


D A L H O U S I E U N I V E R S I T Y

AUJAC

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# Weekend Schedule

## **Friday: February 3rd**

16:00 - 18:00 – Registration: *Atlantica Hotel*

18:00 - 19:00 – Registration: *McCain building lobby*

19:00 - 20:00 – Welcome & first Speaker Jordan Kyriakidis: *McCain Building Scotia Bank Auditorium*

20:00 - 21:00 – Reception & Refreshments: *McCain building lobby*

21:00 - 24:00 – Night Event: *Rogues Roost Brew Pub*

## **Saturday: February 4th**

09:00 - 10:00 – Breakfast: *Rowe building atrium*

10:00 - 11:15 – Student Presentations: *See schedule for locations*

11:15 - 12:15 – Lunch, Grad Fair & Poster Presentations (Grad Fair ends at 13:30): *Rowe building atrium*

12:15 - 13:15 – Student Presentations: *See Schedule for locations*

13:15 - 13:30 – CAP Speaker: *Rowe building, Potter Auditorium*

13:30 - 15:15 – Second Speaker: *Rowe building, Potter Auditorium*

15:15 - 16:45 – Lab Tour: *Dunn Building*

18:00 – Banquet: *University Club*

*With Guest Speaker: Stephen Morris (starts at 19:00)*

## **Sunday: February 5th**

09:00 - 10:00 – Breakfast: *Rowe building atrium*

10:00 - 11:00 – Student Presentations: *See Schedule for locations*

12:00 – Awards and the end

# Guest Speakers

## **Stephen Morris**

### **Why is the Universe not Boring? Pattern Formation in Nature**

Many natural systems spontaneously self-organize into surprisingly ordered structures, even though they are driven far from thermodynamic equilibrium. Regular spatial patterns emerge, for example, as ripples on wind blown sand, convection cells in heated fluids, ripples on icicles and columnar fracture patterns in lava flows. In this talk, I will discuss the physics of nonlinear patterns, and do a live demonstration.



### **Bio:**

Stephen Morris is a Professor of Physics at the University of Toronto. His research involves experiments on emergent patterns in icicle, fluids, granular media and fracture. He is also interested in the history of physics. He has appeared occasionally on the Discovery Channel.

## **Jordan Kyriakidis**

### **The (entangled) Spiel on Adiabatic Quantum Computing**

Conventional quantum computing is, in style, similar to ordinary vanilla computing: An algorithm is implemented by a series of logic gates which operate on bits to produce some output. But in substance, it is dramatically different and can do things no classical computer can do. Unfortunately, building such a device has proven very difficult, although we've already made far more progress than most critics thought we would. An alternative unconventional quantum computing model, adiabatic quantum computing, has arisen over the last few years which, on the surface, bears no resemblance to the gate model of computing and is even stretching the definition of what we mean by "algorithm". In this talk, I'll give an overview of the above, and I'll outline how we are using AQC platforms both to develop algorithms -- factoring, for example -- and to explore the potential and practical computational power of AQC.



#### **Bio:**

Prof. Jordan Kyriakidis is an Associate Professor at Dalhousie University originally from Toronto Ontario. He completed his PhD at the University of Basel in Switzerland. After Basel he came to North America and did his postdoc in both Boulder Colorado and Ottawa Ontario. He has been working on theoretical conventional quantum computing at Dalhousie since 2002.

## **Andrew Rutenberg**

### **Living Nanotech: How and Why Cyanobacteria Count**

Bacteria thrive at the nanoscale. I will introduce these remarkable machines, and some of the interesting puzzles they provide for physicists. Then I will talk about *Anabaena*, which is a model cyanobacterium: cyanobacteria first freed the oxygen we breathe billions of years ago, and still form an important part of the global geochemical cycle. *Anabaena* grows as blue-green filaments. When no external fixed nitrogen is available, these filaments develop striking one-dimensional patterns of nitrogen-fixing heterocyst cells that provide fixed-nitrogen to the remaining cells. Spatially-resolved mass spec of the fixed-nitrogen appeared to show that this fixed-nitrogen transport acts against a gradient! I will show you how quantitative modelling helped us to reconcile this with diffusive transport. We then adapt the model to explore how to place heterocysts optimally, and how the patterns that *Anabaena* form should adapt to its environment. Many questions remain, and I will finish by giving you a taste of how we will address them experimentally with a combination of physics and biology and theoretically with computational models.



