AUPAC 2014

Saint Mary's University

Contents

Welcome

Professor Robert Thacker, Chair
Dept. of Astronomy & Physics
Saint Mary's University
Halifax, Nova Scotia
24th January 2014

Dear Attendees & Delegates,

On behalf of the Department of Astronomy & Physics at Saint Mary's University, I am delighted to welcome you all to Halifax, and the 2014 Atlantic Universities Physics & Astronomy Conference (AUPAC).

AUPAC is one of the highlights of the undergraduate calendar for physics and astronomy in Atlantic Canada. It provides a unique opportunity for students present their research, interact with peers from other universities, consider graduate school options, and also to meet some engaging guest speakers. This year we are delighted to welcome Dr Norman Murray, Dr Luigi Gallo and Dr Kevin Hewitt. As you may well know, two of those speakers are astrophysicists reflecting perhaps a small local subject bias, but then we are an astronomy and physics department after all!

Organizing a conference is a real challenge. So on a personal note, I would especially like to thank the students, staff and faculty on the local organizing committee for the hard work they've put in over the past few months, as well as for the work they'll be doing over the weekend. Don't hesitate to ask one of "the locals" if you need help or directions at any time!

I'd also like to pass on great thanks to Science Atlantic for their ongoing enthusiasm for, and sponsorship of AUPAC. Thanks are also due to the various offices at Saint Mary's that have contributed funds to make this event possible.

Even given the full conference program, I also hope that you have an opportunity to explore our diverse and vibrant communities and take in some of the beautiful local scenery. Halifax is justifiably well known for its history, culture and hospitality!

Welcome! Enjoy the Conference!

Prof. Robert Thacker

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

AUPAC 2014

Dear Participants,

On behalf of the Astronomy and Physics department at Saint Mary's University, we would like to personally welcome each of you to the Atlantic Undergraduate Physics and Astronomy Conference 2014. It's an exciting time for Saint Mary's University, as we have worked diligently towards providing not only an educational weekend, but an enjoyable one as well. We are extremely excited to meet each person attending AUPAC this year and to discuss our mutual love for physics and astronomy. These subjects are vast and incredibly exciting areas to study, and we are thankful that Science Atlantic continues to bring inspired people together in conferences such as this one.

Atlantic Canadian physics and astronomy departments are often tight-knit but open communities, where it is easy to get to know everyone. It is always exciting when many of these departments come together and share knowledge not only of different topics in physics, but also of different experiences. It is this knowledge and these experiences that will guide us toward the future, preparing us to wisely and effectively contribute to it.

During this conference, many of you will give presentations, for which we are very grateful. It is in part because of you that AUPAC is held annually, providing an opportunity for aspiring physicists to join in and become emboldened by your example.

Before we close, we would like to thank everyone who has helped make this event possible. We are grateful for the all the guidance and support we have received over the past year, and we appreciate the work so many have contributed to the organization of AUPAC 2014. Finally, we would like to extend our thanks to each of you for attending our conference and bringing your expertise to our gathering.

We hope you have a lively, enjoyable conference.

Sincerely yours,

Logan Francis, Maria Cristina Suteanu, and Kieran MacLeod

Co-chairs
AUPAC, 2014

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

President's Office
T 902.420.5401
F 902.420.5102
E president@smu.ca

To the Participants of the Atlantic Undergraduate Physics and Astronomy Conference,

On behalf of the Saint Mary's University community and the organizers and hosts of the Conference, I am delighted to welcome you to the 2014 Atlantic Undergraduate Physics and Astronomy Conference. We at Saint Mary's are very proud of the achievements of our undergraduate astronomy and physics students and are pleased that they have put together an excellent programme.

Academic conferences are always exciting and dynamic events. They bring together participants from many different universities across the Atlantic Provinces and permit not only the dissemination of ideas and research results but they can provide a catalyst for further work and collaboration. Informal networking is also a vital component and with such a talented group of students and a distinguished panel of faculty I know that the corridors will be a buzz of conversation and debate and that you will return to your studies thoroughly invigorated.

