Atlantic Universities Physics and Astronomy Conference 2016

February 5-7, 2016

Conference Program

MEMORIAL UNIVERSITY

ExxonMobil

Science Atlantic
connecting science education and research

Sponsors

CONTENTS

WELCOME LETTER

Welcome to Memorial University and the Atlantic Universities Physics and Astronomy Conference! Our organizing committee is very excited to be able to bring together young scientists from around the Atlantic Provinces, and we look forward to hearing all of your research presentations. The 2016 conference will be a full and busy time, with student presentations, lectures from prominent scientists, a graduate school fair, a Women in Science panel, a banquet, and, last but not least, a social on infamous George Street.

We hope that you'll find the city of St John's to be as curiously unique as we do, and we're sure you'll find something here that will capture your imagination. The purpose of AUPAC is to bring together young scientists to share research and knowledge, but also to share culture and heritage. We're very fortunate to have such a rich heritage to be able to share with you all. If you can manage to decipher some of the famous local vernacular, some of you might even leave here as official Honorary Newfoundlanders!

Our organizing team has worked tirelessly over the past 12 months to bring this conference to life, and we would like to take this opportunity to thank them for all of their hard work and dedication. We would also like to thank our invited speakers for taking the time to talk to us about their experiences and impart some of their knowledge. Finally, we would like to thank all of the presenters, without whom there would be no conference. Once again, welcome to AUPAC 2016, and we hope you enjoy your time at Memorial!

Tyler Downey & Anna O'Grady
AUPAC 2016 Planning Committee Co-Chairs

GUEST SPEAKERS

CHRIS STEVENSON: THE ST. JOHN'S CENTRE OF THE RASC AND OBSERVATIONAL ASTRONOMY IN NEWFOUNDLAND: AGAINST THE ODDS

Friday, February 5, 2016. 7:30PM to 8:30PM – IIC 2001

Chris Stevenson, MSc.
Royal Astronomical Society of Canada
St. John's Centre

A native of St. John's, Newfoundland, Christopher Stevenson is the son of a retired physics professor who, himself, made telescopes. He joined the St. John's Centre of the Royal Astronomical Society of Canada (RASC) in 1981. After getting his B.Sc and M.Sc in Physics at Memorial University of Newfoundland, and then five years of doctoral studies at York University in Ontario (during which he was a constant denizen of that campus' twin-domed observatory, and lucky enough to observe at Kitt peak in Arizona and Las Campanas, Chile), he returned to St. John's in 1994 and quickly got back in touch with the St. John's Centre, becoming an Executive member, which he's been ever since. Most recently, he was Centre President from 2013 until 2015. He lives with his music teacher cellist/runner wife and young daughter in East End St. John's, where he operates a small observatory and they gently tolerate his endless astronomical pursuits.

Abstract

The St. John's Centre of the RASC was founded in 1965, and despite the challenges of Newfoundland weather, its hardy members have always managed to be productive in observations, outreach, and science, in a place more famous for its meteorology than its astronomy - and all without a dedicated observatory (which the Centre should finally have in place in a nearby park in 2016). Technological developments since the early years, such as electronic imagery, telescope control and computer processing, have certainly helped, but a stubborn determination remains essential. This talk sketches the history, activities and accomplishments of the Centre and its die-hard members, in regions as diverse as eclipse chasing, deep-sky astrophotography, innovative telescope making, high-resolution planetary imaging, meteoroid research through all-sky fireball cameras, the age-old art of sketching at the eyepiece, recent forays into spectroscopy, and of course many public events (weather permitting!) for the curious in the Avalon Peninsula region of the province, and across the island.

DR. LOUISE EDWARDS: HOW TO REACH OUT TO THE PUBLIC: LESSONS LEARNED IN ASTRONOMY OUTREACH

Saturday, February 6, 2016. 2:30PM – 3:30PM – IIC 2001

Louise Edwards, Ph. D.
Yale University
Department of Astronomy

Dr. Louise Edwards grew up in Victoria, BC and completed an undergraduate degree in Physics and Astronomy (with a Minor in Math) from the University of Victoria. She spent 2 years in Halifax at Saint Mary's for an MSc and 4 years in Quebec City at Laval for a PhD. She was a postdoc at Caltech from 2008-2011. Dr. Edwards uses telescopes in Arizona, Chile and California to study the largest galaxy in the local universe, and studies these systems with undergraduates in her research group at Yale. She looked through her first telescope on her back porch with her dad at age ~12.

Abstract

There are several ways that scientists can communicate with the public and share their knowledge and enthusiasm with the people around them. In my own career, I have valued this experience for many reasons: 1) It is highly enjoyable to engage with people of all ages and backgrounds 2) There is a sense of pride when connecting with the community by sharing knowledge 3) There are real problems that need to be solved to be able to continue to sustain life as we know it on this planet. Who will solve these problems? It is important that those who want to pursue difficult problems in STEM are encouraged to do so, and know that these fields are out there. Furthermore, members of the voting public (and government leaders), who may not have taken many science classes in school need to make decisions that require an understanding of how science works. In this talk I will discuss some of the experiences I have had in my own career as it has developed, and suggestions for how you can get involved in outreach as well.

DR. HARI KUNDURI: BLACK HOLE NO-HAIR THEOREMS AND WHY THEY ARE IMPORTANT

Saturday, February 6, 2016. 8:00PM – 9:00PM – Hatcher House

Hari Kunduri, Ph. D.
Memorial University of Newfoundland
Department of Mathematics and Statistics

Hari Kunduri is a mathematical physicist whose research focusses on black holes in general relativity and string theory and the associated connections to Riemannian geometry. He has been an assistant professor in the Department of Mathematics and Statistics at Memorial University since September 2011.

Dr. Kunduri first completed a BSc in physics and mathematics at the University of Toronto before completing a Masters' and Ph.D at University of Cambridge in 2007. He also held an STFC UK research fellowship at the University of Nottingham (2007) and the University of Cambridge (2008-9), and then returned to Canada to hold a PIMS (Pacific Institute for the Mathematical Sciences) fellowship at the University of Alberta (2009-11). In addition to discussing his research with experts in his field, he enjoys giving talks aimed at interested non-experts.

Abstract

Black holes are the most elementary solutions of Einstein's equations of general relativity (GR). Remarkably, they are more than just mathematical curiosities: there is now very strong evidence that black holes really exist in the Universe. An important result in GR states that, roughly, equilibrium black holes are described by just a few parameters (their mass, angular momenta, and charge). This is referred to as the 'black hole no-hair theorem'.

In this talk I will give an outline of how GR describes gravity mathematically in terms of geometry. I will also explain how a black hole arises in this context, and explain in a (hopefully) simple way how black hole uniqueness theorems work and why they are surprising. Finally, I will explain why the study of black holes has driven progress in developing a quantum theory of gravity.

DR. KRISTIN PODUSKA: WHAT CAN YOU DO WITH A PHYSICS DEGREE? ANYTHING YOU CAN IMAGINE!

Sunday, February 7, 2016. 11:00AM – 12:00PM - IIC 2001

Kris Poduska, Ph. D.
Memorial University of Newfoundland
Dept. of Physics and Physical Oceanography

Kris has long been interested in science, but she did not intend to be a physics professor. Her early career aspirations included geologist (age 5), followed by astronaut (age 6-7), and aeronautical engineer (age 7-17). However, once she tried science research in a chemistry lab (age 19), she knew that research was the career path for her. After doing an undergraduate degree in physics (Carleton College, Minnesota, USA), a PhD in physics (Cornell University, USA), and post-doctoral research in chemistry (York University, Toronto), she moved to Memorial University where she has been a physics professor for more than 12 years. Students who have worked in her research have used their research skills to go on to employment in start-up companies, government labs, science outreach organizations, and universities. She loves her job.

Abstract

Physics is a discipline devoted to problem solving. I will describe how my research team uses physics to address fascinating problems related to materials science. We develop detailed understanding of a material's structure to provide clues about how it was formed, and also to provide hints about how it might change during future use. This talk will focus on two examples: the electrical and optical properties of semiconductors (for applications such as sensors and coloured light), and structural disorder in archaeological materials (to help identifying an object’s intended use and its age).

Women in Science Panelists

Dr. Kristin Poduska

Memorial University of Newfoundland, Dept. of Physics and Physical Oceanography

Dr. Kris Poduska studies how structural order affects the magnetic, optical, electronic, or mechanical properties of solid materials for archaeological and technological purposes. In addition, she has participated in a number of industry related projects and is the Director of Science Policy for the Canadian Association of Physicists.

Dr. Louise Edwards

Yale University, Department of Astronomy

Dr. Louise Edwards uses telescopes in Arizona, Chile and California to study the largest galaxy in the local universe, and studies these systems with undergraduates in her research group at Yale.

