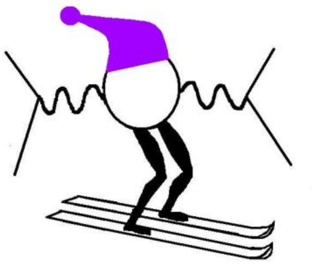
The 45th Winter Nuclear and Particle Physics Conference

The Banff Centre
Banff, Alberta, Canada
February 15-17, 2008

Mt. Rundle, Banff, Alberta
Courtesy of Banff Lake Louise Tourism



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Welcome to WNPPC 2008!

We are pleased to welcome you to WNPPC 08. The next few days will be full of information, with some time to enjoy the beautiful mountain surroundings along the way. Here are a few notes to start your weekend off right.

Wireless Internet:

Free Wireless Internet is available throughout the Banff Centre in several buildings. To take advantage of this service, you must have wireless capability on your laptop that is preconfigured for DHCP. The wireless network is titled "Banffcentre" and should appear in your list of available networks.

Bagged Lunch:

A bagged lunch will be provided for those who requested it in advance. These will be available in the TCPL Foyer.

Building Names and Abbreviations:

TCPL = TransCanada Pipelines Pavilion Building
- Meeting Room PAV 201

PDC = Professional Development Centre
- Front Desk and Bedrooms

SBB = Sally Borden Building
- Vistas Dining Room, 4th Floor
- Recreational Facilities

Fitness and Recreation:

The Banff Centre's Sally Borden Recreation Facility is available to all overnight guests of the Banff Centre at no extra charge. The facility includes a 25 metre pool, steam rooms, whirlpool, weight room, full-sized gymnasium with indoor running track, badminton, squash court, and climbing wall.

Skiing:

For those looking to take advantage of the local mountains on Saturday afternoon, there are two ski hills near Banff.

Ski Banff @ Norquay	www.banffnorquay.com
Sunshine Village	www.skibanff.com

Tourism Information:

For more information on Banff, visit www.banfflakelouise.com.

The organizing committee would like to express our sincere gratitude to all invited speakers for accepting our invitation and attending at their own expense. We also welcome all of the researchers with contributed papers.

Our thanks go to TRIUMF and the UBC Department of Physics and Astronomy for their financial support, particularly in sponsoring three prizes for the best student presentations. The winners will be announced at the end of the last session on Sunday.

We also would like to express many thanks to the previous organizing committees for their advice and support.

We welcome all comments, and hope you enjoy the conference. For more information please talk to the organizers or see the conference website at http://www.phas.ubc.ca/wnppc08.

Joanna Karczmarek, WNPPC08 Co-Chair
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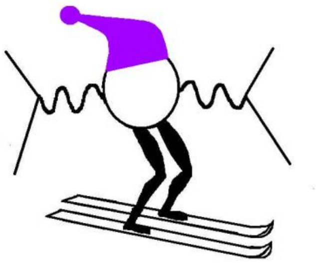

The 45th Winter Nuclear and Particle Physics Conference

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SCHEDULE

Friday, February 15, 2008

4:00 – 6:00pm	Registration	PDC Foyer
5:30 – 7:00pm	Dinner	Dining Room
6:30 – 8:00pm	Registration	TCPL Foyer
7:30 – 9:00pm	Plenary Session	TCPL Room 201
9:00 – 11:00pm	Reception	TCPL Foyer

Saturday, February 16, 2008

7:00 – 8:30am	Breakfast	Dining Room
8:30 – 10:15am	Plenary Session	TCPL Room 201
10:15 – 10:30am	Coffee Break	TCPL Foyer
10:30 – 12:15pm	Plenary Session	TCPL Room 201
12:15pm	Lunch	Dining Room
	Free Afternoon	
6:00 – 7:30pm	Dinner	Dining Room
7:30 – 9:00pm	Plenary Session	TCPL Room 201
9:00 – 9:15pm	Coffee Break	TCPL Foyer
9:15 – 10:45pm	Plenary Session	TCPL Room 201

Sunday, February 17, 2008

7:00 – 8:30am	Breakfast	Dining Room
8:30 – 10:15am	Plenary Session	TCPL Room 201
10:15 – 10:30am	Coffee Break	TCPL Foyer
10:30 – 12:15pm	Plenary Session	TCPL Room 201
12:15pm	Lunch	Dining Room

WNPPC08 Schedule of Talks

Friday Feb 15

Session 1

Time	Speaker
19:30 - 19:35	Greetings
19:35 - 20:10	B. Davids *Recent Experiments in Nuclear Astrophysics at TRIUMF*
20:10 - 20:30	R. MacDonald *Results of a New Muon Decay Measurement by TWIST*
20:30 - 20:50	J. Bueno *Progress on the final measurements from the TWIST experiment*
20:50 - 21:10	S. Triambak *Isospin symmetry breaking in the mass-32 system and the Standard Model*