I would like to thank the sponsors of the Conference. They share our belief at Saint Mary's that undergraduate research is a critical foundation for the building of science and technology future of Canada.

I hope you all have a productive and lively conference.

Sincerely,

Dr. J. Colin Dodds
President and Vice-Chancellor

923 Robie Street • Halifax • Nova Scotia B3H 3C3 • Canada • www.smu.ca

Weekend Schedule

Friday, January 31

4:00PM – 6:30PM	Registration (table at Westin Hotel entrence)
7:30PM – 8:30PM	Speaker: Luigi Gallo (Westin Hotel Atlantic Ballroom)
8:30PM – Late	Social Activities (Gorsebrook Lounge)

Saturday, February 1

7:30AM – 8:30AM	Breakfast (Westin Hotel)
8:30AM – 9:00AM	Judges Meeting (SB159)
9:00AM – 10:30AM	Presentations (SB260, SB265)
10:30AM – 12:00PM	Tours (Burke-Gaffney Observatory, Data Cave)
12:00PM – 1:00PM	Presentations (SB260, SB265)
1:00PM – 2:00PM	Lunch (SMU) and Tours
1:30PM – 2:00PM	Science Atlantic Meeting (SB159)
2:00PM – 3:30PM	Presentations (SB260, SB265)
4:00PM – 6:30PM	Grad Fair (Westin Hotel Mezzanine)
6:30PM – 8:30PM	Banquet Dinner (Westin Hotel Atlantic Ballroom)
8:30PM – 9:30PM	Speaker: Norm Murray (Westin Hotel Atlantic Ballroom)
10:00PM – Late	Social Activities, Observatory Tours

Sunday, February 2

8:00AM – 9:00AM	Breakfast (Westin Hotel)
9:00AM – 10:30AM	Presentations (SB260, SB265)
10:30AM – 11:00AM	Coffee (SMU)
11:00AM – 12:00PM	Lunch (SMU), Judges Meeting (SB159)
12:00PM – 1:00PM	Speaker: Kevin Hewitt (SB 255)
1:00PM – 2:30PM	Awards (SB255), Departure

Tours

Tour of the Burke-Gaffney Observatory (BGO) and the Data Cave will be available on Saturday, February 1st at the following times :

BGO 10:45–11:15AM, 11:15–11:45AM, 1:15–1:45PM

BGO (night) 9:30PM–12:00AM (Weather Dependent)

Dava Cave 10:40–11:00AM, 11:00–11:20AM, 11:20–11:40AM, 11:40–12:00AM, 1:10–1:30PM, 1:30–1:50PM

The Data Cave is a three dimensional immersive environment (i.e., a "Holodeck") designed for visualizing complex simulations. The Institute for Computational Astrophysics requested the Data Cave as a part of the ACEnet proposal in order to visualize our three dimensional hydrodynamic and magneto-hydrodynamic simulations of stars and jets. Twenty minute tours will be given by Diego Casteneda during the indicated times.

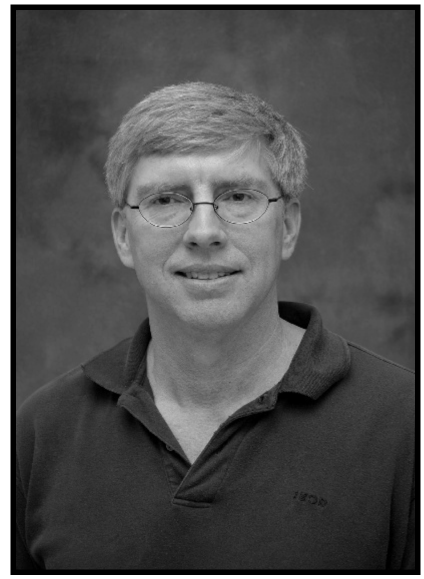
The observatory is named in honour of Reverend M. W. Burke-Gaffney , S. J (1896–1979). It is located on the top of the 22-storey Loyola residence tower, and was made possible by an anonymous benefactor who wished to honour Saint Mary's University's well-loved astronomer. Dave Lane will be conducting the thirty minute tours.