### **Bio**

Prof. Andrew Rutenberg is an associate professor in the Department of Physics at Dalhousie. He studied honours Math and Physics at the University of Toronto, and then completed a PhD in theoretical physics at Princeton with David Huse and postdocs at Manchester, Oxford, and McGill on the non-equilibrium statistical physics of pattern formation in coarsening systems. Since joining Dalhousie University, Prof. Rutenberg has been studying self-organized structures observed within bacteria. (See <http://www.physics.dal.ca/~adr> for more information, or email [adr@dal.ca](mailto:adr@dal.ca))

# Student Presentation Schedule

<u>Saturday</u>		Rowe 1007		Rowe 1014	
Start	End	Name	Title	Name	Title
10:00	10:15	Chieh-Ting(Jimmy) Hsu	Using photobleaching to quantify the initial number of GFPs in a cell by Baysian Monte Carlo technique	Jennifer Clare Lahey	Fish Velocites in the Strait of Georgia, BC
10:15	10:30	Kimiko Sakamoto	Biomass burning observed over halifax, Canada in summer 2011	Alanna Flynn	Dynamics of Uncharged and Anionic Bicellar Mixtures
10:30	10:45	Caitlyn Darrach	Localization and Spectral Characterization of Biological Chromophores with Point Radiance Spectroscopy in a Tissue Phantom for Applications in Prostate Neoplastic Diagnostics and Treatment Monitoring	Aaron Whiteway	Controlling Polymer Translocation
10:45	11:00	Eamonn Alexander Campbell	Synthetic Johnson Cousins Colours for Red Giants	Marisa E Smith	laser muSR in Biomedicine
11:00	11:15	Robert Lee MacDonald	Leak-Detection System for a Heavy Gas Cherenkov Detector	Sarah Thomas	Calculating Soft Tissue Thickness Through X-ray Scattering
12:15	12:30	Rebecca Campbell	A Reaction-Yield Macro to Support Experiment Planning with High-Energy Gamma Rays at the Mainz Microtron	Graham Dennis Reid	Atomic Potential Corrections to Multislice Simulation of TEM Images

12:30	12:45	Jessica Campbell	Research and Development for a Scintillating Fiber Coordinate Detector for High-Energy Electrons	Cathryn Parsons	Optimization of the Monocular Indirect Ophthalmoscope.
12:45	13:00	Andrew Charles Valencik	Probing the interaction potential of the neutron-rich Lithium-11 isotope with protons.	Colby R Brown	In-situ X-ray diffraction observations of stress within copper films
13:00	13:15	Martin Antoine Chiasson	Effect of pressure on the optical/electrochromic properties of MoO <sub>3</sub>	Matthew Ronald Charles Fitzpatrick	Dipole-Exchange Spin Waves in Magnetic Thin Films
<b>Sunday</b>		<b>Rowe 1007</b>		<b>Rowe 1014</b>	
10:00	10:15	Alexandre doucet	Effet laser avec des céramiques d'oxyde d'yttrium dopé à l'ytterbium	Mike Yvan Grudich	A Closer Look at FTIR Spectra of Minerals
10:15	10:30	Ari Silburt	Improving the Beam Asymmetries for Compton Scattering from the 2008 Data	Vincent Basque	Decrease of Transition Temperature in Vanadium Dioxide Thin Films with Joule Heating
10:30	10:45	Gregory J.S. Tomney	Probing excited states of 12-lithium	Julien Edouard Arthur Legere	Electrochromic Mirrors Using Amorphous and Crystalline WO <sub>3</sub> Thin Films
10:45	11:00	Chris Marc Sherman	Proton Efficiency in the TAPS-CB Detector Set-Up	Stephane Melanson	Optically detected magnetic resonance of cesium atoms



# Student Abstracts

## Oral Presentations

### **Decrease of Transition Temperature in Vanadium Dioxide Thin Films with Joule Heating - Vincent Basque**

Vanadium dioxide thin films have switching properties in the near-infrared. This property can be acquired but heating the thin film above the transition temperature, 68°C for bulk. The thin film undergoes a MIT, Metal-Insulator Transition, with high reversibility. VO<sub>2</sub> thin films were deposited with the RF magnetron sputtering technique. The transmission of these films can go up to 65% at 2500 nm and goes down to near zero after the transition. Resistivity drops nearly 2 orders of magnitude upon switching to the metallic state. The switching can now be induced by depositing the thin film on top of ITO-coated glass substrates and by inducing an electrical current through the ITO sub-layer. This new type of heating brings down the transition temperature by 4-7°C compared to the traditional heating. The presence of the ITO sublayer also seems to significantly bring the resistivity of the VO<sub>2</sub> down even in the monoclinic phase.

### **In-situ X-ray diffraction observations of stress within copper films – Colby Brown**

Electroless deposition of copper from liquid electrolytes onto non-conductive surfaces is required for mounting electronic components e.g. for consumer electronics. More demanding specifications for the conducting copper paths (smaller size and smoother substrates) make it necessary to monitor and control the mechanical properties of the copper films. My presentation will discuss the use of X-ray diffraction to measure the intrinsic stress of electroless copper films during deposition. Specifically, I will consider the effect of deposition temperature on the deposition rate and the resulting strain in the copper films. For the specific electrolyte studied, higher deposition temperatures reduced the tensile strain.