21:10 - 23:00	**Reception**

Saturday Feb 16

Session 2

Time	Speaker
8:30 - 9:05	P. Krieger *The ATLAS Detector at the CERN Large Hadron Collider*
9:05 - 9:25	G. McGregor *Counting B mesons at BaBar*
9:25 - 9:45	G. Kertzscher *Search for Charged Higgs Boson Using the DZero Experiment*
9:45 - 9:50	DNP Thesis Prize presentation
9:50 - 10:10	S. Turbide *Electromagnetic radiation from matter under extreme conditions*

10:10 - 10:30	**Coffee**

Session 3

Time	Speaker
cancelled(*)	A. Chen *Experiments with radioactive ion beams and the origin of galactic Aluminum-26*
10:30 - 10:50	K.G. Leach *Internal γ Decay and the Superallowed Branching Ratio for theβ^+Emitter ^{38m}K*
10:50 - 11:10	A.A. Phillips *Structure of the 4_3^+ States in $^{186,188}Os$*
11:10 - 11:30	P. Finlay *Precision Branching Ratio Measurement for the Superallowed β^+Emitter ^{62}Ga*
11:30 - 11:50	C. Sumithrarachchi *Study of Beta-delayed neutron decay of ^{22}N*

(*) This talk is cancelled due to an emergency in the speaker's family

Free Afternoon

Session 4

Time	Speaker
19:30 - 20:05	A. Ritz *Direct and indirect detection of pseudo-degenerate WIMP dark matter*
20:05 - 20:25	M. Forbes *Observing Dark Matter: A ``Strange'' Proposal*
20:25 - 20:45	K. Lawson *Observational signatures of dark matter?*
20:45 - 21:05	K. Wunderle *Can profiles from N-body simulations explain structures down to globular cluster scales?*

21:05 - 21:25	**Coffee**

Session 5

Time	Speaker
21:25 - 22:00	D. Lunney *Weighing atoms for (nuclear) physics*
22:00 - 22:20	E. O'Connor *Light elements in Supernovae*
22:20 - 22:40	U. Hager *Nuclear astrophysics with DRAGON*

Sunday Feb 17

Session 6

Time	Speaker
8:30 - 9:05	H. Tanaka *The T2K Experiment: The Next Generation of Neutrino Oscillation Studies*
9:05 - 9:25	C. Licciardi *Wavelength Shifting Fibers for the T2K Fine Grained Detector*
9:25 - 9:45	M. Ku *Spin-Polarized Ultracold Fermions in Traps*
9:45 - 10:05	J. Wong *Neutron Multiplicity Discrimination Studies in DESCANT - DEuterated SCintillator Array for Neutron Array*

10:05 - 10:25	**Coffee**

Session 7

Time	Speaker
10:25 - 11:00	A. Schwenk *Three-nucleon interactions and matter at the extremes*
11:00 - 11:20	A. Micherdzinska *The Q_{weak} experiment as a test of the Standard Model*
11:20 - 11:40	A. Olin *The ALPHA Experiment at CERN: Present status*
11:40 - 12:00	J. Storey *Particle Detection Techniques for Antihydrogen Confinement with the ALPHA Experiment*
12:00 - 12:15	Awards for best student talk

Contributed Abstracts for WNPPC08

RECENT EXPERIMENTS IN NUCLEAR ASTROPHYSICS AT TRIUMF[a]

B. Davids[b],

TRIUMF, 4004 Wesbrook Mall, Vancouver BC V6T 2A3, Canada

TRIUMF is one of the world's leading laboratories in the field of experimental nuclear astrophysics. Its unique beams and experimental facilities enable experiments that are impossible elsewhere. In this talk I will describe recently obtained results on nuclear reactions important in massive stars, supernovae, and x-ray bursts on accreting neutron stars.

[a]Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
[b]*E-mail:* davids@triumf.ca

RESULTS OF A NEW MUON DECAY MEASUREMENT BY TWIST[a]

R. MacDonald[b]

University of Alberta

with the TWIST Collaboration

The TWIST experiment at TRIUMF measures with high precision the momentum and decay angle of the positrons from muon decay. The Michel parameters ρ, δ, and $P_\mu\xi$, which describe the distribution of decay positrons in energy and angle, are measured by studying the shape of high-statistics decay spectra, and these parameters have implications on the form of the weak interaction. TWIST has just completed a new measurement of the parameters rho and delta, on its way to its ultimate goal of an order of magnitude improvement over pre-TWIST limits. The experiment will be described, and results of the most recent analysis will be presented, with a discussion of the substantially reduced statistical and systematic uncertainties.