Sign up sheets will be available outside of the presentation rooms (Sobeys 260 and 265) from 8:30AM onwards on Saturday on a first come first serve basis. There are a total of 60 spots available for the observatory tour and 24 for the Data Cave tour.

Guest Speakers

Norm Murray

Institution: University of Toronto
Research Interests: Nonlinear Dynamics, Solar System Dynamics, Active Galactic Nuclei
Talk Title: Star Formation in Self-gravitating Turbulent Fluids



Abstract: I will describe a model of star formation in self-gravitating turbulent gas. I treat the turbulent velocity field as a dynamical variable, and assume that it is adiabatically heated by the collapse. The theory predicts the run of density, infall velocity, and turbulent velocity, and the rate of star formation. Unlike the case in self-similar solutions, the turbulent pressure is dynamically important at all radii, a result of the adiabatic heating powered by the collapse. The infall velocity is significantly smaller than the turbulent velocity, making the infall difficult to detect observationally. The accreted (stellar) mass grows super-linearly with time, roughly as the square of the time since the star of the collapse. The model shows that for objects with virial parameters near one, the large scale effects of gravity, not the turbulence, set the star formation rate.

Luigi Gallo

Institution: Saint Mary's University
Research Interests: Active Galactic Nuclei, Narrow-line Seyfert 1 Galaxies, Ultraluminous Infrared Galaxies
Talk Title: Approaching the Event Horizon: X-ray Observations of Supermassive Black Holes
Abstract: Active galactic nuclei (AGN) are powered by accretion of matter onto supermassive black holes. The X-rays originate closest to the black hole in an environment that is modified by extreme temperature and gravity – a region just before the material disappears beyond the event horizon. I will discuss recent enhancements in our understanding of AGN that have come about from high-quality X-ray observations. I will discuss what this tells us about the black hole environment and even about the black hole itself.

Kevin Hewitt

Institution: Dalhousie University
Research Interests: Materials Experiments, Raman Spectroscopy, Medical Imaging, Superconductivity, Combinatorial Materials
Talk Title: Molecular Imaging for Early Detection of Cancer
Abstract: The early detection of cancer has a dramatic impact on survival rates. Molecular Imaging - that is, the in vivo visualization and quantification of the molecular signatures of disease, is considered the means by which this early detection will be possible. It is considered the future of medical imaging because, rather than image the products of the molecular changes, it images the molecular markers themselves. It requires: (i) the selection of appropriate cellular and sub-cellular targets, (ii) the development of biocompatible molecular imaging probes and (iii) a molecular specific imaging modality with high spatial/temporal resolution and sensitivity. I will discuss our contributions to the latter two aspects of this interdisciplinary continuum, wherein we image a protein marker that is common to cancers of the head and neck, prostate, kidney, ovary, breast, skin, pancreas, bladder and lung. The promise and limitations of this technique will be illustrated in an interactive presentation.