## **Synthetic Johnson Cousins Colours for Red Giants - Eamonn Campbell**

Using the synthetic spectra developed by Phoenix, a computer program developed to simulate a star's flux under specific conditions (for example the surface temperature of a star), the synthetic color indices of Red Giant stars will be determined. Since we will be investigating Red Giant stars, it will be necessary to calculate the indices over the 4000 Kelvin to 5500 Kelvin temperature range. Also under consideration will be the effect of a star's gravity and metallicity (i.e. the abundance of elements heavier than Helium) on the synthetic indices. Furthermore the thermodynamic treatment Phoenix uses to calculate the indices will also be investigated. By passing the synthetic flux spectra generated by Phoenix through various filter sets (including the Bessel UBVRI, Cousins RI and the Johnson UBVRI systems) and calibrating the indices to Vega, we will be able to compare our results to actual catalogued data (for example the indices from the Bright Star, Lanz and Mermilliod catalogues). In carrying out this investigation we hope to confirm both the reliability of Phoenix and the effect of color indices as a function of several stellar parameters (temperature, gravity and metallicity). We also hope to determine the difference between at least two thermodynamic models.

## **Research and Development for a Scintillating Fiber Coordinate Detector for High-Energy Electrons – Jessica Campbell**

This presentation will provide an overview of the design and technical considerations required to build a scintillating fiber coordinate locator detector system for the BigCal detector in Hall A at Jefferson Lab (a nuclear physics research facility in Virginia operated by the US Department of Energy). The first consideration in the design phase was to gather the technical requirements associated with the operation of the detector system. These specifications were then used to research alternative options for identifying equipment and components necessary to build such a detector system. Furthermore, the options analyses looked at what could be done using local resources in order to control overall costs. At the end of this research initiative, a first-draft proposal, that includes technical drawings and specifications for the coordinate locator detector system, was produced. This work was performed in parallel with other lab duties that provided orientation and hands-on experience with detector system technologies associated with using and testing scintillating fibers; this resulted in the construction of a small, thin plastic scintillator to support ongoing graduate research in this area being carried out by my in-lab supervisor, Jason Sharpe.

## **A Reaction-Yield Macro to Support Experiment Planning with High-Energy Gamma Rays at the Mainz Microtron - Rebecca Campbell**

This presentation will report on summer research activities in Mainz, Germany, at the Nuclear Physics Institute of the Johannes-Gutenberg University. The Institute houses a race-track microtron known as the Mainz Microtron (MAMI). The microtron accelerates electrons, producing a beam with energies up to 1.5 GeV. This research project was with the A2 Collaboration, focusing on investigations of high-energy gamma-ray interactions with the proton - specifically meson production and Compton scattering. The complex detection system in A2 is comprised of two primary gamma-ray detector arrays the Crystal Ball (CB) and the Two-Arm Photon Spectrometer (TAPS) with two charged-particle systems embedded in the CB (a Particle Identification Detector, and a Multi-wire Proportional Chamber). This detector system measures the amount of energy deposited by the reaction products, as well as tracking their position. The specific summer research project reported here was the development of a Root software macro to help with experiment planning by providing a prediction of the yield/detection rates for certain experiments (either Compton scattering or neutral pion photoproduction from the proton). These calculations account for beam energy and current, target type and thickness, reaction cross-section (provided from previous experiment or theory), the effective electron count rate, and numerous efficiency values acquired by simulation. The result of the macro is a yield rate for the experiment type in question, which is also dependent on the photon energy range and detection-angles considered.

## **Effect of pressure on the optical/electrochromic properties of MoO<sub>3</sub> – Martin Chiasson**

Chromogenic references to the reversible optical property change that occurs in certain materials under certain conditions. An example of this is electrochromism, where an electric field is used to alter the optical properties of the sample. In this presentation, we will discuss the correlation between the optical/electrochromic properties and nanostructures of molybdenum trioxide (MoO<sub>3</sub>) thin films when the material is deposited at various pressures. The results show that the transmission of the material greatly changes as the pressure varies, a property also observed after lithiation. Future research will focus on further study of the nanostructure of MoO<sub>3</sub> deposited at pressures optimizing AFM imaging of the sample.

## **Localization and Spectral Characterization of Biological Chromophores with Point Radiance Spectroscopy in a Tissue Phantom for Applications in Prostate Neoplastic Diagnostics and Treatment Monitoring – Caitlyn Darrach**

Fiber-optic monitoring is being investigated for use in the detection, localization, and spectral characterization of two biologically-relevant chromophores (the contrast agent indocyanine green and the naturally-occurring methemoglobin) associated with prostatic neoplasms (cancerous tumors of the human prostate) within a highly-scattering, tissue-mimicking phantom. The research utilizes point radiance spectroscopy (PRS) within an Intralipid-1% solution to measure directional light absorption and extinction with side-firing radiance fibers. Radiance fibers accept light at a single point within a well-defined, solid angle, and are able to be rotated 360° on insertion axis, potentially providing improved spatial resolution in contrast to invasive fluence measurements. The proposed application of this research involves the insertion of a fiber detector into the prostate urethra which is then illuminated by a fiber transmitting a light source contained in the rectum, with the aim in detecting the absorption characteristics, size, and location of tumor chromophores contained within the glands. Objectives of the project include [1] localizing and spatially characterizing several sizes of chromophore targets at various off-axis distances from light source and detector and [2] spectrally characterizing targets over VIS-NIR wavelengths by quantifying source-detector differences in directionally-based plots. It is hoped that the study will reveal optical properties of the chromophores in a tissue-like medium through angular-resolved variation in radiance which can then be correlated to a function of target size and polar angle from the detector. The detection of these chromophore targets using interstitial radiance fiber probes contributes to the information bank in the development of non-invasive optical modalities for prostate cancer diagnostics and treatment monitoring.