Dr. Cora Young

Memorial University of Newfoundland, Dept. of Chemistry

Dr. Cora Young uses laboratory experiments and field measurements to understand the chemistry of pollutants in our environment. She started as an assistant professor in the Department of Chemistry at Memorial University in September 2012. Cora's research group develops methods and instrumentation for the measurement of atmospheric pollutants, focusing on the long-range transport of persistent pollutants and ocean-atmosphere interactions.

Dr. Jacqueline Blundell

Memorial University of Newfoundland, Dept. of Psychology

Dr. Jacqueline Blundell is an Associate Professor at MUN in the psychology department. Her area of interest is behavioral neuroscience and specifically, the effects on stress on the brain and behavior. Ultimately, Dr. Blundell's interest is in understanding the neural mechanisms underlying stress-induced psychiatric illnesses.

Awards

Undergraduate Research Awards...1st - $300, 2nd - $100
Sponsored by Science Atlantic

This award is presented to the student (or students) giving the best research presentation(s) at an annual Science Atlantic conference. The award consists of a cash prize and a letter of commendation.

Judging:
Awarded by volunteer faculty and graduate student judges based on the following criteria

- Abstract – Statement of problem, objectives, principal findings
- Presentation – Clarity, visual aids, organization
- Scientific merit – Experimental design, innovative approach, and interpretation of data
- Overall knowledge and response to questions
- Demonstrated potential to pursue graduate studies and research

Science Communication Award..$200
Sponsored by Canadian Science Publishing

This prize is awarded to the student who is best able to communicate a science topic to their peers. The award consists of a letter of commendation and a cash prize, as well as the opportunity to write a blog post about the winner's research with professional editorial support. Each winner's article will be posted on the CSP blog.

Judging:

Awarded by volunteer faculty and graduate student judges.

ACEmat Award in Computational Modeling of Materials....................................$100
Sponsored by the ACEnet Institute for Materials Modeling and Simulation

The ACEnet Institute for Materials Modeling and Simulation Award in Computational Modeling of Materials is presented at three Science Atlantic student conferences each year. This Award is given for the best undergraduate presentation using computational methods to study systems of interest to materials science.

Judging:

Awarded by volunteer faculty and graduate student judges.

GRADUATE FAIR

Bruneau Center Lobby - 11:30AM to 1:30PM
Saturday February 6, 2016

The Graduate Fair will include representatives from the following organizations:

DALHOUSIE UNIVERSITY

IQC Institute for Quantum Computing

SAINT MARY'S UNIVERSITY SINCE 1802
One University. One World Yours.

Western UNIVERSITY · CANADA

UNIVERSITY OF NEW BRUNSWICK UNB

UNIVERSITÉ DE MONCTON

UNIVERSITY of GUELPH

MEMORIAL UNIVERSITY

Science Atlantic Atlantique

Presentation Schedule

Saturday, February 6, 2016

Time	AA1043	AA1046
8:30	**A Study of Intra-Cluster Light in Galaxy Clusters** *Anna O'Grady* *Memorial University of Newfoundland*	**Investigation of the Dynamics of Rod-like Colloids during Sedimentation** *Haruki Hirasawa* *Memorial University of Newfoundland*
8:42	**Geometric Inequalities of Black Holes** *Riley Brooks, Memorial University of Newfoundland*	**Analyzing the Acid-Base-Acid Cleaning Procedure for Archaeological Graphite with Raman Spectroscopy** *Erica Hayward, Memorial University of Newfoundland*
8:54	**Searching for neutrinos at the South Pole: Simulation and Reconstruction with the IceCube Project** *Cole Walsh, Memorial University of Newfoundland*	**Using Surface-Enhanced Raman Spectroscopy to Develop Sensors for Monitoring Water Quality** *Stephanie Gallant, Memorial University of Newfoundland*
9:06	**Monte Carlo simulations of kagome lattices with magnetic dipolar interactions** *Andrew Way, Memorial University of Newfoundland*	**Employing Surface Enhanced Raman Spectroscopy for Practical Environmental Analysis** *Melanie Snow, Memorial University of Newfoundland*
9:18	**On the connection between the theorems of Gleason and of Kochen and Specker** *Taylor Landry, St. Francis Xavier University*	**Nanomechanical Imaging of Rat Vasculature by Atomic Force Microscopy** *Garett McDougall, Memorial University of Newfoundland*
9:30 ⋮ 10:00	**Break**	
10:00	**A network model of human aging: Limits, errors, and information** *Spencer Farrell, Dalhousie University*	**Harriet, one of the most luminous starbursts in the universe** *Ryan Perry, Dalhousie University*
10:12	**Collagen fibril architecture in tendons using atomic force microscope** *Josh Sampson, Dalhousie University*	**Constraining Inclination Angles of Rapidly Rotating Stars** *Laura Sponagle, Mount Allison University*

10:24	**Modelling *Listeria* invasion in the face of innate immunity** *Hong Yi Shi Yang, Dalhousie University*	**Photometric observations of Epsilon Cephei with 16-inches telescope of the Université de Moncton.** *Sébastien Noël, Université de Moncton*
10:36	**Exploring the Use of X-ray Fluorescence to Detect Zinc Concentration in Bone** *Kelly Foran, Mount Allison University*	**Validating Tidal Models in the Bay of Fundy using Surface Drifters** *Kody Crowell, Acadia University*
10:48	**A Comparison of Portable X-Ray Fluorescence Devices for Medical Applications** *Craig Groskopf, Mount Allison University*	**Modeling the Effects of Latitude on Nutrient Transfer from Rivers to the Open Ocean.** *Emma Shouldice, Dalhousie University*
11:00 ⋮ 1:30	**Lunch and Graduate School Fair**	
1:30	**X-Ray Fluorescence to Analyze Strontium and Calcium Ratios in Sturgeon to Trace Migratory Patterns** *Michael Reno, Mount Allison University*	**Nanopure Water Treatment and its Effects on the Corrosion Resistance of Nitinol** *Bradley LeGallais, Dalhousie University*
1:42	**Calibration method for measurement of chromium in nail-clippings using portable XRF** *Chris Ware, Mount Allison University*	**Search for infrared lines for abundance analysis** *Isabelle Gallant, Université de Moncton*
1:54	**Applying the Iso-configurational Ensemble to Proteins** *Thomas Faour, St. Francis Xavier University*	**Free Energy Comparison of Cylindrically Confined Ring Polymer Models** *Deanna Kerry, University of Prince Edward Island*
2:06	**Optical Properties of Thermally Heated Porcine Muscle from Ex Vivo Radiance Measurements** *Jonathan Horrocks, University of Prince Edward Island*	**Polymer Translocation through a Conical Channel** *Phoenix McCloud, University of Prince Edward Island*
2:18	**A study of predator-prey dynamics within a city landscape: The story of the urban fox** *Patrick Strongman, University of Prince Edward Island*	**Simulation Study of the Confinement Free Energy of Polymers** *Aidan Tremblett, University of Prince Edward Island*
2:30 ⋮ 4:00	**Break and Guest Speaker**	

4:00	**TEM Analysis of MnSi on SiC** *Brendan Edwards, Acadia University*	**The Dependence of a Charge Density Wave's Wavevector on Intercalate Concentration** *Stefanie Beale, Acadia University*
4:12	**Exploring Impedance Growth in Lithium-Ion Cells Using a Transmission Line Model** *Daniel Abarbanel, Dalhousie University*	**Physics Beyond the Standard Model: Search for the Dark Photon** *Kyle Marshall, Acadia University*
4:24	**Layered perovskite materials as an alternative to lead-based thin films in solar cells** *Samuel Cameron, Dalhousie University*	**Using Nuclear Probes to investigate the Nuclear Energy Production Cycle** *Tait Du, Mount Allison University*
4:36	**Differential Thermal Analysis of Li-Ion Battery Electrolytes** *Sarah Hyatt, Dalhousie University*	**Resonance effects in B decays** *Daniel Hatfield, Mount Allison University*
4:48	**Physical Properties of Carbon Nanotube Tapes** *Stefan Juckes, Dalhousie University*	**Neutron Scalar Polarizabilities: Background Simulations for Experimental Extraction via Compton Scattering** *Meg Morris, Mount Allison University*
5:00	**Perovskites: a bright future for solar cells.** *Drew Riley, Dalhousie University*	**Neutron Photo-pion Amplitudes and Quasi-Freeπ 0 Photo production from Deuterium in the Threshold Region** *Hannah Stegen, Mount Allison University*
5:12	**Calibration and Validation of Tidal Models in the Bay of Fundy** *Jon Smith, Acadia University*	**Darboux-Crum Tranformations, Supersymmetric Quantum Mechanics, and the Eigenvalue Problem.** *Kyle Bryenton, University of Prince Edward Island*