Student Presentation Schedule

Saturday, February 1

	Room 1, SB260		Room 2, SB265
9:00–9:15 A01	Nathan Murtha *In-Situ Gamma-Ray Energy Calibration of the Crystal Ball Detector at the Mainz Microtron*	9:00–9:15 B17	Julia Purcell *Looking for excited states in ^{11}Li and ^{22}Ne through inelastic scattering with a solid hydrogen target*
9:15–9:30 A02	Maria Cristina Suteanu *Using Pion Photoproduction from the Proton as a Calibration Check of the CB/TAPS Detector at the Mainz Microtron*	9:15–9:30 B18	Robyn Campbell *The Use of AdS/QCD Form Factors in Rare Dileptonic $B \rightarrow K^*$ decays*
9:30–9:45 A03	Joshua Landry *Cross Section Calculations for Unpolarized Compton Scattering from the Proton near Pion Threshold*	9:30–9:45 B19	Wesley Smith *Spectroscopy of Luminescence Materials for Approximating Down-Conversion Efficiency*
9:45–10:00 A04	Scott Clarke *Timelike Virtual Compton Scattering*	9:45–10:00 B20	Sébastien Lord *The Forms of Beauty*
10:00–10:15 A05	Ryan Baker *Improving the Calibration Fitting Macro for the Crystal Ball Detector*	10:00–10:15 B21	Derek Hilchie *Bayesian Statistics: Past to Present*
10:15–10:30 A06	Jeremy Crowe *Proton Efficiency of the CB and TAPS Detectors*	10:15–10:30 B22	Wesley Bowman *Digital In-line Holographic Microscopy: Obtaining and Reconstructing Holograms*
12:00–12:15 A07	Kieran MacLeod *A Bayesian Analysis of Four Kepler Stars*	12:00–12:15 B23	Wyatt Kirkby *Orbital-Free Density-Functional Theory for an Inhomogeneous Two-Dimensional Fermi Gas*
12:15–12:30 A08	Tracy Lavoie *Photometry of Stars in Open Cluster M34*	12:15–12:30 B24	Eric Dilcher *Ultrafast adiabatic rapid passage in single InAs quantum dots*

	Room 1, SB260		Room 2, SB265
12:30–12:45 A09	Ian Roberts *Simulating double peaked meteor light curves*	12:30–12:45 B25	Simon Meynell *Quantized Magnetic Structure on the Smallest Scales: Unwinding of Nanoscale Magnetic Helices in MnSi Thin Films*
12:45–1:00 A10	Christopher MacMackin *Constraining Models of Galaxy Evolution Using Observational Data*	12:45–1:00 B26	Collin Knight *Determining the Stability of Pressure-Induced Interdigitated Phase in Bicellar Mixtures Containing Anionic Lipids*
2:00–2:15 A11	Stephen Campbell *Ruminations and Simulations: Modelling Twin Jets with ZEUS-3D*	2:00–2:15 B27	Taylor Dunn *Studying Polymer Translocation with Dissipative Particle Dynamics*
2:15–2:30 A12	Logan Francis *Simulation of Gravitationally Driven Fragmentation of a Collapsing Molecular Cloud with ZEUS-3D*	2:15–2:30 B28	Mark LeBlanc *Measuring Arsenic in Tissue using X-ray Fluorescence*
2:30–2:45 A13	Shihao Wu *Search for Dark Matter: Dark Photon and Z' Boson*	2:30–2:45 B29	Kristen Callaghan *Spectro-angular signatures of gold nanoparticles in Intralipid-based biological phantoms*
2:45–3:00 A14	Aidan Bharath *Tidal Resource Assessment in the Bay of Fundy*	2:45–3:00 B30	Logan Montgomery *Using Point Radiance Spectroscopy to Map Gold Nanoparticle Inclusions in Porcine Tissue Phantoms*
3:00–3:15 A15	Jacques Thibodeau *Pulsed laser deposition of Yb-doped Y2O3 luminescent thin films*	3:00–3:15 B31	Xiaojun Su *The effects of crowding on polymer translocation*
3:15–3:30 A16	Ashley Arsenault *The construction of infinite classes of exactly solvable potentials using supersymmetric quantum mechanics*	3:15–3:30 B32	Susan Blackmore *Measuring the Sorptivity of Mortars and Concretes Using Magnetic Resonance Imaging (MRI)*