[a]Work supported by the Natural Sciences and Engineering Research Council and the National Research Council of Canada, the Russian Ministry of Science, and the U.S. Department of Energy. Computing resources are provided by the WestGrid computing facility.
[b]*E-mail:* rmacdon@phys.ualberta.ca

PROGRESS ON THE FINAL MEASUREMENTS FROM THE TWIST EXPERIMENT [a]

James Bueno[b]
University of British Columbia

The TRIUMF Weak Interaction Symmetry Test (TWIST) continues to make excellent progress towards its precision goal. The experiment is preparing to analyse its final muon decay data, and this talk will describe the improvements that have taken place in data acquisition and analysis.
The talk will focus on the asymmetry in the muon decay spectrum, which is described by the product $P_\mu\xi$, where P_μ is the polarisation of the muon from pion decay, and ξ is one of the four Michel parameters. This product is sensitive to new physics, such as left-right symmetric models for the weak interaction.
The experiment uses highly polarised muons from pion decay, and uncertainties on the previous TWIST measurement of $P_\mu\xi$ were dominated by our understanding of the muon beam depolarisation. The improvements in understanding will be described, including the results from a subsidiary muon spin relaxation experiment.

[a]Work supported by the Natural Sciences and Engineering Research Council and the National Research Council of Canada, the Russian Ministry of Science, and the U.S. Department of Energy. Computing resources are provided by the WestGrid computing facility.
[b]*E-mail:* jbueno@triumf.ca

ISOSPIN SYMMETRY BREAKING IN THE MASS-32 SYSTEM AND THE STANDARD MODEL

S. Triambak
University of Guelph

Our understanding of Nature at the fundamental level is based on the so called Standard Model of particle physics. Over the years, the Standard Model has been subjected to rigorous experimental tests and has emerged a triumphant victor. However, there is reason to believe that the theory is not complete and is part of a more profound (yet-to-be-discovered) theory that offers a complete, unified description of Nature. In this talk I shall give a brief description of nuclear physics contributions to tests of the Standard Model via high precision measurements. In particular, I shall focus on direct and ancillary measurements of isospin symmetry breaking in the mass 32 region that provide meaningful insight into present and future experiments in the search of "physics beyond the Standard Model".

THE ATLAS DETECTOR AT THE CERN LARGE HADRON COLLIDER

Peter Krieger
University of Toronto

Later this year, after almost two decades of planning and preparations, the CERN Large Hadron Collider will begin producing collisions between 7 TeV beams of protons. Two general purpose experiments, ATLAS and CMS, will record the products of these collisions, opening up, for the first time, an experimental window on physics at the TeV scale. This talk will review the motivations for the LHC experimental programme and summarize the status of the LHC construction, and the construction and commissioning of the ATLAS detector, in which Canada has long played a leading role.

COUNTING *B* MESONS AT BABAR

G. McGregor[a]
The University of British Columbia

The primary goal of the BaBar Collaboration is to probe the Standard Model of Particle Physics through high precision studies of Charge-Parity (*CP*) violation and B meson decays. The BaBar detector is located at the Stanford Linear Accelerator Center, in California, U.S.A.. To date, we have recorded over 300 million B meson decays.
Because the B meson count is used as a normalization factor in the vast majority of B-physics analyses with BaBar, it is of utmost importance to have an understanding of precisely how many B mesons are produced and the uncertainties in this number.
We report on the first major update of B Counting at BaBar since 2000, and recent work to improve the efficiency and systematic uncertainties in B meson counting.

[a] *E-mail:* gmcgreg@phas.ubc.ca

SEARCH FOR CHARGED HIGGS BOSON USING THE DZERO EXPERIMENT[a]

G. Kertzscher[b], B. Vachon, C. Potter
McGill University

The existence of a charged Higgs boson is hypothesized in different extensions of new physics beyond the Standard Model of particle physics. To date, no evidence for this particle has been found. A search for the charged Higgs boson decaying to a top and a bottom quark was carried out using data collected by the DØ experiment at Fermilab. Preliminary results obtained using nearly 1 fb^{-1} of data will be presented.

