are identified up to now but for only 30 of them experimental data about the neutron branching ratios are available, most of them in the light mass region below A=30. The International Atomic and Energy Agency (IAEA) has identified the urgency and picked up this topic recently in a Coordinated Research Project on a Reference Database for Beta-Delayed Neutron Emission Data. This project will review, compile, and evaluate the existing data for neutron-branching ratios and half-lives of -delayed neutron emitters and thus help to ensure a reliable database for the future discoveries of new isotopes and help to constrain astrophysical and theoretical models. Various experimental campaigns to investigate βn-emitters will be introduced (e.g. TRIUMF/ Canada, IGISOL/ Finland, and RIKEN/ Japan).

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Sunday February 16, 9:30

INVESTIGATING THE STRUCTURE OF THE LOW-LYING EXCITED 0^+ STATES IN ^{116}SN

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The even-even tin isotopes are known to exhibit shape coexistence, the phenomenon where multiple shapes coexist within a narrow energy region at relatively low-lying levels of the nucleus. These nuclei have a 0^+ spherical ground state and multiple excited 0^+ states, one of which is a band head for a deformed rotational band that is caused by the promotion of two protons across the $Z = 50$ shell gap. The ^{116}Sn nucleus has been investigated in the past with the goal of accurately describing the nature of the mixing that occurs between the vibrational phonon levels and the deformed rotational band by probing the character of the excited 0^+ states. It was thought that the 0^+ states showed almost equal mixing of rotational and vibrational character, however, this result was based on an indirect fit of the intensity of a weak 85 keV transition[b]. The current work, a high statistics ^{116}Sn measurement, demonstrates that there is unequal mixing of character between the two excited 0^+ states based on a direct measurement of the intensity of the 85 keV transition. Our results could prompt a new interpretation of the structure of ^{116}Sn. The experiment was conducted at TRIUMF, Canada′s National Laboratory for Nuclear and Particle Physics. A high-intensity and high-purity beam of ^{116}In was used to populate states in ^{116}Sn via beta decay. The resulting gamma rays were observed with the 8π detector array, which consists of twenty high-purity germanium detectors coupled with a suite of ancillary detectors for beta-particle detection and conversion electron spectroscopy.

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[b]N.-G. Jonsson, A. Bäcklin, R. Julin, J. Kantele, M. Migahed, Institute of Physics, University of Uppsala, UUIP-1000 (1979).

Sunday February 16, 9:45

MEASUREMENT OF THE TOP QUARK MASS IN THE ALL-HADRONIC $t\bar{t}$ DECAY CHANNEL WITH $\sqrt{s} = 8$ TeV PROTON-PROTON COLLISION DATA FROM THE ATLAS EXPERIMENT

T. McCarthy[a],

This talk outlines a current measurement of the top quark mass being made with $\sqrt{s} = 8$ TeV ATLAS data, specifically using events in which pairs of top quarks are created, and which subsequently decay to an all-hadronic final state. The top quark, discovered in 1995 at Fermilab, is by far the heaviest of the known fundamental particles making up the Standard Model of Particle Physics. One of the primary challenges of this all-hadronic (or all-jets) decay channel is the presence of other QCD-initiated background events which mimic signal events and which have a production cross-section several orders of magnitude larger than signal events. Techniques which take advantage of the kinematic properties of $t\bar{t}$ events, together with a data-driven estimation of the QCD background, must be employed in order to separate the signal from this overwhelming background. An additional complication arises from the combinatorics of assigning the correct jets to each of the top quark decay products when reconstructing top quark candidates. Means to address both of these challenges will be discussed in order to make such a top quark mass measurement competitive with other decay topologies.