## **Effet laser avec des céramiques d'oxyde d'yttrium dopé à l'ytterbium - Alexandre Doucet**

Un laser est fait de trois composantes principales, un résonateur, un milieu actif et un mécanisme de pompage. On se sert de céramiques d'oxyde d'yttrium avec un dopage à l'ytterbium de 10 % et 20 %. Lorsqu'on pompe ce matériel avec un laser diode émettant à 915nm, nous mesurons une émission de lumière variant de 900 nm à 1100 nm. Nous avons monté un résonateur avec deux miroirs hautement réfléchissants, la céramique est placée dans le résonateur de façon à être parallèle aux miroirs, puis sa fluorescence est amplifiée. La lumière qui s'échappe du résonateur est d'une longueur d'onde de 1080 nm. Nous avons aussi utilisé un montage en plaçant les céramiques en configuration de Brewster, qui laisse le passage de la lumière ayant une polarisation P avec moins de pertes et réfléchit la lumière de polarisation S.

## **Dipole-Exchange Spin Waves in Magnetic Thin Films – Matthew Fitzpatrick**

With the emergence of spintronics in the 1980s, there has been an increasing interest in the study of the dynamical properties of magnetic thin films. One of the problems faced in magnetic data storage presently is the thermal noise which arises in magnetic sensors due significantly to spin waves. By understanding the fundamental aspects of magnetic interactions and their interplay with geometrical effects, it is possible to reduce this thermal noise through design engineering. Most theoretical calculations of spin wave spectra in constrained geometries have been limited to zero temperature or have not included dipolar interactions at finite-temperature. We are currently studying the excitation spectra in a stacked square lattice of dipole-exchange coupled classical spins using Monte Carlo spin dynamics. This technique combines the numerical integration of the equations of motion with initial states generated from Monte Carlo Simulations. Values for the frequencies, amplitudes and decay constants of the spin wave modes at finite temperature are calculated from a spectral analysis of the finite temperature correlation function. We present the results for a multilayer system.

## **Dynamics of Uncharged and Anionic Bicellar Mixtures – Alanna Flynn**

Deuterium nuclear magnetic resonance ( $^2\text{H}$ -NMR) has been used to study the temperature phase diagram of mixtures of long and short chain lipids, referred to as bicellar mixtures. Two types of mixtures were studied: one containing 1,2-dimyristoyl-sn-glycero-3-phosphocholine (DMPC) and 1,2-dihexanoyl-sn-glycero-3-phosphocholine (DHPC), and another also including the anionic lipid 1,2-dimyristoyl-sn-glycero-3-phosphoglycerol (DMPG). Spectra were obtained for a 4:1 long to short chain lipid ratio with a varied ratio of anionic to neutral ratio in the range 10-54°C. 25% of the long chain lipid in each mixture was chain perdeuterated (DMPC-d<sub>54</sub>). The echo decay measurements suggest that slow motions in DMPC-d<sub>54</sub>/DHPC were more heavily damped than in vesicle samples of DMPC alone. Addition of DMPG progressively altered the mixture properties. These observations provide some new insights into how charge and chain-length mismatch influence morphology of these lipid structures.

## **A Closer Look at FTIR Spectra of Minerals - Mike Grudich**

Fourier transform infrared spectroscopy is a robust method by which sample composition can be determined by matching spectral peaks to known standards. However, the actual shapes of the absorption lines yield further information about the sample and allow us to differentiate between samples of identical composition but

different histories and degrees of local disorder. We discuss the techniques for performing this analysis as well as its applications.

### **Using photobleaching to quantify the initial number of GFPs in a cell by Bayesian Monte Carlo technique - Chieh-Ting(Jimmy) Hsu**

Photobleaching of fluorophores (e.g. GFP) is a stochastic process, though it leads to an exponential decay on average. The fluctuations away from the average exponential decay are not white noise, and so traditional least-squares fits of the decay are not appropriate. Since the fluctuations are due to the photobleach events, which are similar to radioactive decay, we can use them to quantify the number of fluorophores in a cell. However, to extract the fluctuations we need the average decay. What if we have only a single cell? I will present our Monte Carlo Maximum Likelihood with Bayesian statistics approach that allows us to extract information (or "fit") about the photobleach decay for an individual cell.

### **Fish Velocities in the Strait of Georgia, BC – Jennifer Lahey**

Velocities of fish and water in the Strait of Georgia were detected by an acoustic doppler current profiler (ADCP) which uses sonar to pick up on echoes provided by scatterers such as fish or zooplankton. The ADCP was deployed in May 2011 at a depth of 100m in the mouth of the Fraser River, though data was collected from early August until the second week of September while salmon return numbers were expected to be high. Backscatter images of decibels vs. depth were used but since discerning between fish and zooplankton is often difficult from the images alone, two sets of velocities were analyzed to determine proper depths of fish. Large differences in velocities between water and scatterers indicate fish while small differences in velocity imply zooplankton or fish passively drifting along with the water. Fish that swam at the highest velocities seemed to prefer depths of either 10-20m or 80-100m, with occasional fish in between these ranges. Types of salmon native to the Strait of Georgia include chinook, chum, coho, pink and sockeye, and while these types are all common to the area, determining which type of salmon or fish is not currently possible.