[a] This work is being supported by NSERC, FQRNT and CRC
[b] *E-mail:* gustavok@physics.mcgill.ca

ELECTROMAGNETIC RADIATION FROM MATTER UNDER EXTREME CONDITIONS[a]

Simon Turbide[b], Charles Gale

McGill University

The production of real and virtual photons in relativistic heavy-ion collisions is studied. Low-p_T photons, dominated by hadron gas contributions, are evaluated within a massive Yang-Mills approach, where p_T denotes the photon's momentum transverse to the collision axis. Earlier calculations are reexamined with additional constraints, including new production channels and form-factors. The intermediate to high-p_T region is dominated by the physics of jets. A treatment, complete to leading-order in the strong coupling, is used to calculate the energy lost by the jets in the strongly interacting medium. This approach is convolved with a physical description of the initial spatial distribution of jets and with an expansion of the emission zone. The role played by jet-medium interactions is highlighted, showing that they dominate in the range $2 < p_T < 4$ GeV, at the Relativistic Heavy Ion Collider (RHIC). This mechanism has an important impact on both the total photon yield and the photon elliptic flow. The results are compared to experimental measurements of photons from PHENIX. The good agreement, along with the importance of the quark-gluon plasma (QGP) processes, strongly suggests the formation of a QGP phase at RHIC.

[a]Word supported in part by the Natural Sciences and Engineering Research Council of Canada, and in part by McGill University.
[b]*simon.turbide@mail.mcgill.ca:*

EXPERIMENTS WITH RADIOACTIVE ION BEAMS AND THE ORIGIN OF GALACTIC ALUMINUM-26

Alan Chen

Department of Physics and Astronomy, McMaster University, Hamilton ON

The goal of understanding the production of galactic ^{26}Al brings together progress in nuclear astrophysics from observations, theory, meteoritics, and laboratory experiments. In recent experimental work, significant progress has been made in light of new developments in unstable ion beam production at laboratories worldwide. Our group has recently studied several nuclear reactions at such facilities, including TRIUMF, RIKEN, and the NSCL, in order to probe both directly and indirectly the key reactions responsible for the synthesis of ^{26}Al in stars. This presentation will discuss these experiments, their results, ongoing analysis, and astrophysical implications

INTERNAL γ DECAY AND THE SUPERALLOWED BRANCHING RATIO FOR THE β^+ EMITTER ^{38m}K[a]

K.G. Leach[b], D. Bandyopadhyay, P. Finlay, P.E. Garrett, G.F. Grinyer, A.A. Phillips, M.A. Schumaker, C.E. Svensson, J. Wong

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

G.C. Ball, E. Bassiachvilli, S. Ettenauer, G. Hackman, A.C. Morton, S. Mythili, O. Newman, C.J. Pearson, M.R. Pearson, H. Savajols

TRIUMF, 4004 Wesbrook Mall, Vancouver, BC, V6T 2A3, Canada

J.R. Leslie

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D. Melconian

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C. Barton

Department of Physics, University of York, Heslington, York YO10 5DD, United Kingdom

A measurement of the branching ratio for the superallowed β^+ decay of ^{38m}K was performed at TRIUMF's ISAC radioactive ion beam facility. Through the use of the 8π γ-ray spectrometer and SCEPTAR, an M3 internal γ-ray transition between the isomer and the ground-state of ^{38}K was observed. The internal-conversion corrected transition branching ratio was determined to be 330(43) ppm. This measurement leads to a revised superallowed branching ratio for ^{38m}K of 99.967(4) % and increases the ^{38m}K *ft*-value, the most precisely determined for any superallowed decay, by its entire quoted uncertainty to *ft* = 3052.1(10) s.

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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:*kleach@physics.uoguelph.ca

STRUCTURE OF THE 4_3^+ STATES IN ^{186,188}Os[a]

A.A. Phillips[b], P.E. Garrett, G.A. Demand, P. Finlay, K.L. Green, K.G. Leach, M.A. Schumaker, C.E. Svensson, J. Wong
University of Guelph

R. Hertenberger
Ludwig Maximilians-Universität München

T. Faestermann, R. Krücken, H.-F. Wirth
Technische Universität München

L. Bettermann, N. Braun
Universität zu Köln

D.G. Burke
McMaster University

The structures of 4_3^+ states in Os nuclei have been the subject of debate for the past several decades. Based on measured B(E2) values, they were interpreted in $^{186-192}$Os as K$^\pi$=4$^+$ two-phonon vibrations, whereas inelastic scattering results, and single-proton transfer (t,α) imply a hexadecapole phonon description. Uncertainties in the (t,α) reaction mechanism, however, were cited as preventing a firm conclusion based on those data. To help clarify the nature of these K$^\pi$=4$^+$ bands, we have performed a (^{3}He,d) stripping reaction on targets of ^{185,187}Re using 30 MeV ^{3}He beams provided by the MP-tandem facility of the LMU/TUM in Garching. With an energy resolution of 13 keV, the deuterons were analysed at 9 angles ranging from 5° to 50° with the Q3D spectrograph, and absolute cross sections were obtained for levels up to 3 MeV in excitation energy. Preliminary results will be presented.