Sunday, February 2

	Room 1, SB260		Room 2, SB265
9:00–9:15 C33	Patrick Cormier *Optimization of indium tin oxide thin films for applications in thermochromic coatings*	9:00–9:15 D38	Sophie McGibbon-Gardner *Heterogeneous nucleation of a liquid on a soluble impurity*
9:15–9:30 C34	Vickie Loosemore *The addition of nickel to an electroless copper plating solution*	9:15–9:30 D39	Connor Buhariwalla *Ice Nucleation Near the Widom Line in Simulations of Supercooled Water*
9:30–9:45 C35	Allison Sibley *Substrate Dependence of Cantilever Stress Measurements for Electroless Copper Deposition*	9:30–9:45 D40	Siobhan Morris *Coexistence of distinct liquid phases in simulations of supercooled water*
9:45–10:00 C36	Kevin Lacaille *Sifting Through Galactic Fossils: Determining the Mass of The Triangulum Galaxy (M33)*	9:45–10:00 D41	Tyler Downey *Making Stable and Monodisperse Water-in-oil Droplets*
10:00–10:15 C37	Asmita Sodhi *Monodromy in the Spherical Pendulum*	10:00–10:15 D42	Amy-Rae Gauthier *Do all students of introductory physics benefit from classroom demonstrations?*

Student Abstracts

A01 In-Situ Gamma-Ray Energy Calibration of the Crystal Ball Detector at the Mainz Microtron

Nathan Murtha

The Mainz Microtron (MAMI) electron accelerator facility based in Mainz, Germany, is being used by an international team of physicists to study properties of the proton and other nuclei. Our research group works with the A2 Collaboration at MAMI in order to utilize high-energy gamma-rays generated by the up-to 1.5 GeV electron beam as the probe to study the proton. One of the main detector systems used by the A2 Collaboration to detect gamma-rays in the final state of an induced nuclear reaction is the Crystal Ball. The Crystal Ball is a highly segmented sphere consisting of 672 sodium iodide crystals that are sensitive to gamma-rays and scintillate light proportional to the gamma-ray energy deposited in the crystal. The crystals must be properly calibrated in order to ensure the detected gamma-ray energy can be accurately determined from the generated light pulse-height data. However, the calibrations cannot be done prior to the experiment since the response of each crystal's light-detector (photomultiplier tubes) can change in time and thus must be done "in-situ" using data acquired during an experiment, and determined through offline analysis. The overall facility and beam production will be briefly overviewed before discussing the detectors being used in the experiments, including the Crystal Ball. Reasons for calibrating, and the in-situ energy calibration process, will then be addressed in more detail.

A02 Using Pion Photoproduction from the Proton as a Calibration Check of the CB/TAPS Detector at the Mainz Microtron

Maria Cristina Suteanu

At the Mainz Microtron (MAMI) electron accelerator — located in the Nuclear Physics Institute, Johannes Gutenberg University, Germany — an experimental program was conducted in December 2012 to perform high-energy Compton scattering from the proton. The experiments used a linearly polarized gamma-ray beam incident on a liquid hydrogen target. Final-state recoiling protons and gamma-rays produced in the nuclear reaction were detected in the CB/TAPS detector facility. While the research focus was on using Compton scattering to study aspects of proton structure, a sensitive calibration check of the overall detector system performance is the measurement of a better-known reaction, pion photoproduction. This presentation thus focuses on the process of extracting the unpolarized cross section for pion production. The various experimental parameters that allow selection and isolation of pion production events is illustrated with a sample of the data set: invariant mass cuts, missing mass reconstructions, timing cuts, and weighted subtraction involving missing mass plots were applied to the data, allowing identification of the number of pion production events involved. It is likewise shown how the incident luminosity can be determined at MAMI (i.e. the incident beam current, and the target density thickness—all related to the total number of reaction opportunities). Other correction factors that must be taken into account to accurately extract the pion production cross section are discussed: tagging efficiency, target thickness, and detection efficiency. Overall status of this calibration check project will be presented.

A03 Cross Section Calculations for Unpolarized Compton Scattering from the Proton near Pion Threshold

Joshua Landry

Of the four forces of nature, the Strong Force, which is responsible for binding the nucleons and nucleus together, is one of the least thoroughly understood. Devising methods for experimentally obtaining fundamental structure constants, such as the polarizibilities of the proton, has proved to be a promising approach in evaluating the various theoretical models that predict their values. The A2 Collaboration at the Institut fuer Kernphysik in Mainz, Germany, has recently conducted a Compton scattering experiment in attempt to determine these polarizibilities and a crucial step in this calculation is the computation of the cross section, which is essentially the probability of an interaction between particles. While the analysis may not be entirely complete, much progress has been made towards solving for these values.