### **Electrochromic Mirrors Using Amorphous and Crystalline WO<sub>3</sub> Thin Films – Julien Legere**

One of the multiple applications of thin films is the Electrochromic mirror. Also known as a smart window, this device has the useful property of changing its optical properties when an electrical tension is applied. This change is also reversible. Electrochromic mirrors have multiple applications: such as darkening rear-view mirrors, Protection of objects under glass

in museum displays from the effects of light, etc. Thus there is sufficient interest in their fabrication and optimisation. The present work consists of the study of characterizing WO<sub>3</sub> thin films produced by pulsed direct current reactive sputtering and how their optical properties change following an amorphous to polycrystalline structure change.

### **Leak Detection System for a Heavy Gas Cherenkov Detector – Robert MacDonald**

Cerenkov light is produced anytime an incident particle passes through a medium with a velocity exceeding the speed of light in that medium. The detectors of this light are important for a diverse number of functions involving the identification of the incident particles and play a crucial role in an accelerator's detector package. The photons produced can be quite few in number and are susceptible to a number of types of interference including contamination of atmosphere as a function of oxygen content. My project involves the design and implementation of an apparatus for detecting Cerenkov light and measuring the performance of this apparatus when subjected to contaminants.

### **Optically detected magnetic resonance of cesium atoms - Stephane Melanson**

Optically detected magnetic resonance (ODMR) is a magnetic resonance technique that is used with very dilute systems. The first step consists of optically pumping the sample with circularly polarized light, inducing a dark state. Then, we apply an oscillating magnetic perpendicular to the propagation of light which, when the frequency corresponds to the Larmor frequency of the sample, changes the energy level of the atoms. This change removes the atoms from their dark state. By changing the different parameters of the magnetic field we can measure different properties of the atoms, such as longitudinal and transverse relaxation rates and gyromagnetic ratios.

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### **Optimization of the Monocular Indirect Ophthalmoscope – Cathryn Parsons**

The ophthalmoscope is an important instrument for all optometrists and ophthalmologists for characterizing the state of health of the eye. In the early 1990s the monocular indirect ophthalmoscope went out of production, and without the on-going support of the manufacturer, the optics of the device can deteriorate over time. A local optometrist initiated this research project, with the goal being to determine the optical elements causing the aberration, and how they may be fixed. In order to understand the complex optics of the instrument and to investigate changes in the component on the end-use performance, an interactive computer program was developed, in the Processing™ environment, to model the device and an emmetropic eye using a matrix optics formalism. The schematic model of the eye used was the Le Grand Full schematic

eye. This research will hopefully aid optometrists in maximizing the performance of their monocular indirect ophthalmoscopes for many years to come.

### **Atomic Potential Corrections to Multislice Simulation of TEM Images - Graham Reid**

The multislice method is an efficient method of simulating electron diffraction in TEM imaging. A large drawback of the method is the relatively imprecise method of calculating the specimen potentials. This places limits on the minimum step size of the simulation and therefore its overall accuracy. We provide an alternate formulation of the multislice method, accurate to arbitrarily small step sizes and demonstrate that the traditional formulation of the method shows little divergence from our results

### **Biomass burning observed over Halifax, Canada, summer 2011 - Kimiko Sakamoto**

Biomass burning emissions from Ontario fires were observed over Halifax, Nova Scotia (44.6N, 63.6W) July 20-21, 2011 as part of the BORTAS-B campaign. The plume was observed in-situ by the Dalhousie Raman Lidar beginning at 22 UTC on July 20. Measurements of CO, ozone, NO<sub>2</sub> and selected VOCs were taken by the FAAM BAe 146-301 large Atmospheric Research Aircraft (ARA) at 00 UTC on July 21. The ARA profiles show a plume structure extending from 3.5-6.5 km with cloud condensation and elevated organic concentrations >50 µg/m<sup>3</sup>. The enhancement ratios of acetonitrile (CH<sub>3</sub> CN) and black carbon, with respect to CO were calculated. The MODIS satellite hotspot images and HYSPLIT model were used to track the plume back to its site of origin in northwestern Ontario.

### **Proton Efficiency in the TAPS-CB Detector Set-Up – Chris Sherman**

The spin polarizabilities of the proton have become a hot topic in particle physics over the last few years. These polarizabilities are fundamental structure constants similar to mass or charge, and their discovery would allow physicists to use another testable piece to check current particle physics theories and ideas. We aim to extract the spin polarizabilities of the proton by using the Compton scattering process, which involves bombarding stationary protons with photons and observing the scattered particles. To extract the polarizabilities properly, it is essential that we know how good our equipment is at detecting these scattered particles. My work involves the determination of the proton efficiency - a measure of how efficient the crystal ball and TAPS detectors are at correctly detecting scattered protons.