[a]Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
[b]*E-mail:* aphillip@uoguelph.ca

PRECISION BRANCHING RATIO MEASUREMENT FOR THE SUPERALLOWED β^+ EMITTER ^{62}GA[a]

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J.J. Ressler
Department of Physics, Simon Fraser University, Burnaby, BC, V5A 1S6, Canada

A high-precision branching ratio measurement for the superallowed β^+ emitter ^{62}Ga has been made using the 8π γ-ray spectrometer in conjunction with the SCintillating Electron-Positron Tagging ARray (SCEPTAR) as part of an ongoing experimental program in superallowed Fermi beta decay studies at the Isotope Separator and Accelerator (ISAC) facility at TRIUMF in Vancouver, Canada, which delivered a high-purity beam of $\sim 10^4$ ^{62}Ga/s in December 2005. The present work represents the highest statistics measurement of the ^{62}Ga superallowed branching ratio to date. 27 γ rays emitted following non-superallowed decay branches of ^{62}Ga have been identified and their intensities determined. These data yield a superallowed branching ratio with 10^{-4} precision, and our observed branch to the first nonanalogue 0^+ state sets a new upper limit on the isospin-mixing correction δ^1_{C1}. By comparing our *ft* value with the world average $\overline{\mathcal{F}}t$, we make stringent tests of the different calculations for the isospin-symmetry-breaking correction δ_C, which is predicted to be large for ^{62}Ga.

[a]This work was supported by the Natural Sciences and Engineering Research Council of Canada (NSERC). TRIUMF receives funding via a contribution agreement with the National Research Council of Canada.

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STUDY OF BETA-DELAYED NEUTRON DECAY OF ^{22}N[a]

Chandana Sumithrarachchi[b],

Department of Physics, University of Guelph, Guelph, Canada

David Morrissey, Andrew Davies, Deborah Davies, Marius Facina, Elaine Kwan, Paul Mantica, Yoshihiro Shimbara, Joshua Stoker, Ranjith Weerasiri

National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, USA

The rapid change in the location of the neutron dripline as one goes from carbon, to oxygen, to fluorine isotopes is still not understood. It has been suggested that the usual shell structure changes significantly in the region of the heaviest oxygen and fluorine isotopes. Recently, the doubly magicity of ^{22}O is evidenced by the observation of a relatively high first excited state comapared to the neighboring even-even oxygen isotopes. The study of the energy levels in ^{22}O has been particularly important for understanding the changes of nuclear structure in this region. One way of exploring information on ^{22}O is to combine the traditional study of the beta-delayed gamma-ray decay of ^{22}N with beta-delayed neutron spectroscopy.

The first measurement of beta-delayed neutrons and gamma-rays from the decay of ^{22}N has been performed at the NSCL. The isotope was produced by fragmenting a 140 MeV/A 48Ca beam in a Be target and then separated from the other reaction products with the A1900 projectile fragment separator. ^{22}N was implanted in a plastic scintillator and the decay was observed in a neutron array and in eight HpGe gamma-ray detectors from NSCL-SeGA. The beta-delayed neutron time-of-flight spectra were analyzed in conjunction with beta-gamma coincidence spectra to determine the emission probabilities and the branching to neutron-unbound and bound states of ^{22}O. The beta decay scheme of ^{22}N will be presented and compared to USD shell model calculations.

[a]Work supported by the National Science Foundation of USA and Michigan State University.

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DIRECT AND INDIRECT DETECTION OF PSEUDO-DEGENERATE WIMP DARK MATTER [a]

A. Ritz[b]

Department of Physics and Astronomy, University of Victoria, Victoria BC V8W 3P6, Canada

WIMP dark matter candidates χ^0 have interesting signatures for direct and indirect detection in regimes where there is a near degeneracy with a heavier charged state $\chi^{\pm}$, as occurs for example along the boundary of the coannihilation strip in the CMSSM. For small splittings of $\mathcal{O}(10)$ MeV, the scattering of WIMPs off nuclei may be dominated by inelastic recombination processes mediated by the formation of $(\chi^- N)$ bound states, leading for example to a distinct signature for direct detection. I will discuss these and other resonant processes that distinguish the detection signatures of this class of WIMP scenarios.

[a]Work supported by the Natural Sciences and Engineering Research Council of Canada.

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OBSERVING DARK MATTER: A "STRANGE" PROPOSAL.[a]

Michael M^c^Neil Forbes[b]

Nuclear Theory Group, University of Washington, Seattle, USA.