SUNDAY, FEBRUARY 7, 2016

Time	AA1043	AA1046
9:00	**An Experimental Investigation of Acoustic Backscatter from Sand and Clay Water Suspensions** *Lina Rotermund, Dalhousie University*	**On the Hunt for Dark Photons: Improving the Tracking of Vertical Drift Chambers** *Dylan Linthorne, Saint Mary's University*
9:12	**Surface Kinetics in Electroless Copper Plating** *Eric Logan, Mount Allison University*	**Density-functional theory for the crystalline phases of a two-dimensional dipolar Fermi gas** *Warren Ferguson, St. Francis Xavier University*
9:24	**Lithium-ion Differential Thermal Analysis** *Josef Rucska, Queen's University*	**Evaluating a source of polarization-entangled photons with quantum tomography.** *Patrick Poitras, Université de Moncton*
9:36	**Investigation of Unknown Resonance States of ^{20}Mg** *Orry Workman, Saint Mary's University*	**Analyzing Big Data systems in Quantum Chemistry using Machine Learning Algorithms** *Andrew Cameron, University of Prince Edward Island*
9:48	**Using Neutrons to Examine Microstructure in Bread Dough** *Nukhalu Callaghan-Patrachar, St. Francis Xavier University*	**Ice Nucleation in Simulations of Supercooled Water** *Siobhan Morris, St. Francis Xavier University*
10:00	**Nucleation in the Metamagnet** *Daniella James, St. Francis Xavier University*	**The Pulsed Laser Deposition and Characterisation of Yb:CaF2 thin films** *Denis Melanson, Université de Moncton*
10:12	**Developing a High-Resolution Imaging System for Ultracold Atoms** *Michael Kinach, St. Francis Xavier University*	**Newtonian Mechanics Proficiency and Learning Gains in Introductory Physics taught in the Context of Life Sciences.** *Seshu Iyengar, University of New Brunswick*
10:24	**Are Density Fluctuations Important in Heat Transport in One-Dimensional Chains?** *Nicholas Barrett, Cape Breton University*	**Tagging Efficiency and Linear Polarization of the May 2015 Beamtime.** *Kalli Hood, Mount Allison University*

PRESENTATION ABSTRACTS (IN PRESENTATION ORDER)

SATURDAY, FEBRUARY 6, 2016 - 8:30AM TO 9:30AM

A Study of Intra-Cluster Light in Galaxy Clusters

Anna O'Grady, Memorial University of Newfoundland

A 10 hour image of cluster Abell 569 was studied in order to search for intra-cluster light (ICL), compile a catalog of the cluster, create characteristic profiles of the cluster, and create a residual of the Brighter Cluster Galaxy (BCG). Abell 569 was observed by the Dragonfly Telescope Array – 10 Canon lenses attached to CCD cameras – which sacrificed some resolution quality to improve low surface brightness. Over 31,000 objects were found in the image, approximately 12,000 of which were unmatched to an observing catalog. Photometric calibration was also completed. From this data, profiles of the flux and surface brightness of the BCG and the magnitude and ellipticity of the total population of galaxies were created. A color-magnitude diagram was also constructed. The underlying substructure of the BCG and surrounding area was studied using galaxy masking, revealing potential ICL structures near the BCG. Finally, a residue of the BCG was created, which 'deletes' the BCG from the image and allows for previously hidden objects to be viewed. The residue of the BCG shows a large structure at the centre of the main galaxy, as well as several small galaxies and possible light structures surrounding the BCG.

Investigation of the dynamics of rod-like colloids during sedimentation.

Haruki Hirasawa, Memorial University of Newfoundland

The physics of colloids, nano- and micrometer scale particles, has seen increasing investigation in recent years in part due to the fact their ability to self-assemble. One area of interest is the self-assembly of colloids in non-equilibrium systems. Over the past months we have studied one such system, one in which rod-like colloids sediment. By studying experimental systems of rod-like colloids using confocal microscopy and doing quantitative and qualitative comparisons of our results to those from previous works on macroscopic particles, we hope to gain a better understanding of the dynamics of rod-like particles during sedimentation.

Geometric Inequalities of Black Holes

Riley Brooks, Memorial University of Newfoundland

Black holes are described in general relativity by asymptotically flat geometries that satisfy Einstein's field equations. They are specified be a small number of geometric invariants such as the mass, angular momentum and charge. I will discuss recent developments on inequalities satisfied by these invariants, which have implications for dynamical black holes.

Then I will discuss my own work on investigating generalizations of these inequalities to higher dimensions.

Analyzing the Acid-Base-Acid Cleaning Procedure for Archaeological Graphite with Raman Spectroscopy

Erica Hayward, Memorial University of Newfoundland

Graphitic materials are highly important due to their applications in technology and archaeology. I will describe how an acid-base-acid (ABA) washing procedure, a common method for removing contaminants from archaeological graphite, influences the composition and structure of charcoal samples. By comparing Raman spectroscopic data after different stages in the washing process, we identified shifts that emerged in the characteristic carbon vibration peaks (including graphite and defect modes) after the samples were exposed to acidic and basic solutions.

Searching for neutrinos at the South Pole: Simulation and Reconstruction with the IceCube Project

Cole Walsh, Memorial University of Newfoundland

Located at the South Pole, the IceCube Neutrino Observatory searches for high-energy astronomical neutrinos which provide information on some of the most violent astrophysical sources including exploding stars, gamma-ray bursts, and cataclysmic phenomena involving black holes and neutron stars. Neutrinos are nearly massless subatomic particles which move at close to the speed of light in a vacuum. These particles very rarely interact with matter, but when they do they can produce charged leptons (electrons, muons, or taus). These charged leptons emit Cherenkov radiation when they move faster than the phase velocity of light in a given medium. This radiation can be detected by photomultiplier tubes contained in the digital optical modules comprising IceCube following a neutrino interaction within the Antarctic ice. From the signals in the detector, we can reconstruct the parameters of the incoming neutrino (interaction point, energy, and angle) and gain information on these elusive particles and their origins.

Using Surface-Enhanced Raman Spectroscopy to Develop Sensors for Monitoring Water Quality

Stephanie Gallant, Memorial University of Newfoundland

Water is one of the most vital resources on earth, and it is important to observe and maintain its quality wherever possible. In particular, it is crucial for fields such as the oil industry to continually monitor produced water and potential oil spills. We are working on developing sensors which will be selective for common components of oil, such as certain polycyclic aromatic hydrocarbons (PAHs), in order to consistently monitor water quality on-site. We are using surface-enhanced Raman spectroscopy, or SERS, to characterize and develop the substrates which will be used in these sensors. While looking for a selective method, a particular issue is reproducible analyte uptake. This requires a good understanding of the surface physisorption of the material, which is an area we are looking to study in the near future.

Monte Carlo simulations of kagome lattices with magnetic dipolar interactions

Andrew Way, Memorial University of Newfoundland

The antiferromagnetic compound IrMn3, a crucial component of the read transducer in hard drives, can be characterized by a 3D stacking of kagome (corner-sharing triangles) planes of magnetic Mn ions. As bit dimensions shrink, a greater understanding of the thermal stability of these materials is desirable. Zero temperature ground state calculations, as well as finite temperature Monte Carlo simulations, of classical spins on kagome lattices with the long-range dipolar interactions are described. In the 2D case, sixfold-degenerate ground states and a phase transition to magnetic order, are revealed. Preliminary results which extend this analysis to the 3D case are presented.

Employing Surface Enhanced Raman Spectroscopy for Practical Environmental Analysis

Melanie Snow, Memorial University of Newfoundland

Analyzing contaminants found in water from industrial processes is necessary to protect our water resources. A method, which offers high specificity, gives adequate signal and offers minimal sample preparation is ideal when handling environmental samples. Ideally these samples would be analyzed on site. Raman Spectroscopy coupled with surface enhanced Raman (SERS) offers a practical analysis method. Various functional groups present in many water contaminants allow for them to be easily analyzed via SERS. Employing an appropriate substrate for use in analysis can overcome much interference, such as intense fluorescence, which is often encountered when employing traditional Raman analysis. We focus on developing and employing many of these sensors for environmental analysis.

On the connection between the theorems of Gleason and of Kochen and Specker

Taylor Landry, St. Francis Xavier University

We present an elementary proof of a reduced version of Gleason's theorem and the Kochen–Specker theorem to provide a novel perspective on the relation between both theorems.