## **Improving the Beam Asymmetries for Compton Scattering from the 2008 Data - Ari Silburt**

It is only very recently that we have had the means to experimentally probe the nature of the subatomic world, and determine the validity of leading theories such as the Standard Model. My research, under the supervision of Dr. David Hornidge, has been to probe the nature of the proton, and specifically extract the spin polarizabilities of the proton. These spin polarizabilities are fundamental constants of the proton, and play a significant role in electromagnetic interactions. Using the Compton Scattering technique, much of my research has consisted of determining the beam asymmetry of the proton - a prerequisite to finding the spin polarizabilities of the proton.

## **Laser muSR in Biomedicine – Marisa Smith**

The long-term goal of our research is directed at improving Photodynamic Therapy (PDT) applied to cancer. The aim of our research is to characterize the free radicals responsible for the anticancer activity in PDT, and develop new drugs that will produce them more effectively. We use muonium, which is a bound state between a muon and an electron to study the free radicals. The laser-muon interface system allows us to study short-lived free radicals of our sample. In PDT, a patient receives a drug that 1) selectively interacts with cancer cells and 2) can absorb laser light at a particular frequency that causes the drug molecule to form reactive free radicals. These free radicals, being localized within the cancer cell, react with cell components and kill the cell. PDT- in principle- is a much healthier choice than other treatments because the cancer cells can be targeted specifically, thus minimizing harmful side effects. We have seen a significant difference between illumination with laser and our "dark" data; furthermore, this was the first time a significant muonium signal was observed in dodecane.

## **Calculating Soft Tissue Thickness Through X-ray Scattering - Sarah Thomas**

Soft tissue thickness is a useful quantity to be able to measure and is required for some medical measurements such as when determining strontium concentration in bone. X-ray fluorescence (XRF) photons are a type of secondary x-rays which are increasingly being explored as an elemental detection method for the human body. At this point in time a second device, the ultrasound, is needed to get the soft tissue measurement but ideally the portable XRF could be used for both purposes. This research examines the viability of using the portable XRF system to accurately measure soft tissue thickness. Phantoms will be used in order to ensure reproducibility.

## **Probing excited states of $^{12}\text{Li}$ – Gregory Tomney**

A proposal is made to study excited states of  $^{12}\text{Li}$  in the  $^{11}\text{Li}$ - $\text{Li}$  deuteron stripping reaction using silicon detector arrays. The particle of interest,  $^{12}\text{Li}$ , is an exotic nuclei lying beyond the neutron dripline. The excited states of  $^{12}\text{Li}$  are of interest to physicists both looking to observe new phenomena, and looking to ameliorate previous knowledge founded on the study of stable nuclei. The proposed deuteron-stripping reaction will have to contend against other reactions recently used to occupy excited states of  $^{12}\text{Li}$ . The optimal scattering angle ranges to examine are determined by taking theoretical values for the angular distribution for different neutron angular momenta. In these ranges, the angular resolution of a segmented annular detector and segmented box-shaped detector will be compared. The optimal arrangement of these detectors is deduced

## **Probing the interaction potential of the neutron-rich Lithium-11 isotope with protons – Andrew Valencik**

Lithium-11 is a halo nucleus, which is characterized by an unusual matter distribution. Two weakly bound outermost neutrons form a halo by orbiting a compact lithium-9 core. This structure raises important questions about the formation of nuclear halos and their interactions with other nuclei. A particular interest is in the nuclear interaction potential of lithium-11 with stable targets. An experiment was performed at TRIUMF (Canada's National Laboratory for particle and nuclear physics) using an accelerated beam of  $^{11}\text{Li}$  and a thin  $\text{CH}_2$  foil as a proton target. Using the Saint Mary's Silicon Telescope and understanding the kinematics of various reactions, we can separate reaction channels and identify the detected particles. The ability to separate reactions is necessary for further analysis such as measuring the cross section. Additionally the data will aid in looking for excited states of lithium-11, which could manifest as the outer neutrons oscillating against the core. The process of particle filtering and its importance to future work will be discussed, along with the search for excited states.

## **Controlling Polymer Translocation – Aaron Whiteway**

Current DNA sequencing techniques are prohibitively expensive and time consuming. Research suggests that using magnetic tweezers; to pull a strand of DNA through a nanopore could provide quicker and cheaper DNA sequencing. Using a combination of Monte Carlo and Molecular Dynamics computer simulation techniques, we are exploring this possibility by finding the free energy profiles and correlation times; the model we are using is a tethered polymer translocating through a nanopore against a potential. For our Monte Carlo simulation, we are using non-biased sampling techniques to keep the model

simple while soft potentials are used to describe interactions within the system. For both the Monte Carlo and Molecular Dynamics simulations, a combination of the Fene bond potential and truncated Leonard-Jones potential is used to describe the bonds between monomers. The truncated Leonard-Jones potential is employed to describe all other interactions (ie with other monomers or with the walls). The Molecular Dynamics simulation uses the full Langevin equation; however, we have opted to neglect hydrodynamics in order to keep the model simple.