In this talk, I will discuss the idea that much of the missing Dark Matter in our universe may consist of nuclear density nuggets of cold strange quark antimatter. Not only is this model consistent with the many known cosmological constraints, but it naturally explains some puzzling diffuse emissions from the core of our galaxy. Furthermore, this model makes definite predictions that should soon be confirmed, or ruled out. If correct, the model provides a natural explanation for both dark matter and baryogenesis.

Synopsis:

1. There is only about 5 times more dark matter than baryonic matter, $\Omega_{\text{DM}} \approx 5\Omega_B$, suggesting they may be related.
2. Baryogenesis requires CP violation that is naturally provided by QCD: aka. the strong CP problem.
3. Domain walls resolving the strong CP problem can form quark (anti)nuggets at the QCD phase transition.
4. This CP asymmetry results in more antimatter nuggets, creating the observed baryon excess (baryogenesis).
5. Formation stops when the nuggets become colour superconductors, naturally explaining the photon/baryon ratio.
6. Constraints on dark matter interactions are easily satisfied by the geometric size of the nuggets $B \sim 10^{20-33}$.
7. Nugget properties are firmly rooted in nuclear physics: There are no free parameters.
8. Electrons and protons annihilating on the antimatter nuggets in the core of the galaxy should produce a variety of emissions from eV to GeV scales.
9. These emissions have been observed, and are non-trivially consistent with the properties of the nuggets.
10. We can make model independent predictions that will confirm or rule out this proposal in the next few years.

In this talk, I will present this basic picture, and discuss how observations of galactic emissions can confirm or rule out this proposal in the next few years. In a later talk, Kyle Lawson will discuss details about the emission mechanisms and observations.

[a] Work supported by the US Department of Energy under Grant DE-FG02-97ER41014.

[b] *E-mail:* mforbes@u.washington.edu

OBSERVATIONAL SIGNATURES OF DARK MATTER? [a]

Kyle Lawson[b]

The University of British Columbia

The physical structure of dark matter is a major open question in the field of cosmology. There is little or no consensus as to which of the proposed models is the most likely candidate. This difficulty arises primarily due to the lack of potential evidence offered by these models. Most theories of dark matter involve the introduction of new particle species whose interactions with ordinary matter are fundamentally weak making any direct observation difficult. An alternative scenario, to be discussed here by Michael Forbes, in which the dark matter consists of ordinary quarks and antiquarks in a colour superconducting phase several observational consequences arise. In this talk I will discus several observational signatures that necessarily accompany this dark matter candidate. These will be shown to be not only consistent with present data but may indeed provide the source of several forms of cosmic emission not currently explained by know astrophysical phenomenon.

[a]Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.

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CAN PROFILES FROM N-BODY SIMULATIONS EXPLAIN STRUCTURES DOWN TO GLOBULAR CLUSTER SCALES? [a]

K. E. Wunderle [b] , R. Dick

Department of Physics and Engineering Physics, University of Saskatchewan, 116 Science Place, Saskatoon, SK, S7N 5E2, Canada

We find that the most commonly used profile predicted by N-body simulations, the NFW profile, cannot be used to describe the density distribution of globular clusters. Instead we propose a general profile with flat core and variable inner power law index that is derived from a basic equation that arises from numerical modeling of gravitational collapse. For an inner power law index of $2 \leq \alpha \leq 4$ centred around $\alpha \approx 3$ most of the globular clusters from the Harris catalogue are in agreement with the theoretically predicted parameter space. This is significantly steeper than the density profiles of galaxies and galactic haloes which usually have inner power law indices in the range $1 \leq \alpha \leq 1.5$.

[a]Work supported by NSERC Canada, a University of Saskatchewan Graduate Scholarship, a William Rowles Fellowship and a Gerhard Herzberg Memorial Scholarship.

[b]*E-mail:* Kai.Wunderle@usask.ca

WEIGHING ATOMS FOR (NUCLEAR) PHYSICS

David Lunney[a]

Visiting Scientist at TRIUMF-ISAC, Vancouver, BC, Canada
from CSNSM-IN2P3-Université de Paris Sud, Orsay, France

Mass measurements allow the determination of a binding energy through the well-known relation $E = mc^2$. The largest demand for masses comes from the nuclear physics community, essentially because there are so many nuclides (and so little time!). Somewhat like the Standard model, which requires masses to be determined experimentally, nuclear theory has still not succeeded in providing reliable predictions for the most exotic nuclides.
The nuclear binding energy gives important information about nuclear structure as well as the energy available for reactions and decays. As such, there are also "applications" that stem from mass measurements of radioactive species, namely weak interaction studies (including neutrino properties) and nuclear astrophysics.
Mass measurements are necessarily of high precision. Thus, they also provide important information concerning quantum electrodynamics, through the *atomic* binding energy. In addition, masses are required for the determination of fundamental constants – and their eventual variation that might one day constrain string theory.
After an introduction to the realms of physics addressable by mass measurements, a quick review of different techniques will be given, concentrating on the most popular of all: the ion trap. In particular, the first results from TRIUMF's Ion Trap for Atomic and Nuclear physics (TITAN) will be highlighted.