A04 Timelike Virtual Compton Scattering

Scott Clarke

Quantum Chromodynamics is the theory used to describe the strong force that holds together the constituents of hadrons. There are two types of hadrons, baryons and mesons. The aim of the work done at the Mainz Microtron is to experimentally determine the properties of the proton, mainly, the polarizabitilies. Various reactions can be studied to obtain these values, and due to the well known electromagnetic interaction of the pair, dilepton production is very useful. Before real data is studied and analyzed, simulations need to be run to see if the reaction is a feasible one to study. My project involved programming in this new reaction into the software and will be continued by analyzing the simulations.

A05 Improving the Calibration Fitting Macro for the Crystal Ball Detector

Ryan Baker

The A2 Collaboration at the Institut fuer Kernphysik in Mainz, Germany uses the Mainz Microtron in order to examine the fundamental particles and gain insight on one of the four forces of nature, the Strong Force. Two detectors are used in their experiments, the Crystal Ball detector and the Two Arm Photon Spectrometer. This summer a relative calibration was performed on the Crystal Ball detector through the use of a radioactive source. This source produced calibration curves which are then analyzed by a fitting macro. This macro was improved over the course of the summer through the addition of a peak analysis function and added diagnostic protocols. The improved macro is now being used to calibrate the Crystal Ball detector.

A06 Proton Efficiency of the CB and TAPS Detectors

Jeremy Crowe

At JGU in Mainz, Germany the A2 collaboration makes use of accelerated electrons from the MAMI (Mainzer microtron) to conduct high precision nuclear experiments with real photons. In order to observe the outcomes of these experiments, the group makes use of the CB (Crystal Ball) and TAPS (Two Armed Photo Spectrometer) detectors. In experiments to determine the proton spin polarizabilities (a fundamental structure constant, like mass or charge) the particles of primary concern are the photon and the proton. While the CB and TAPS are very effective at accurately detecting photons, the matter of proton detection is a difficult one. In order to accurately calculate cross sections, it must be known how often a proton will be missed for a certain incident energy and recoil angle. Progress has been made to determine the proton efficiency for 2008 and 2012 data runs, but there is more work to be done.

A07 A Bayesian Analysis of Four Kepler Stars

Kieran MacLeod

Asteroseismology uses the oscillations of stars to study their structure and evolution by comparing the observed oscillation frequencies to the modes calculated from theoretical models. With this approach it is possible to obtain parameters (such as mass, age, etc.) that are very difficult to infer using other methods. Thanks to modern space telescopes such as Kepler or CoRoT, sufficient observational data has finally become available in recent years to probe stars other than the Sun in great detail. The Kepler space telescope was designed to detect Earth-like planets, but it also monitors stellar variability with unprecedented precision. However, the accuracy of traditional asteroseismic methods has been constrained by the inadequacies of stellar models, in particular of the outer layers of solar-like stars. Using a new Bayesian method to perform asteroseismic inference I investigated four Kepler targets: Kepler 21, Kepler 36, KIC 10018963, and KIC 7976303. Using a grid containing approximately 10 million models, each containing 50 to 100 oscillation modes, I determined the fundamental parameters for each of these stars.

A08 Photometry of Stars in Open Cluster M34

Tracy Lavoie

The MegaCam observations of open cluster M34 in Sloan filter I are used to perform stellar photometry. The DAOPHOT family of software developed by Peter Stetson of the Dominion Astrophysical Observatory is used for the automatic finding of object position and aperture photometry employing the point spread function. Preliminary growth curves are obtained, and the dependance of the photometric errors on the magnitude of analysed stars is determined from different HJD of observation.