### **Poster Presentations**

#### **Magnetic Contribution to Heat Capacity and Magnetic Entropy of $(\text{Er}_x\text{Y}_{1-x})_2\text{Ti}_2\text{O}_7$ - John Niven**

A pyrochlore is a compound whose structure is composed of corner-sharing tetrahedra with the general formula  $\text{A}_2\text{B}_2\text{O}_7$ , where A and B are rare earth transition metals. Erbium titanate ( $\text{Er}_2\text{Ti}_2\text{O}_7$ ) and yttrium titanate ( $\text{Y}_2\text{Ti}_2\text{O}_7$ ) are two pyrochlores with similar lattice structures.  $\text{Er}_2\text{Ti}_2\text{O}_7$  suffers from geometric frustration and is antiferromagnetic below the Néel temperature ( $T_N = 1.173 \text{ K}$ ). Above  $T_N$ ,  $\text{Er}_2\text{Ti}_2\text{O}_7$  undergoes a magnetic phase transition to a paramagnetic phase. This phase transition can be demonstrated experimentally by observing a peak in the heat capacity curve of  $\text{Er}_2\text{Ti}_2\text{O}_7$  at  $T_N$ .  $\text{Y}_2\text{Ti}_2\text{O}_7$ , however, is diamagnetic at all temperatures and therefore provides a model for the lattice contribution to the heat capacity of  $\text{Er}_2\text{Ti}_2\text{O}_7$ . The structural similarity between  $\text{Er}_2\text{Ti}_2\text{O}_7$  and  $\text{Y}_2\text{Ti}_2\text{O}_7$  makes it possible to create a mixed pyrochlore structure where antiferromagnetic  $\text{Er}^{+3}$  ions are substituted with diamagnetic  $\text{Y}^{+3}$  ions to create a series of compounds with the formula  $(\text{Er}_x\text{Y}_{1-x})_2\text{Ti}_2\text{O}_7$ . The magnetic heat capacity of  $(\text{Er}_x\text{Y}_{1-x})_2\text{Ti}_2\text{O}_7$  has been used to deduce the magnetic entropy as a function of x, temperature and magnetic field strength.

#### **Next Generation of Nuclear Reactors – Marisa Smith**

We are doing research on the chemical reaction of the hydrogen atom with water under sub- and supercritical conditions. Supercritical water is water above the critical point (373.9 C and 220.6 bar). This reaction is one of the most important reactions in the next generation of nuclear reactors called Gen IV, where supercritical water will be used as a coolant. We have been studying this reaction by the  $\mu\text{SR}$  experimental technique.  $\mu\text{SR}$  is the only technique that is able to work under these extreme conditions to provide kinetics data and it can be a billion times more sensitive than other techniques. TRIUMF, the particle accelerator in Vancouver is the facility that we used to collect data.

# CAP Speaker

## **CAP Committee to Encourage Women in Physics - Dr. Li-Hong Xu: Chair of the CEWIP**

The Canadian Association of Physicists (CAP) Committee to Encourage Women in Physics (CEWIP) was established in 1983 when women were dramatically under-represented in the Physics community. This is no less an issue today, for while there have been large shifts in representation of women in fields such as medicine, there are still very few women choosing Physics for a career. CEWIP, whose membership has been composed of both men and women Physicists since its inception, has been actively involved in many activities ranging from outreach nation-wide to encourage girls from Kindergarten to University levels in Physics to network with female Physicists to share common concerns and difficulties. The Committee has organized panel discussions at the CAP annual congress on programs that encourage female physicists in Canada, the USA and Mexico. As well, the committee participates in tri-annual International Conferences for Women in Physics, a series under the International Union for Pure and Applied Physics (IUPAP), with the last one being held in 2011 in Stellenbosch, Cape Town, South Africa. CEWIP hopes to stimulate your interest in a physics career and warmly welcomes your participation in our mission.