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LIGHT ELEMENTS IN SUPERNOVAE [a]

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Core-collapse supernovae are giant stellar explosions that lead to neutron stars and provide a possible site for the formation of heavy nuclei through the r-process. In this talk, we present an equation of state for low-density nuclear matter based on the virial expansion. The virial equation of state makes model-independent predictions for matter near the supernova neutrinosphere (the surface of last scattering for neutrinos). In addition to the standard composition of neutrons, protons and α particles, we include for the first time all light elements through ^{2}H, ^{3}H and ^{3}He. While the mass fraction in light elements is low, of order 10% for the conditions of interest, they have significant effects on the neutrino absorption and therefore for the neutrino spectra in supernovae.

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NUCLEAR ASTROPHYSICS WITH DRAGON

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The DRAGON recoil separator facility at TRIUMF measures radiative alpha and proton capture reactions of astrophysical importance in inverse kinematics. This is done using radioactive and stable ion beams produced and accelerated using the ISAC (Isotope Separator and ACcelerator) facility. Over the last few years, the DRAGON collaboration has embarked on a programme to measure a variety of reactions considered vital to the understanding of various astrophysical scenarios. In particular, we have tried to focus partly on those reactions involved in the creation and destruction of important astrophysical gamma-emitters such as ^{22}Na, ^{26}Al and ^{44}Ti. Such radionuclides are crucial to the understanding of novae and supernovae through their potential for detection with space-based gamma-ray observatories enabling the validation of stellar models. The methodology behind making such measurements with DRAGON will be outlined, and recent and upcoming experiments discussed.

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THE T2K EXPERIMENT: THE NEXT GENERATION OF NEUTRINO OSCILLATION STUDIES[a]

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One of the most important recent developments in the field of elementary particle physics is the establishment of neutrino oscillations, in which neutrinos can transmute between three flavors as they propagate through space. The pattern of oscillations is determined by the masses of the neutrinos and a matrix that relates the neutrino flavors to the masses. Currently, there is an exciting world-wide program to elucidate the properties of neutrinos through further study of neutrino oscillations. In particular, one could probe the possibility of CP violation (differences in the oscillations of neutrinos and their antiparticle counterparts) as well as the mass ordering of the neutrinos. This in turn could have important implications for understanding how our universe came to its matter-dominated state, as well as the quest to have a unified understanding of the quarks and leptons which we believe to be the fundamental constituents of all matter.

The Tokai-to-Kamioka (T2K) experiment will study neutrino oscillations using an intense neutrino beam produced by the J-PARC accelerator complex north of Tokyo directed towards the Super-Kamiokande detector 295 km away. Canadian groups have a critical role in the experiment associated with the construction of a set of two detectors to determine the properties of the neutrino beam prior to any oscillation effects, a novel monitoring device using optical transition radiation to determine the properties of the proton beam delivered by the accelerator, and important components of the neutrino beamline itself. Construction of the beamline and detectors is underway, with data-taking commencing in 2009.

[a] Work supported by the Natural Sciences and Engineering Research Council of Canada and the National Research Council of Canada.
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WAVELENGTH SHIFTING FIBERS FOR THE T2K FINE GRAINED DETECTOR[a]

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The near detector of the T2K experiment includes the Fine Grained Detector (FGD). The FGD uses wavelength shifting (WLS) fibers to collect and transport light from scintillating bars excited by particles interacting with the detector. In this talk, quality control and measurements of light attenuation, light output and mirroring efficiency of these WLS fibers 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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SPIN-POLARIZED ULTRACOLD FERMIONS IN TRAPS[a]

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The physics of strongly-interacting asymmetric Fermi systems plays a central role in nuclear and condensed matter problems. Experiments performed at MIT and Rice University disagree about the existence of an intermediate phase between the superfluid and normal regions in an imbalanced Fermi system. Theoretical considerations using variational calculations show that this intermediate phase must exist in a homogeneous system. In this study, we investigate the existence of this intermediate phase in laboratory traps. The N+1 body problem in oscillator traps is considered, which determines whether an intermediate phase necessarily exists in a given trap.