Nanomechanical Imaging of Rat Vasculature by Atomic Force Microscopy

Garett McDougall, Memorial University of Newfoundland

Arterial stiffness is a predictor of morbidity in hypertensive individuals. Elucidation of the nanoscale material properties of arterial tissue may allow for understanding of hypertensive pathophysiology and the effect of tissue stiffness on cellular responses. Atomic Force Microscopy (AFM) was used to determine the elastic moduli (E) of healthy and hypertensive rats. Preliminary findings have shown mechanical distinctions between the tunicas intima (median E~ 27.1 kPa) and adventitia resected from both the thoracic and abdominal aorta. Further distinction has been found between adventitial layers resected from the abdominal (E~226.1 kPa) and thoracic (E~485.9 kPa) aortas. The greater elastic moduli of adventitial tissues is hypothesized to result from greater collagen density of these tissues relative to intimal tissues.

SATURDAY, FEBRUARY 6, 2016 – 10:00AM TO 11:00AM

A network model of human aging: Limits, errors, and information

Spencer Farrell, Dalhousie University

The Frailty Index (FI) quantifies human aging using the fraction of accumulated age-related deficits. The FI correlates strongly with mortality, accumulating non-linearly and stochastically with age. Clinical data shows a nearly universal limit of FI < 0.8. Using a network model of interacting deficits for each person, we computationally model an aging population. Deficits damage and repair at rates that depend upon the state of connected nodes. The model fits clinical data, except for the frailty limit. We show that the frailty limit can be recovered with false negative errors. Mutual information allows us to assess how well the FI predicts mortality, and how false negative errors reduce the information content of the FI.

Harriet, one of the most luminous starbursts in the universe

Ryan Perry, Dalhousie University

We present an analysis of one of the most luminous starbursts in the universe (19mJy), at a redshift of 2.82 (9.43 billion lyr from the earth). We observed the emission lines from the molecule carbon monoxide in transition from the 5^{th} to 4^{th} total angular momentum quantum level (CO(5-4)). Then using IRAM-PdbI (an interferometer or, the “telescope”), we resolve the source into two components, a blue shifted and red shifted component that appear to be involved in a major merger (separation is approximately 6kpc). The CO(5-4) velocity curves for both galaxies seem to be traced out to the flattened profile, where the mass of the dark matter halo dominates.

Both the PdbI 2mm continuum and SMA 870 continuum agree that the majority of the flux ratio comes from the blue shifted galaxy (Flux = 15mJy, fit with a 29K spectral energy distribution (SED) template.) Thus, the red shifted galaxy must then be around 4mJy with an SED template of approximately 42K). We also observe that the blue shifted galaxy has a “warp” in its structure. This could be due to the forces of the galaxies on one another, or it could just be because it is a very gas rich and disordered disk. Finally, we see that the merger has not had enough time to influence the star formation rate (as compared to simulation), and thus the star formation happening within the two disks, and thus the luminosity, is not due to the merger yet.

Collagen fibril architecture in tendons using atomic force microscope

Josh Sampson, Dalhousie University

Collagen fibrils are the primary load bearing elements in connective tissues such as skin, tendon and ligaments, and are formed by a quarter-staggered arrangement of collagen molecules. This organization leads to a 67 nm periodic fluctuation in molecular density, known as the D-band. It has been previously shown using Atomic Force Microscopy that the ratio of elastic modulus from the gap region to the overlap region forming the D-Band is around 0.8, supporting the quarter stagger model. In this work, we confirm the validity of this ratio on a set of 25 fibrils extracted from the tail tendon of 5 different steers.

Constraining Inclination Angles of Rapidly Rotating Stars

Laura Sponagle, Mount Allison University

The inclination angles of the axis of rotation will be determined of 11 Beta Cephei stars using ROTORC as a 2D modeling code. These stars are all variables and are known to be rapidly rotating. A grid of models at a range of mass and rotation rates were calculated and the pulsation frequencies will be used to determine the true temperature and luminosity and therefore the inclination of the star.

Modelling *Listeria* invasion in the face of innate immunity

Hong Yi Shi Yang, Dalhousie University

Listeria monocytogenes is a food-borne pathogenic bacteria. Experimental studies of the propagation of *L. monocytogenes* infection from an initial focus in a layer of uninfected cells have shown that the number of infected cells grow linearly with time. This implies a decreasing speed of the infection front with time. To understand this system, we model the spread of *Listeria* in a two-dimensional lattice of cells. With a basic model, we obtained quadratic Eden-like growth. We then coupled the infection to a propagating innate immune response. With our full model, we obtained linear growth - qualitatively recovering the experimental behaviour. This work is ongoing, in collaboration with Professor Andrew D. Rutenberg at the department of Physics and Atmospheric science, Dalhousie University.

Photometric observations of Epsilon Cephei with 16-inches telescope of the Université de Moncton.

Sébastien Noël, Université de Moncton

Epsilon Cephei is identified as a Delta Scuti star that shows a number of oscillation frequencies. This star was chosen for observation with BRITE Constellation of nanosatellites. Our project is focused on assessing the feasibility of successful ground-based photometry to assist the BRITE project. Epsilon Cephei was observed in automatic regime with 16-inches telescope of UdM employing the SFT8300 camera. Series of FITS images were taken in U, B, V, Rc, Ic bands and processed using the SExtractor software. The light curves of Epsilon

Cephei were analysed with the help of Period04 software to determine the characteristics of stellar oscillations.

Exploring the Use of X-ray Fluorescence to Detect Zinc Concentration in Bone

Kelly Foran, Mount Allison University

The goal of this project was to determine if x-ray fluorescence (XRF) is a practical method of determining the concentration of zinc in a person's bone. A portable XRF analyzer was used to determine the zinc content in a set of bone phantoms, made from plaster of Paris, of various approximate zinc concentrations. The XRF data (counts vs. energy) was analyzed by fitting a Gaussian curve to the data around the characteristic x-ray energy for zinc. The peak amplitude for each phantom was compared to the approximate zinc concentration using a linear fit. The correlations were quite good with r-squared values of 0.92 for bare bone and 0.94 for measurements done with bolus. Overall, x-ray fluorescence shows promise as a means to quickly detect zinc concentration in bone.

Validating Tidal Models in the Bay of Fundy using Surface Drifters

Kody Crowell, Acadia University

The Finite Volume Community Ocean Model (FVCOM) is used to generate accurate numerical simulations of the tides in the Bay of Fundy in order to better predict the speed of the water in Digby Neck passages. Knowing the model speed, we can calculate and predict the potential power generated by any in-stream tidal turbines. To validate this model, the data was generated at a higher time-resolution within a smaller time window and subsequently compared to experimental data using PySeidon, a python-based validation suite used for analysing FVCOM output. The experimental data was collected from a series of drifter runs throughout the passages during ebb and flow tide. Although the model speed showed a remarkable agreement in trajectory behaviour to the observed speeds, it was consistently shifted by some bias, the origin of which is still under speculation. Plotting the cubed ratio of model and drifter speeds within the passages suggested that the discrepancy could be caused by the model's failure to capture water motion at a lower speed. More work is needed to tune the FVCOM model in order to produce more accurate simulations. Future developments include the possible use of a numerical drifter, which could provide insight into the origin of the speed bias, generate an understanding of particle motion through passages, and predict the interaction marine life might have with tidal turbines.

A Comparison of Portable X-Ray Fluorescence Devices for Medical Applications

Craig Groskopf, Mount Allison University

Upon delivery of a new X-Ray Fluorescence (XRF) System at Mount Allison University, a comparison was made between the new and old system, focusing on medical applications. A series of experiments were preformed to evaluate each systems' ability to detect trace elements in the human body. The experiments were designed to detect lead in bone phantoms, arsenic and selenium in skin phantoms, and zinc and manganese in nail phantoms. These elements were selected due to their presence in the human body, health effects, as well as the broad range of energies required to detect the elements. The results demonstrate the capabilities of XRF technologies, and how they can be applied in the medical field.

Modeling the Effects of Latitude on Nutrient Transfer from Rivers to the Open Ocean.

Emma Shouldice, Dalhousie University

Regions of fresh water, known as river plumes, are formed in coastal oceans as a result of buoyant fresh water inputs interacting with the denser ambient ocean. The associated dynamics and the rate of nutrient transport is influenced by the Coriolis force. It has been suggested that proximity to the equator (i.e. latitude) is an influential factor in determining whether a river plume can effectively reach the open ocean. The research to be discussed in this presentation uses an idealized river plume model implemented with the Regional Ocean Modeling Systems (ROMS). Plume model at different latitudes are analyzed to investigate the effect of latitude on a river's ability to transfer nutrients to the open ocean.