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Sunday February 16, 10:00

AN OPTICAL MAGNETOMETER FOR ULTRA COLD NEUTRON EXPERIMENTS AT TRIUMF[a]

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Magnetometers play a crucial role in symmetry tests measuring the permanent electric dipole moment (EDM) of a subatomic particle. Small inhomogeneities in the magnetic fields utilized in these experiments can affect Larmor precession of a particle enough to mimic the EDM signal. A Canada-Japan collaboration is underway to produce ultra cold neutrons at TRIUMF and measure the neutron EDM, but improving the experimental precision sufficiently to observe an EDM requires precise measurements of the magnetic field to rule out false EDM effects. Sensitive atomic vapour magnetometers will be employed: spin polarized atomic systems inhabiting the neutron trap but interacting very little with either neutrons or container walls. There has been success in previous generation experiments using spin-polarized ^{199}Hg magnetometers; in addition, ^{129}Xe has been proposed as a suitable candidate for magnetometry due to factors such as a high ionization potential. We are developing an atomic vapour magnetometer using xenon gas at pressures in the mTorr range, as part of a dual-magnetometer approach to neutron EDM measurements.

Although xenon nuclei can be readily polarized in an alkali gas mixture through spin exchange optical pumping, we seek methods to polarize and measure xenon spin directly as is done with ^{199}Hg atoms. We have recently demonstrated the feasibility of detecting laser induced fluorescence (LIF) signals from 252nm two-photon excitation of xenon, and have identified a method to probe nuclear polarization via LIF with polarized UV pulses. The time varying change in polarization due to Larmor precession can be used to characterize the magnetic field in real time. Comparing ^{199}Hg and ^{129}Xe signals in a dual magnetometer approach will improve our understanding of systematic effects. This talk will present methods for spin-polarization, results showing the effect of probe polarization on observed LIF signals, and analysis made possible by developing a dual magnetometer approach.

[a] Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
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Sunday February 16, 10:15

GAMMA-RAY SPECTROSCOPY IN THE VICINITY OF ^{100}Sn [a]

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Besides exhibiting super-allowed Gamow-Teller decay with the smallest known $\log Ft$ value and providing experimental data for core quenching effects and rp-process path models, the doubly-magic, heaviest self-conjugate^{100}Sn and its neighbouring species offer valuable insights for nuclear structure. Gamma-ray spectroscopy of ^{100}Sn and nuclei in its vicinity with $N \simeq Z \simeq 50$ will probe and challenge current theoretical models of shell structure and particle-hole excitations across the g9/2 orbit.
The nuclei of interest have been produced at RIKEN RIBF in June 2013. A ^{124}Xe beam with 345 MeV/u energy underwent fragmentation reaction on a thin Be target, producing a record number of ^{100}Sn ($\sim$1800, about six times the previous experiment at GSI) nuclei and others with similar A/Q and Z; previously unobserved species such as ^{99}Sn and ^{97}In were also detected. The fragments were separated using the $B\rho$-ΔE-$B\rho$ method and were identified via ΔE, $B\rho$ and ToF measurements with the BigRIPS separator. The ions were implanted on WAS3ABI, a set of position-sensitive silicon strip detectors that also measured decay beta particles. Subsequent beta-delayed gamma-rays were measured with the EURICA spectrometer featuring HPGe clusters and $LaBr_3$ detectors. Previously known level schemes for more abundant nuclei such as ^{98}Cd have been reproduced in the data, and candidate gamma-ray transitions for more exotic species are presented.

[a] Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
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Sunday February 16, 11:00

EXOTIC MUON DECAYS

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Lepton flavor violation plays an important role in constraining New Physics models and in tests of the Standard Model. In this talk we will present a short review of searches for charged lepton flavor violation with the example of rare muon decays. For rare lepton flavor violating processes not only the signal, but also the physical background must be known precisely. We will concentrate on the muon decay in orbit, the only physical background for the muon - electron conversion experiment. In this experiment muons are stopped and caught in an orbit of an atom, most likely aluminum. The expected New Physics signal, is a coherent conversion of a muon into an electron. This process has a clear signature: a mono-energetic electron carrying energy equal to the mass of the muon. However when a muon caught in an atom decays then, unlike in the free muon decay, the maximum electron energy can equal the muon mass, thereby mimicking the conversion signal. We will present the current understanding of this process and the outlook for the future precise evaluation of electron spectrum.