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NEUTRON MULTIPLICITY DISCRIMINATION STUDIES IN DESCANT - DEUTERATED SCINTILLATOR ARRAY FOR NEUTRON ARRAY [a]

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A novel neutron tagging array is being developed to serve as an auxiliary detector for the TIGRESS spectrometer at TRIUMF for the study of high-spin states of neutron-rich systems. This ground-breaking design will be based upon an array of liquid deuterated scintillators for neutron detectors and is called the DEuterated SCintillator Array for Neutron Tagging or DESCANT. Neutron spectroscopy is typically performed utilizing time of flight (TOF) techniques. However, multiple scattering between detectors poses a major problem to overcome and is commonly dealt with by vetoing signals collected in adjacent detectors. This results in a much reduced detection efficiency for higher neutron multiplicity events. Fast neutron scattering from deuterium is not isotropic in the centre-of-mass frame and the measured pulse height spectra is forward-peaked. This pulse height information can be correlated with the TOF to overdetermine the neutron energy, thus rejecting multiple scattering without the need to veto nearest neighbours. Results from early feasibility tests will be presented, along with the status of our GEANT4 simulations of the array performance.

[a]This $1.8M project is funded by CFI, ORF and TRIUMF.
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THREE-NUCLEON INTERACTIONS AND MATTER AT THE EXTREMES[a]

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Three-nucleon interactions are a current frontier in the physics of nuclei and in understanding matter under extreme conditions. I will present results and discuss the status of the first calculations with microscopic three-nucleon interactions beyond light nuclei. This coherent effort is possible due to advances based on renormalization group methods in nuclear physics.

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THE Q_{WEAK} EXPERIMENT AS A TEST OF THE STANDARD MODEL [a]

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The Q_{weak} experiment will provide the first measurement of the proton's weak charge (Q_W^p), by measuring the parity-violating asymmetry in elastic electron-proton scattering at very small momentum transfer: $Q^2 = 0.03(GeV/c)^2$. Measurement of Q_W^p will in turn constitute a precision measurement of the weak mixing angle ($\sin^2\theta_W$), at low energy, which is sensitive to new physics beyond the Standard Model. The experiment will be conducted at the Thomas Jefferson National Accelerator Facility in Newport News, VA in 2010. The goal of this experiment is a 4% measurement of Q_W^p, which corresponds to a 0.3% measurement of $\sin^2\theta_W$. To achieve this goal systematic effects needs to be under control.

I will present the physics motivation of the Q_{weak} experiment, experimental setup and discuss expected error budget for Q_W^p determination. As the dominant experimental uncertainty is the determination of the electron beam polarization. I will focus on the construction of the electron detector Compton polarimeter for an accurate measurement of the beam polarization. Our group is developing a new technology: application of polycrystalline diamond in an electron Compton polarimeter. I will also present the most recent update on a current status of the experiment preparation.

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THE ALPHA EXPERIMENT AT CERN: PRESENT STATUS [a]

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for the ALPHA Collaboration [c]

The ALPHA (Antihydrogen Laser PHysics Apparatus) project is an international collaboration based at CERNs Antiproton Decelerator. Our long-term goal is to study the symmetry between matter and antimatter by studying the spectroscopy of the antihydrogen atom. The prevalence of matter over antimatter in the cosmos remains a major puzzle in the face of this symmetry in our physical laws.

The collaboration has constructed a innovative and flexible apparatus with the short-term goal of trapping antihydrogen atoms. This talk will describe the ALPHA apparatus and its operation. The description will cover the main components of the apparatus: the positron accumulator, antiproton catching trap and magnetic neutral atom trap. Particle detectors surrounding the traps enable the study of the $\overline{p}$ plasma density and energy. Results will be shown to indicate our progress in the production and cooling of antiproton and positron plasmas.

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PARTICLE DETECTION TECHNIQUES FOR ANTIHYDROGEN CONFINEMENT WITH THE ALPHA EXPERIMENT [a]

James Storey[b]

for the ALPHA Collaboration[c]

Antihydrogen is the simplest atomic system composed entirely of antiparticles. Antihydogen can be used to test CPT invariance by comparing the spectra of hydrogen and antihydrogen atoms. The ALPHA (Antihydorgen Laser PHysics Apparatus) project at the CERN Antiproton Decelerator (AD) aims to confine antihydrogen atoms and perform spectroscopy on the trapped atoms. The trapping of antihydogen is the principal goal of the first phase of the experiment. This talk will outline progress towards antihydrogen trapping, with particular emphasis on the particle detection techniques used in the experiment.

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