Saturday, February 6, 2016 – 1:30PM to 2:30PM

X-Ray Fluorescence to Analyze Strontium and Calcium Ratios in Sturgeon to Trace Migratory Patterns

Michael Reno, Mount Allison University

Sturgeon are among the oldest fish species in the world having a life expectancy of up to 60 years. Throughout their life time, these anadromous creatures migrate between environments of varying levels of salinity (Balazik et al 2012). Alternating levels of salinity (high in saltwater, low in freshwater) have been shown to affect the Sr/Ca ratios of the sturgeon's bony plates called scutes. It has been established that high levels of salinity cause higher ratios of Sr/Ca and vice versa (Kraus and Secor 2004). Analyzing these ratios on different sturgeon species enables the investigation into their preferential habitats. Sr/Ca ratios were compiled using XRF, a non-detrimental approach, on two scutes of differing Sturgeon species, the Shortnose and the Atlantic. Three trials were done on the Shortnose scute, and seven on the Atlantic scute. The Shortnose had a very small Sr/Ca ratio, whereas the Atlantic had much greater. Further, the ratios were higher along the edge of the scute and smaller along the middle. It is implied that the low ratio in the Shortnose scute reveals a residency in freshwater, and the high ratio in the Atlantic scute indicates a residency in saltwater. Thus far, it appears XRF is a promising method in interpreting Sr/Ca ratios to trace residency in Sturgeon species.

Nanopure Water Treatment and its Effects on the Corrosion Resistance of Nitinol

Bradley LeGallais, Dalhousie University

Nitinol is an alloy of nickel and titanium with some very unique properties: shape memory and superelasticity. Due to the problem of toxic nickel being released into the blood stream good corrosion properties of nitinol are essential for its use in stents. In this study the relationship between the surface morphology and the corrosion resistance will be explored. As well, we will apply a nanopure water treatment and characterize its effects on the corrosion resistance. Nitinol was mechanically polished with 120, 240, 600, 1200, and 1500 grit sandpapers to create samples with a variety of surface morphologies. A three electrode cell combined with a potentiostat was used to record the corrosion properties. *In situ* surface imaging techniques were employed, ellipsomicroscopy for surface imaging (EMSI), and contrast enhanced light microscopy. Energy-dispersive X-ray spectroscopy (EDS) and scanning electron microscopy (SEM) were used to investigate changes to the surface after corrosion and the water treatment. Corrosion resistance was found to be dependent on the smoothness of the sample surface, increasing as it became smoother. The water treatment was found to be more effective on rougher samples, it had almost no effect on the smoothest ones. The critical potential of corrosion was found to be higher than SS 316 LVM, a highly corrosion resistant stainless steel. The critical potential of the roughest samples, G120, without water treatment was much higher than the potentials found within the body. This illustrates that nitinol is highly resistant to corrosion *in vivo*.

Calibration method for measurement of chromium in nail-clippings using portable XRF

Chris Ware, Mount Allison University

A calibration method for measurements of chromium in nail clippings is demonstrated. Phantoms were created with chromium concentrations of 0, 2, 5, 10, 15, 20µg g(-1). Phantoms were clipped with commercial nail clippers, and then grouped into samples of five different masses: 20, 40, 60, 80, 100 mg for each concentration. Using portable XRF x-ray spectra were acquired for each of the 30 samples. Calibration lines relating the XRF signal and elemental concentration were created. These lines were used to create a semi-empirical relationship that uses the slope of the calibration lines and the mass of nail clippings to determine chromium concentration.

Search for infrared lines for abundance analysis

Isabelle Gallant, Université de Moncton

We present the results of a search for infrared atomic absorption lines that may be used for abundance analysis and more specifically for the detection of vertical abundance stratification in chemically peculiar (CP) stars. This analysis aims to verify if sufficient lines exist in theoretical infrared spectra that could be detected by the forthcoming SPIRou

(SpectroPolarimètre Infra-Rouge) spectropolarimeter at the Canada-France-Hawaii Telescope. The data from the analysis of such infrared lines could be added to the results obtained from lines in the visible part of the spectrum to better characterize vertical stratification profiles in CP stars.

Applying the Iso-configurational Ensemble to Proteins

Thomas Faour, St. Francis Xavier University

The iso-configurational (IC) ensemble have been used to investigate dynamical heterogeneity in glasses. It has revealed features that are structural in origin in these systems. In this study, we have extended the IC method to investigate a model liquid water, SPC/E model of water at 300K and a simple well investigated model protein, Met-enkephaline. Our aim is to characterize any heterogeneities in the dynamics and investigate any structural or conformational origin even at these high temperatures. This approach, if successful may then be applied to systems containing other model proteins to reveal the mechanisms of protein folding and may provide insights into the process. Molecular Dynamics simulations are undertaken using the GROMACS software package.

Free Energy Comparison of Cylindrically Confined Ring Polymer Models

Deanna Kerry, University of Prince Edward Island

The mechanics of how bacterial chromosomes segregate after replication are not well understood. One explanation is that it is related to the entropy of the ring-shaped chromosomes within the bacteria cell. Using hard sphere chains as simple chromosome models, it can be shown through Monte Carlo simulations that cylindrically confined two-polymer systems have higher entropy when the polymers are separated rather than overlapping. As systems always favour configurations with maximum entropy, the polymers will spontaneously segregate from one another whenever possible—a phenomenon that may be occurring with bacterial chromosomes. The goal of this work is to compare free energy calculations from this two-polymer model to one with a single polymer confined within a bottle-shaped cylinder.

Optical Properties of Thermally Heated Porcine Muscle from Ex Vivo Radiance Measurements

Jonathan Horrocks, University of Prince Edward Island

The application of thermal heating to muscle or other biological tissue samples, whether in vivo or ex vivo, can yield complex and varying results depending on the measure, temperature, or timescale used. One option to determine the interstitial tissue damage and other effects caused by thermal heating is the measurement of certain optical properties. Characterizing the changes in these optical properties, as well as a proper understanding of the changes that thermal heating has on the tissue at a cellular level, can be useful in medical or research applications, such as certain cancer diagnostic and treatments methods. For this project, porcine muscle is used as a phantom mimicking human prostate tissue.

Optical absorption and scattering properties were extracted from measurements using an earlier developed model and then compared with the corresponding properties in native tissue. Significant increases in scattering as well as other notable changes indicate the potential for detecting the presence of coagulated tissues using radiance measurement techniques.

Polymer Translocation through a Conical Channel

Phoenix McCloud, University of Prince Edward Island

Polymer translocation is the passage of a polymer through a nano-pore in a barrier. Applications of polymer translocation are found in biological processes, such as the movement of RNA out of the nucleus, and in DNA sequencing techniques. The computational study of conically-shaped nano-channels has been motivated by experimental use of conical transport proteins. Monte Carlo computer simulations and simple theoretical predictions were used to study how variations in the channel dimensions and polymer length affect the translocation free energy. It was found that the qualitative trends from the simulations were in agreement with the theoretical predications.

A study of predator-prey dynamics within a city landscape: The story of the urban fox

Patrick Strongman, University of Prince Edward Island

The study of animal movement is becoming more important recently as the growing population of predators near cities creates the potential for violent encounters or transmission of disease to humans. One such predator is the red fox of PEI. We hope to understand why they are beginning to prefer urban settings as opposed to their natural environment through field studies and simulation techniques designed to model animal movement on 2-D fractal landscapes. Simulations thus far have used animal models that follow different foraging strategies from the simpler Brownian random walk to more sophisticated multi-state strategies such as the composite correlated random walk. The parameters used to generate the fractal landscapes were varied to study how different measures of confinement and fragmentation of the environment affect the movement, foraging efficiency, and other important metrics of different searching strategies. A cluster labeling technique based off the Hoshen-Kopelman algorithm was also developed as a new way to analyze and compare the data collected from the simulations with field data. We are also working on improving these simulations through the implementation of animal memory to our walkers, and adding urban features like houses and fences to the landscapes in order to study how these barriers affect different foraging strategies. In the future we hope to extend these concepts to model coyotes with the intent of studying the predator-predator-prey dynamics between the coyotes, foxes, and their prey.

Simulation Study of the Confinement Free Energy of Polymers

Aidan Tremblett, University of Prince Edward Island

Using Monte Carlo simulations, we studied the conformational behaviour of a linear polymer under confinement, and compared the results with theoretical predictions. Our computational simulation modeled the polymer as a chain of hard spheres within an infinitely long cylindrical tube of diameter, D. The focus of the research was to understand the effects that confinement had on the variation of the free energy, F, of the polymer with respect to the distance between the ends of the chain. By varying the diameter, D, of the tube, and the length, N, of the polymer, we were able to determine the dependence of the free energy barrier on N and D, and extrapolate the data to find the regime in which the theoretical predictions were valid. Furthermore, the linear polymer model was expanded to include the study of a three-arm star polymer under cylindrical confinement. The motivation behind this research was rooted in the emerging field of nanofluidics, in which polymers, like DNA, are studied under confinement of nanometer size channels.