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Sunday February 16, 11:15

RECONSTRUCTION FOR T2K'S FINE GRAINED DETECTORS

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T2K is a long-baseline neutrino oscillation experiment searching for ν_e appearance in a ν_μ beam. T2K's near detector is comprised of many complementary subdetectors. Two of these are the fine grained detectors (FGDs) which contain thousands of plastic scintillator bars and are used both as a target mass and for tracking and particle identification. Currently, the locations of all the bars with charge deposits are used to reconstruct the trajectory and momentum of the particle(s). In this presentation, I will discuss in more detail the methods and performance of the current reconstruction techniques along with outlining a new, likelihood based reconstruction algorithm that is currently under development. This new fitting technique has some potential as it uses both the location and deposited charge to reconstruct the most likely particle trajectory.

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Sunday February 16, 11:30

MAGNETIC SHIELDING FOR THE NEUTRON ELECTRIC DIPOLE MOMENT EXPERIMENT AT TRIUMF[a]

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If a non-zero neutron electric dipole moment (nEDM) were discovered, it would signify a previously unknown source of CP (or T) violation. New sources of CP violation are believed to be required to explain the baryon asymmetry of the universe. The TRIUMF nEDM experiment aims to measure the nEDM to the level 10^{-27} e·cm in its initial phase, which is an order of magnitude more precise than the previous best experiment. The experimental method relies on placing ultracold neutrons in a bottle with electric and magnetic fields and performing precise NMR experiments over hundred second measurement times. The magnetic field in the experimental volume must be strictly controlled during this time, and a combined passive and active magnetic shielding system is being developed to meet the requirements of the experiment. Prototype systems are being constructed at U. Winnipeg. My work relates primarily to the prototype active magnetic shielding system. The prototype uses a fluxgate magnetometer to provide magnetic field measurements at the center of Helmholtz-like coil set. The currents in the coils are adjusted by custom software dependent on the fluxgate measurements, forming a feedback loop. The system provided RMS shielding factors $>$ 1000 for magnetic field perturbation frequencies $\sim$20 mHz, and $>$ 100 for frequencies $\sim$0.5 Hz, and can therefore reduce magnetic field variations on the order of tens of μT to the level of tens of nT. This prototype represents good progress towards the eventual system for nEDM experiments, where multi-axis low-frequency field drifts of 100 nT require active shielding to $<\sim$1 nT. Limitations of the present system with view to future improvements will be discussed.

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Sunday February 16, 11:45

MAGNETIC MOMENT OF A POLY-ELECTRON SYSTEM[a]

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The purpose of this work is to determine to what extent the interaction of the positron with the two electrons modifies the magnetic moment of the positronium ion. This effect is expected to be analogous to that in hydrogen-like atoms and ions, where the nuclear electric field modifies the g -factor of an electron , and thus be a correction of order α^2, enhanced relative to the free-particle effects in this order in the coupling constant. Effects of this origin have been studied with high precision in hydrogen-like ions. Combined with measurements with a five-fold ionized carbon they are the basis of the most precise determination of the electron mass. For a three-body system like Ps^-, theoretical calculations are more difficult because the wave function is not known analytically, in any approximation. Thus, even without self interactions, the binding effect has not been evaluated yet. In this paper we neglect self interactions and focus on the dynamics of a charged particle, bound with two oppositely charged antiparticles.

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Sunday February 16, 12:00

COLLINEAR LASER SPECTROSCOPY ON NEUTRON-RICH RUBIDIUM ISOTOPES (^{98}RB,^{98M}RB AND ^{99}RB) AT TRIUMF

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The TRIUMF collinear laser spectroscopy setup coupled with the reverse-extracted bunched beam from the Titan Radiofrequency Quadrupole (RFQ) buncher allows measurements of nuclear ground state properties on rare isotopes. Recently, an experimental campaign has been established on the heavy Rubidium isotopes (^{98}Rb,^{98m}Rb and ^{99} Rb) in order to investigate the extent at which the sudden shape deformation seen at N=60 in the Strontium chain carries through to the Rubidium chain . A new technique has been developed by the laser spectroscopy group at TRIUMF using high frequency chopping of continuous laser light with an electro-optic modulator (EOM) to reduce both background noise and unwanted optical pumping.The TRIUMF experimental collinear laser spectroscopy setup will be described along with the current status of data analysis.

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