# Grad Fair Participants

- *University of Carleton/University of Ottawa* -

- *University of Guelph/University of Waterloo* -

- *Queen's University* -

- *Institute of Quantum Computing (IQC)* -

- *Memorial University* -

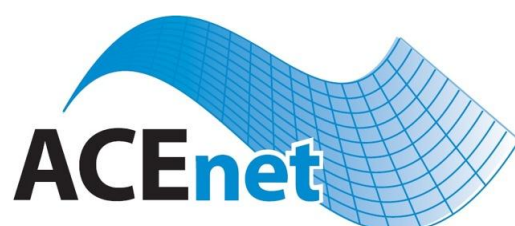
- *Ryerson University* -

- *Dalhousie University* -

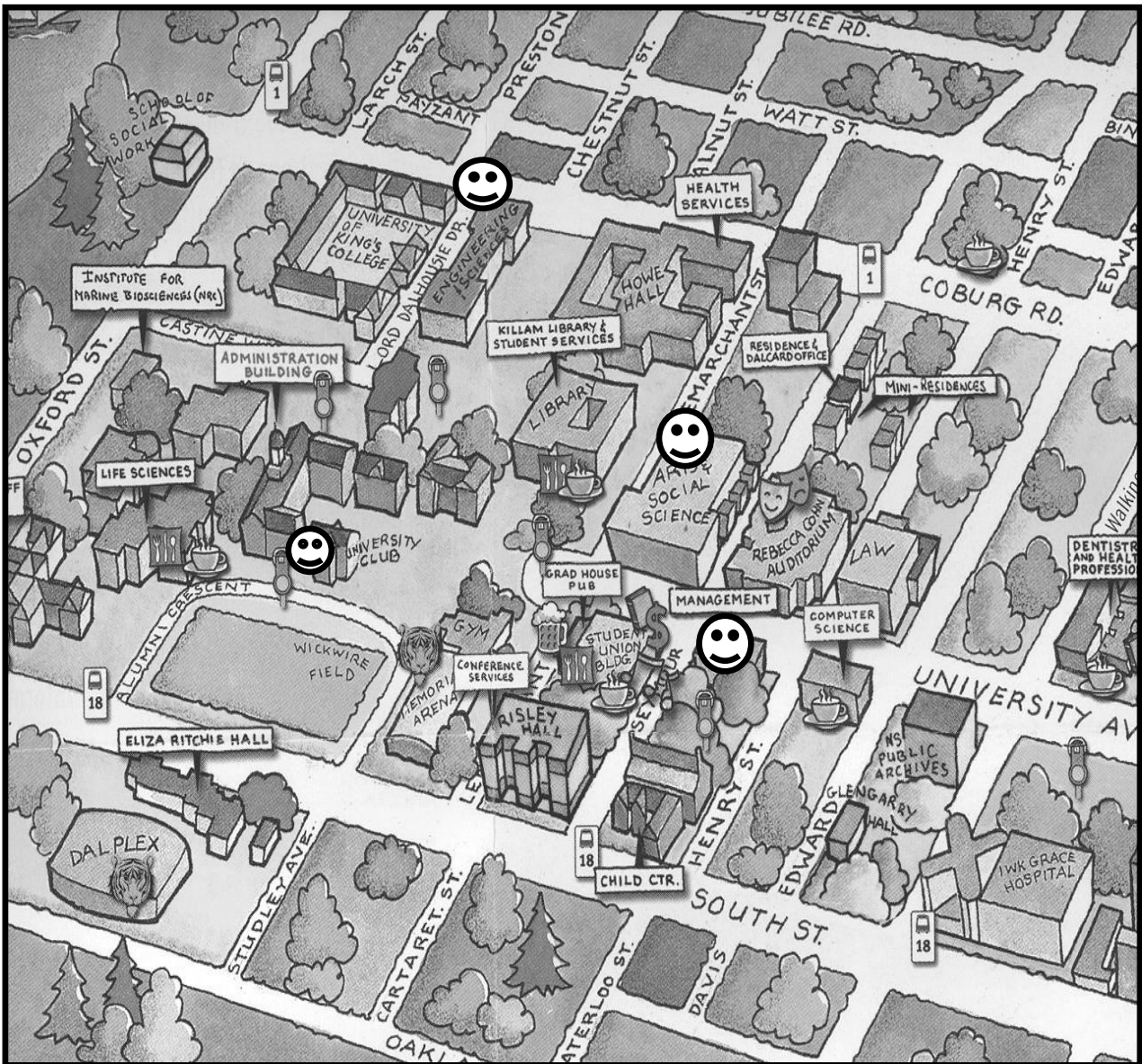
- *Saint Mary's University* -

- *University of New Brunswick* -

# Acknowledgements



# Maps



☺Arts and Social Science – McCain Building

☺Management – Rowe Building

☺Engineering Science – Dunn Building

☺University Club

A map of the area around the Atlantica Hotel. The hotel is marked with a smiley face icon and the text "Atlantica Hotel". A dashed box with an arrow points from the hotel towards the bottom right, labeled "To University". Other landmarks include "St Vincent's Nursing Home", "Home Grown Organic Foods", "Atlantic Superstore", "Cyclesmith", "Therapeutic Approach Yoga Studio", "Kings Palace", "Blockbuster Canada", "Atlantica Hotel Hall", "McDonald's", "MCS", "NSLC", and "Weirdy's". Streets shown include Allan St, Welsford St, Robie St, Quinpool Rd, Pepperell St, Shirley St, Linden St, Vernon St, and Cherry St. A black box in the top left corner contains the text "Important Places".

A detailed street map of downtown Halifax, Nova Scotia. The map highlights two specific locations with dashed boxes and arrows. The first box, labeled 'Rouges Roost', is located on Queen Street near the intersection with Sackville Street, marked with a smiley face icon. The second box, labeled 'Dalhousie University', is located in the lower-left quadrant of the map, near the intersection of University Avenue and South Street. The map shows various streets including Veterans Memorial Ln, Sackville St, Queen St, University Ave, and South St. Key landmarks such as the IWK Health Centre, Dalhousie University, and the Nova Scotia Rehabilitation Centre are labeled.