SATURDAY, FEBRUARY 6, 2016 – 4:00PM TO 5:30PM

TEM Analysis of MnSi on SiC

Brendan Edwards, Acadia University

Thin film MnSi grown on SiC substrates has recently been an area of interest due to its potential to exhibit out-of-plane skyrmions. Skyrmions are locally stable magnetic knots that can have great ramifications on the field of spintronics, if proved to be easily producible. Researchers at Dalhousie University have developed a technique to grow these films and have performed XRD and AFM measurements on the samples. In this project, sample analysis is continued with multiple TEM techniques.

The Dependence of a Charge Density Wave's Wavevector on Intercalate Concentration

Stefanie Beale, Acadia University

Charge density waves (CDW) are a coupled modulation of conduction electron density and crystal lattice structure that occurs primarily in low-dimensional metals. The Nb3M4 (M=Se, Te) system contains Nb chains which provide a quasi one-dimensional structure in which a CDW may form. These structures also contain large hexagonal tunnels into which intercalate may be added in order to study the effects of intercalation on CDW behaviour. In this research, we have shown that a CDW can be induced in the Nb3Se4 compound via the intercalation of thalium. We have also studied the effects of indium and thalium intercalation on CDW in Nb3Se4 and Nb3Te4 crystals.

Exploring Impedance Growth in Lithium-Ion Cells Using a Transmission Line Model

Daniel Abarbanel, Dalhousie University

Lithium-ion batteries have enjoyed widespread use in portable electronics for over two decades, and are increasingly relevant for electric vehicles as operational life and energy density continue to increase. The use of high voltage $LiMO_2$ (M = Ni, Mn, Co) positive electrode materials improves the energy density of the cell, but difficulties arise in maintaining the calendar life and coulombic efficiency at high voltage. Electrochemical impedance spectroscopy (EIS) is a powerful diagnostic tool, because the impedance of a lithium-ion cell is closely associated with its health. It is important to connect the features seen in EIS spectra with the correct internal processes occurring within a cell. A comprehensive circuit model for the impedance of a cell is needed to understand these processes. In this talk, a transmission line circuit model of a lithium-ion cell positive electrode will be presented. The EIS results found from altering key parameters in the model will be shown to be in surprising disagreement with claims about Li-ion impedance in the literature.

Physics Beyond the Standard Model: Search for the Dark Photon

Kyle Marshall, Acadia University

The standard model is the leading theory in particle physics which attempts to unify the four fundamental forces and explain the physical phenomena of the universe in which we live. However, the standard model is incomplete and requires additional particles to be included in order to explain phenomena such as dark matter and dark energy. By examining the decay branch of the Higgs boson into photons, we find that theory does not agree with experiment. This shows promise for new physics to be discovered. Decay branches that include a new theorized particle, the dark photon, are added to the Higgs decay and theoretical parameters for the new particle can be calculated.

Layered perovskite materials as an alternative to lead-based thin films in solar cells

Samuel Cameron, Dalhousie University

Due to the lead content of most perovskite solar cells (PSCs), wide-scale implementation may pose environmental risks. This motivates the study of new thin film materials to replace the current technology. In this talk, a brief summary of current PSCs are presented, followed by presentation of the electronic and optical properties of a new layered perovskite thin film material, $Cs_3Sb_2I_9$. The importance of these properties with regard to fabricating solar cells are then discussed. The electronic properties of $Cs_3Sb_2I_9$ are examined using x-ray photoelectron spectroscopy (XPS), ultraviolet photoelectron spectroscopy, as well as inverse photoelectron spectroscopy (IPES).The ionization energy was determined to be 5.6eV, with the material being slightly p-doped. An optical bandgap of 2.05eV was observed using ultraviolet-visible spectroscopy (UV-vis). Although only modest device efficiencies of initial solar cells fabricated using Cs3Sb2I9 were observed, this class of layered perovskite materials are promising candidates for new, thin film, lead-free solar cell technology.

Using Nuclear Probes to investigate the Nuclear Energy Production Cycle

Tait Du, Mount Allison University

Using nuclear probes in the form of evolution of spin polarization of positive muons, we investigated different aspects of the nuclear energy production cycle. In particular, positive muons were employed via muon spin rotation to probe water radiolysis at extreme conditions where conventional methods fail, and we investigated hydrogen formation in clays to improve nuclear waste storage techniques. Through our investigations, we have observed non-traditional behavior of water radiolysis near the critical point as well as possible evidence of hydrogen formation in the talc interlayer space with further implications for 2-D chemistry.

Differential Thermal Analysis of Li-Ion Battery Electrolytes

Sarah Hyatt, Dalhousie University

Lithium-ion batteries are what power our cell phones, laptops, and electric vehicles. Improving their lifetime is crucial for future applications. Differential thermal analysis (DTA) can be used to study Li-ion battery electrolytes in order to gain a better understanding of them. In this talk, I will discuss the use of DTA to investigate electrolytes containing ethyl methyl carbonate (EMC) and LiPF6, and present a phase diagram constructed from experimental results.

Resonance effects in B decays

Daniel Hatfield, Mount Allison University

I present the branching ratio and forward backward asymmetry (AFB) distribution for the rare dileptonic decay B to K*l+l- for the full range of q2, the dimuon mass squared, region. For the required form factors, we use non-perturbative inputs as predicted by the anti-de Sitter/Quantum Chromodynamics (AdS/QCD) correspondence. I account for the psi and psi' resonances effect in the non-resonance region of the spectrum, to improve accuracy with the experimental data. We find our predictions to be in better agreement with the experimental data for the branching ratio where as the AFB remains mostly unchanged.

Physical Properties of Carbon Nanotube Tapes

Stefan Juckes, Dalhousie University

Carbon nanotubes (CNTs) represent a promising technology for mitigating climate change, and improving energy and aerospace technologies. CNT bulk materials have physical properties that are several orders of magnitude less extraordinary than their nanoscale constituents. However, their properties can still be useful in some applications. Electrical resistance was measured on three CNT tape samples synthesized at the University of Cambridge during the summer, using a Physical Properties Measurement System. Parallel thermal conductance (PTC) measurements were then carried out on four more samples to compare their thermal conductivity to other tapes. Electrical resistance data show primarily semiconducting behaviour. Results for thermal conductance show promising behaviour, and thermal conductivity calculations give reasonable values, using approximate dimensions measured using scanning electron microscopy (SEM). However, more accurate thickness measurements are needed to determine thermal conductivity. Further thermal conductance measurements will also be completed on replicate CNT tape samples.

Neutron Scalar Polarizabilities: Background Simulations for Experimental Extraction via Compton Scattering

Meg Morris, Mount Allison University

The A2 collaboration at the Institute for Nuclear Physics in Mainz, Germany, is experimentally determining the polarizabilities of hadrons. The scalar polarizabilities of the neutron, specifically, have been difficult to determine due to the additional challenges involved. Previous work with deuterium as a target has produced unsatisfactory results due to large uncertainties. Lead by the Glasglow and Mount Allison groups, the A2 collaboration is in the process of preparing a high-pressure, active helium-3 target, which will house events and detect the recoiling nuclei for an experiment set to run in 2016. Recent work using Chiral Perturbation Theory [D.Shulka, A.Nogga, and D. Phillips, NPA 819, 98 (2009)] has shown that coherent Compton scattering on such a target should minimize nuclear effects and allow a more accurate determination of these neutron structure constants. As part of the preparations for the measurement, background studies are being carried out to investigate the contamination that can be expected from the various channels in the Compton data. Preliminary results will be presented.

Perovskites: a bright future for solar cells.

Drew Riley, Dalhousie University

Organo-metal halide perovskite materials have recently seen a rapid surge in interest due to their promising performance as the absorber layer in photovoltaic devices, with cell efficiencies increasing from 3.8% to over 20% since 2009. This novel photovoltaic material has made great strides in efficiency, with little known about its fundamental material properties. In this study, we used femtosecond pulses of light in a differential transmission setup to study the charge-carrier dynamics on sub picosecond timescales. These studies will further our understanding of key characteristic material properties paramount for the working of a successful photovoltaic material.