A09 Simulating double peaked meteor light curves

Ian Roberts

The Canadian Automated Meteor Observatory (CAMO) (Weryk et al. 2013) detects occasional meteor events showing two distinct local maxima in their light curves. Conventional meteor theory expects meteors to produce a single-peaked light curve, making this double-peaked effect an observational anomaly. This research attempts to explain the production mechanism of these double-peaked light curves (DPLC), through the utilization of a computer model. A quartic Runge-Kutta numerical technique was used to solve the differential equations governing the evolution of important meteor parameters — ie. temperature, mass, velocity, height, and luminous intensity — with respect to time. Solving these differential equations allows for the generation of a simulated light curve. We demonstrate that a two-component dustball model, with an initial release of grains followed by a second, late, grain release, is sufficient to model our sample of DPLC well. 9 DPLC were successfully modelled for both peaks, while 1 DPLC was only modelled well for the late peak. In general the grain masses used to model the early peak were smaller than the ones used to model the late peaks. The range of grain masses used for our models was 10^{-5} kg to 10^{-12} kg. Because meteoroids are often the progeny of comets, understanding meteoroid grain structure gives insight into the conditions of the pre-planetary nebula by tracing meteoroid grains through their parent comets back to the dust making up the pre-planetary nebula. Additionally understanding the grain structure of meteoroids can help optimize satellite protection against potentially catastrophic, high velocity impacts.

A10 Constraining Models of Galaxy Evolution Using Observational Data

Christopher MacMackin

Previous work by Wurster and Thacker has compared various models of feedback from AGN (active galactic nuclei) during galactic mergers. Here, feedback refers to energy from matter accreted by the SMBH (super-massive black hole) which is returned to nearby galactic gas. Observational research has tried to determine how BHAR (black hole accretion rates) varies over the course of galactic evolution and has also looked for correlations between SFR (star formation rate) and BHAR. The focus of this summer's research was to compare the simulated SFRs and BHARs with this observational data. Due in part to differences in luminosities of the simulated and observed galaxies, the results of this comparison were, unsurprisingly, mixed. General trends were reproduced but some variances in behaviour were found, due in part to the difficulty of obtaining data for systems similar to the one simulated. However, it has become clear that plots of SFR against BHAR may be useful to track and compare the evolution of different models and simulations. Further research should include attempts to populate such a plot with simulations of many different galaxies.

A11 Ruminations and Simulations; Modelling Twin Jets with ZEUS-3D

Stephen Campbell

Astrophysical jets are long outflows of fluid emanating from either protostellar objects (PSO) or active galactic nuclei (AGN). These jets are believed to be two-sided such that opposing jets are launched from the central engine. Typically, AGN jets are on the scale of 106 light years in length and the fluid can reach speeds >99% the speed of light. In practice, the equations governing the physics of these jets need to be solved computationally. Using the magnetohydrodynamical (MHD) code ZEUS-3D, hydrodynamical calculations of twin jets were run in both 2-D and 3-D. By comparing these current simulations to previous examples it was found that the current working version of ZEUS-3D remains reliable for these types of calculations. This allows for simulations with additional physics (e.g., magnetic fields) to be undertaken in the near future.

A12 Simulation of Gravitationally Driven Fragmentation of a Collapsing Molecular Cloud with ZEUS-3D

Logan Francis

A protostar is the earliest stage in stellar evolution, an object wherein nuclear reactions have yet to begin, formed from the collapse of a gas cloud composed of molecular hydrogen and dust.

Observations show that groups of protostars are often formed in the collapse of the molecular cloud, creating multiple star systems. The process of fragmentation that divides a collapsing cloud requires modelling the physics of both gravitation and magnetohydrodynamics(MHD). The fluid dynamics code ZEUS-3D models the equations of ideal MHD required to simulate this process, while an FFT based algorithm developed for ZEUS-3D was used to model the Poisson equation for gravity. During the collapse, care must be taken to ensure that the Jean's Length of the cloud is sufficiently resolved by tracking the maximum Jean's number, which is a measure of the resolution adequacy. The roles which the intial magnetic fields, rotation, and thermal energy of the molecular cloud play in the fragmentation are investigated to identify what conditions a multiple star system may form under.