Neutron Photo-pion Amplitudes and Quasi-Free π 0 Photo production from Deuterium in the Threshold Region

Hannah Stegen, Mount Allison University

The isospin characteristics of the neutron and the proton show they are the same particle in different states, however by analysing the quark content they have an up-down quark difference suggesting a violation in isospin symmetry. The mass difference between the up and down quarks have a small effect that can be quantified by the photon interaction constants know as Multipoles. At the Mainzer Microtron(MAMI) experiments have been conducted in the π 0 threshold region in search for the neutron photo-pion amplitudes/multipoles through the d(γ,π 0 n)p reaction. Electrons were accelerated to 225 MeV and entered the A2 Collaboration hall where they hit a radiator undergoing Bremsstrahlung Radiation, producing a photon beam in the energy range E γ =95.7-208.5 MeV. The photons were tagged using the Glasgow-Mainz tagger. The scattered photons, a product of the decayed pion, after the collision were measured with the TAPS Spectrometer and a BC-505 liquid scintillator detector measured the energy and angle of the scattered neutron. The proton with essentially no kinetic energy enables a quasi-free reaction and allows us to probe an almost free neutron to extract the multipoles from the experimental cross sections. Several interaction experiments have already been conducted and the multipoles extracted, but none with this reaction.

Calibration and Validation of Tidal Models in the Bay of Fundy

Jon Smith, Acadia University

The purpose of this project was to analyze the results of the Finite Volume Community Ocean Model (FVCOM) on modelling the tides within various passages in the Bay of Fundy. Furthermore, the model was calibrated via a number of adjustable model parameters in order to agree with collected ocean data. An optimization scheme and scoring method were developed in order to effectively perform this calibration. The calibration method is fairly successful in improving model performance at important tidal sites. Improved accuracy for data will allow for more reasonable power estimations to be made.

Darboux-Crum Tranformations, Supersymmetric Quantum Mechanics, and the Eigenvalue Problem.

Kyle Bryenton, University of Prince Edward Island

The Darboux transformation and its generalization, Crum's method, are tools used to generate exactly solvable eigenvalue problems. The focus of this research is on generating new classes of exactly solvable quantum potentials for the Schrödinger equation. The Schrödinger equation is a fundamental equation in quantum mechanics which describes the behaviour of non-relativistic particles. Prior to generating new classes of potentials, an examination of the underlying mathematical theory beneath both the Darboux transformation and supersymmetric quantum mechanics is conducted, including a detailed proof of their equivalence. Following the analysis of methods, one of the most significant molecular potentials used in physics to describe the interaction between two atoms, the Hulthén Potential, is examined. Using Darboux-Crum techniques and supersymmetry, an extended solvable class of Hulthén potentials are constructed. Furthermore an analysis of the Hermite differential equation, which appears in solving the quantum harmonic oscillator problem, will be conducted. Finally, some new and interesting results will be shared on the Crum-generalization of the shifted non-linear quantum harmonic oscillator.

SUNDAY, FEBRUARY 7, 2016 – 9:00AM TO 10:30AM

An Experimental Investigation of Acoustic Backscatter from Sand and Clay Water Suspensions

Lina Rotermund, Dalhousie University

An apparatus was built in order to measure mass-concentration, velocity and particle size in two-component sediment suspensions, using multi-frequency pulse-to-pulse coherent acoustic Doppler profilers. The two particle types used were sand and clay because they have very different physical properties, but are often found concurrently in marine environments. The apparatus consists of a vertical pipe settling column, with two multi-frequency Doppler profilers to measure the horizontal and vertical profiles of the sediment suspension. It allowed for simultaneous extractions of time-resolved 1-D profiles of mass-concentration and velocity for sand and clay along the vertical and horizontal axis.

On the Hunt for Dark Photons: Improving the Tracking of Vertical Drift Chambers

Dylan Linthorne, Saint Mary's University

The current standard model (SM) of particle physics does not account for the dark matter (DM) presence within the universe. A theoretically proposed new force, governed by a U(1) Boson, has been an ongoing subject of experimental searches as a bridge between SM particles and DM models. An experimental search for the Dark Photon/A' Boson will commence in experimental Hall A at Jefferson Lab some time in 2016-17. The Hall A High Resolution Spectrometer (HRS) will be used in attempt to detect the A' Boson with masses O(50MeV − 500MeV) as it decays into electron-position pairs. The high luminosity required for the experiment creates HRS trigger rates of 5 Mhz, which presents a problem for the tracking efficiency of the resultant electron-position pairs. The HRS uses four vertical drift chambers (VDC) to detect particle tracks by means of gas ionization. Previously, VDC signal data has been analyzed using an older ”brute force” algorithm which was appropriate at much lower particle rates (lower Background). This presentation reports on a new VDC algorithm created to better handle higher particle traversal rates, and tested using previously obtained high-rate test data.

Surface Kinetics in Electroless Copper Plating

Eric Logan, Mount Allison University

Electroless copper plating is a key process in the industrial production of printed circuit boards (PCBs) that are found in modern electronics. In the process we investigate, aqueous copper ions are chemically reduced using formaldehyde to form a conductive metallic layer on an otherwise non-conducting substrate. Often, nickel is added to electroless plating baths to promote adhesion and improve plating rates, which is plated alongside copper in a secondary reaction. In this study, a number of different bath parameters were investigated to determine their effects on the final thickness of the film. Parameters include: concentrations of hydroxide, formaldehyde, nickel and other stabilizing compounds. We have developed a quantitative model inspired by Langmuir adsorption models that describes plated thickness and the amount of co-plated nickel as a function of the plating bath parameters. This model describes the substrate surface as a set of sites that can either be active or passive. The active surface fraction then helps to determine the plating rate. Specific effects have also been identified, such as a poisoning of the surface by the stabilizer, and an interaction between nickel and stabilizer to recover plating rates. Ni incorporation is increased at high plating rates because copper becomes depleted at the plating surface. While development of the model is still in progress, it does well in describing most of the empirical data.

Density-functional theory for the crystalline phases of a two-dimensional dipolar Fermi gas

Warren Ferguson, St. Francis Xavier University

Density-functional theory is utilized to investigate the zero-temperature transition from a Fermi liquid to an inhomogeneous stripe, or Wigner crystal phase, predicted to occur in a one-component, spin-polarized, two-dimensional dipolar Fermi gas. Correlations are treated semiexactly within the local-density approximation using an empirical fit to quantum Monte Carlo data. We find that the inclusion of the nonlocal contribution to the Hartree-Fock energy is crucial for the onset of an instability to an inhomogeneous density distribution. Our density-functional theory supports a transition to both a one-dimensional stripe phase and a triangular Wigner crystal. However, we find that there is an instability first to the stripe phase, followed by a transition to the Wigner crystal at higher coupling.

Lithium-ion Differential Thermal Analysis

Josef Rucska, Queen's University

Differential thermal analysis is a technique that uses latent heat to deduce the temperature at which phase changes occur in a substance. A prototype for an apparatus which conducts differential thermal analysis for the electrolyte in “18650” lithium-ion cells has been created and tested. Subjecting a battery to this test does not appear to adversely affect its performance. Preliminary results suggest that further research could allow lithium-ion differential analysis to be used as an in-situ method of deducing the electrochemical composition of a lithium-ion battery, and thus the stage of life of that battery.

Evaluating a source of polarization-entangled photons with quantum tomography.

Patrick Poitras, Université de Moncton

The qubit is the base unit of quantum information. Unlike the classical bit, qubits can exhibit entanglement, a property that can be used for novel technologies such as quantum computing and quantum cryptography. A particularly attractive system in which to encode qubits is a photon's polarization, due to its very low decoherence rate and high velocity. Parametric downconversion has been used extensively to produce entangled photon pairs, but creating quantum states with more than 2 entangled photons is more challenging. Recently, multi-photon entanglement has been produced using a novel technique called cascading downconversion, which makes it possible to directly produce entangled photon triplets from a single photon. Here, we present our efforts to build on these promising results by building a phase-stable source of polarization-entangled photon triplets. In particular, we will focus on our method to evaluate the quality of the source, including the implementation of a computer program to automate the processing of raw data to reconstruct the density matrix of the quantum state through quantum state tomography. The tools developed in this project will enable rapid characterization of the entangled-photon source, which we hope will allow us to optimize the fidelity of the produced quantum states.

Investigation of Unknown Resonance States of ^{20}Mg

Orry Workman, Saint Mary's University

The ^{20}Mg nucleus located at the proton drip-line is of interest for both nuclear astrophysics and understanding the structure of rare isotopes. In particular, the proton unbound resonances in ^{20}Mg play an important role in evaluating whether the two-proton capture reaction of ^{18}Ne could be a potential breakout path from the Hot CNO cycle to the rp-process. These resonance energies also show high sensitivity to understanding the nuclear force. Theoretical calculations for three-nucleon forces in proton rich nuclei have recently been made, and ^{20}Mg is a good candidate for testing those calculations, as the ordering energy levels of the 0^+ and 4^+ excited states is inverted between calculations using three-nucleon force and two-nucleon force. There is currently no experimental information on the resonance states of ^{20}Mg. We have, therefore, performed the first experiment to look into resonances above the proton emission threshold this summer at TRIUMF. To measure the resonances in ^{20}Mg we made use of the IRIS facility to study the $^{20}Mg(d,d')$ inelastic scattering. A beam of ^{20}Mg was accelerated to an energy of 8.5A MeV and interacted with a solid deuterium target. The scattered deuterons were detected using silicon strip detector and CsI(Tl) detector arrays to study the reaction channel of interest. It is important to understand how the various aspects of the experimental conditions, such as the target thickness, beam profile, detector resolution, contribute to the observed excitation energy spectrum. To accomplish this, I have been developing a Monte Carlo simulation of the experiment. In this presentation, I will describe the ^{20}Mg experiment that was performed this summer as well as the work I did on the simulation of the ^{20}Mg(d,d')^{20}Mg scattering reaction.

Analyzing Big Data systems in Quantum Chemistry using Machine Learning Algorithms

Andrew Cameron, University of Prince Edward Island

Machine learning algorithms are employed to discover relationships between elements within large datasets. Progress in applying such techniques to the solution of the non-relativistic Born-Oppenheimer Schrödinger equation has been challenging due to a lack of sufficiently large datasets to afford an exact inductive solution. Recent progress in our group to develop an open, online platform and data repository for computational quantum chemistry has shown promise in addressing this important challenge. As more quantum chemical calculations become accessible the potential to learn from this data becomes more realistic. In this presentation I will describe our approach to using supervised machine learning in computational chemistry to rapidly generate, optimize, and assess the performance of unique composite methods for determining the non-relativistic electronic energy of a general chemical system. We make use of data from over 270 model chemistries to automatically construct and evaluate 11.9 billion composite methods against a CCSD(T)/CBS benchmark. The performance of our algorithms and the resultant composite methods, as well as a variety of applications will be presented.

Using Neutrons to Examine Microstructure in Bread Dough

Nukhalu Callaghan-Patrachar, St. Francis Xavier University

Ultra-small angle neutron scattering (USANS) is a powerful technique used to study microscale structures. We have used it to characterize and model doughs made from different wheat cultivars. The problem is to understand whether dough structures are altered by NaCl, since reducing the sodium content leads to a ""sticky"" dough which increases the cost of bread production. This is an economically-important issue since Health Canada guidelines will mandate a 30% reduction of sodium in bread. We have used USANS to deduce fractal dimensions, D, of structures obtained via the relationship, $\log I(q) \simeq D \log q$.

Ice Nucleation in Simulations of Supercooled Water

Siobhan Morris, St. Francis Xavier University

Despite recent debate, free energy simulations of supercooled water using the ST2 potential have confirmed the existence of a liquid-liquid phase transition (LLPT) in this water model. However, the influence of the LLPT on the nucleation of ice in this model has not been quantified, in particular, the influence on the height of the nucleation barrier. To address this question, we carry out umbrella sampling Monte Carlo simulations of ST2 water to evaluate the free energy of formation of small sub-critical clusters of ice Ic. We estimate this free energy over a range of temperature and pressure in the supercooled region of the phase diagram straddling the so-called Widom line and approaching the region of the critical point associated with the LLPT. Our results reveal a crossover in the behavior of the free energy of formation of small ice clusters as the liquid moves from the high density to the low density regime. We also present evidence that small ice embryos are wetted by low-density liquid (LDL) even under conditions where the bulk LDL phase is neither stable nor metastable.

Nucleation in the Metamagnet

Daniella James, St. Francis Xavier University

We conduct simulations of a 2D metamagnet below the tricritical temperature in order to study the nucleation process from a metastable phase to a stable phase in the presence of an additional metastable phase. At fixed temperature below the tricritical temperature, the phase diagram as a function of the direct and staggered magnetic fields contains a triple point at which three phases coexist, two antiferromagnetic phases and a ferromagnetic phase. We examine the nucleation process from one antiferromagnetic phase to the other as a function of the direct field. We find that the decrease in the free energy barrier for nucleation as the direct field increases can be understood in terms of the influence of the proximity of the metastable ferromagnetic phase in the free energy surface of the system. Our results have implications for understanding nucleation in systems with multiple metastable phases, such as may occur in deeply supercooled water.

The Pulsed Laser Deposition and Characterisation of Yb:CaF2 thin films

Denis Melanson, Université de Moncton

Wide band-gap materials such as CaF_2 have many practical laser applications, from gain medium to optical filters. The luminescent properties of Yb^{3+} when doped in CaF_2 are interesting for electroluminescence devices. Thus the potential of pulsed laser deposition as a means of depositing low porosity Yb:CaF_2 thin films for laser applications is studied. We look at the effect of the doping concentrations and the laser energy and wavelength on the quality of the film. The deposited films are characterised by ellipsometry and x-ray diffraction as well as mass spectrometry, and optical spectroscopy of the ablation plume are analysed and discussed.

Developing a High-Resolution Imaging System for Ultracold Atoms

Michael Kinach, St. Francis Xavier University

Modern laser cooling and trapping techniques allow for the study of atoms at extremely low temperatures, typically in the microkelvin to nanokelvin range. At these temperatures, the quantum-mechanical properties of the atom become apparent. One of the main methods of gathering data from these ultracold systems is through optical imaging. In this pursuit, we have developed an absorption imaging system that achieves a high spatial resolution of approximately 2 micrometers. This upgrade in imaging capability will yield new experimental opportunities in the study of ultracold lithium and rubidium.

Newtonian Mechanics Proficiency and Learning Gains in Introductory Physics taught in the Context of Life Sciences.

Seshu Iyengar, University of New Brunswick

At the University of New Brunswick, there are generally two flavours of introductory physics - one presented in a life science context and the other physical science context - but recently there was one offering that combined the two. We compared the learning gains of these groups using pre-instruction and post-instruction assessment of conceptual understanding of mechanics. Our results demonstrate that gains were slightly improved by the addition of life science elements into teaching and that assessment scores correlated with a variety of assessment tools beyond traditional exams.

Are Density Fluctuations Important in Heat Transport in One-Dimensional Chains?

Nicholas Barrett, Cape Breton University

Low-dimensional transport has produced a number of puzzles and unanswered questions in the past few decades. In simulation studies of one-dimensional chains an approximation is usually used which neglects the effect of density fluctuations in the chains. The regime of validity of this approximation has not been explored. We are using Lennard-Jones chains to examine what the conditions are which cause this approximation to fail.

Tagging Efficiency and Linear Polarization of the May 2015 Beamtime.

Kalli Hood, Mount Allison University

No Abstract

Acknowledgements

Organizing Committee Members

Riley Brooks

Eric Davidson

Tyler Downey

Erica Hayward

Haruki Hirasawa

Evan Kielley

Anna O’Grady

Stephen Spencer

Cole Walsh

Logo Design

Ryan Murphy

Faculty Advisors

Dr. Rick Goulding

Dr. Kris Poduska

Organizations

Memorial University of Newfoundland Dept. of Physics and Physical Oceanography

Memorial University of Newfoundland Faculty of Science

Science Atlantic

And all volunteers and judges!

Time	Friday Feb 5, 2016	Saturday Feb. 6, 2016	Sunday Feb. 7, 2016
7:00 AM		Shuttle to MUN - 7:15	
7:30 AM		Registration	
8:00 AM		Arts Atrium	Shuttle to MUN - 8:00
8:30 AM		Student Presentations	
9:00 AM		A1043 and A1046	Student Presentations
9:30 AM		Break - Arts Atrium	A1043 and A1046
10:00 AM		Student Presentations	
10:30 AM		A1043 and A1046	Break - Arts Atrium
11:00 AM		Lunch - Arts Atrium	Guest Speaker
11:30 AM			Dr. Kris Poduska
12:00 PM		Lunch and Grad Fair	Awards Ceremony
12:30 PM		IIC Lobby	IIC 2001
1:00 PM			
1:30 PM		Student Presentations	Lunch
2:00 PM		A1043 and A1046	Breezeway
2:30 PM		Guest Speaker - IIC 2001	
3:00 PM		Dr. Louise Edwards	
3:30 PM		Break - Arts Atrium	
4:00 PM		Student Presentations	
4:30 PM		A1043 and A1046	
5:00 PM			
5:30 PM		Women in Science Panel	
6:00 PM	Registration	IIC 2001	
6:30 PM	Bruneau Center Lobby	Free Time	
7:00 PM		Banquet and	
7:30 PM	Guest Speaker - IIC 2001	Guest Speaker	
8:00 PM	Christopher Stevenson	Dr. Hari Kunduri	
8:30 PM	Shuttle to Delta - 8:45		
9:00 PM		Hatcher House	
9:30 PM	George Street Tour	Dining Hall	
10:00 PM		Shuttle to Delta - 10:15	