A13 Search for Dark Matter: Dark Photon and Z' Boson

Shihao Wu

The presence of dark matter suggests the possible existence of new particles, suchas weakly interacting massive particles (WIMPs). Based on Standard Model (SM), newelementary particles can be introduced as mimics of SM particles with dierent physicalparameters, such as mass and coupling. In this research a hypothetical photon mimic(dark photon) and a Z boson mimic (Z') were introduced. Depending on the consis-tence between theoretical prediction and the experimental measurements, exclusion plotswere made to represent possible physical parameters for these new particles. Theoret-ical prediction calculations were at the next leading order (NLO) loop level. In 2015, the Thomas Jeerson National Accelerator Facility (JLab) will start a new set of ultra-precision experiments following the upgrade from 6 GeV to 12 GeV, including the Mollerexperiment. The SuperB experiment is also developing at Istituto Nazionale di FisicaNucleare (INFN) in Italy as an international project. The results of the research wouldinform the experiments about the best kinematic conditions for search for these particles.

A14 Tidal Resource Assessment in the Bay of Fundy

Aidan Bharath

Tidal resource assessment is a growing industry concerned with the optimal placement of tidal turbine fields. Direct measurements of possible turbine locations are limited by the cost and time available to collect the necessary data for a full assessment. A full assessment of a location relies on numerical flow modelling to develop a larger understanding of a regions potential. Fully 3D CFD models are computationally expensive and require large amounts of simulation time to model short flow periods. Simplifying the complexity of the models increases the timescales that can practically simulated, but then raises questions of the validity of the results. An FVCOM model was used to analyze regions of interest to the tidal assessment group and the results are shown against data collected by acoustic doppler current profilers. The correlations of the flow structure measured and modelled are examined with emphasis on the maximum power that can be extracted from the tidal flows.

A15 Pulsed laser deposition of Yb-doped Y2O3 luminescent thin films

Jacques Thibodeau

Fluorescent thin films of Yb3+-doped Y2O3 were deposited on SiO2 substrates using two different pulsed laser deposition systems (standard PLD and cross-flow of oxygen to entrain the ablated particles) at various chamber pressures and beam energies of a 355 nm pulsed laser, followed by post annealing up to 1000 °C in air. The targets were comprised of a Y and Yb alloy in different proportions that react with oxygen after laser ablation. If we compare the two deposition methods, there are differences in the thin films such as different densities, stoichiometry, and luminescent efficiency. Using the standard method, post annealing is crucial to achieve crystallization, sufficient oxidation, and therefore fluorescence. The thin films could be used as a laser material for a solid-state laser.

A16 The construction of infinite classes of exactly solvable potentials using supersymmetric quantum mechanics

Ashley Arsenault

Most physicists will agree that the Schrödinger equation is the most important contribution to quantum mechanics. But it is a well-known fact that the number of cases in which it is useful is limited as the Schrödinger equation is generally quite difficult to solve. Additionally, relatively few potentials are actually exactly solvable. For these reasons, there is currently a significant amount of research being done on quantum mechanical systems which attempts to find new exactly solvable potentials.

By incorporating supersymmetric quantum mechanics, or SUSY QM (pronounced Suzy-Cue-Em), and Riccati-type equations, we can construct complicated potentials as well as their complete exact solutions. Specifically, two generalized classes of potentials were solved using this elegant technique, with infinite other possibilities to be explored. The first is known as the quantum isotonic nonlinear oscillator potential, which can be described as a harmonic oscillator with a centripetal barrier. The second is commonly known as the spiked harmonic oscillator potential, which represents a harmonic oscillator with an electron placed at the origin. These two classes each share a supersymmetric relationship with the easily solved simple harmonic oscillator potential, which is key to the SUSY QM technique for solving potentials. The Riccati equations, on the other hand, are useful in enabling the construction of promisingly complex yet exactly solvable models. The unprecedented pairing of these two concepts promises the advent of an unlimited number of new exactly solvable potentials, well beyond the two familiar (albeit more generalized than ever before) classes presented in this study.

B17 Looking for excited states in ^{11}Li and ^{22}Ne through inelastic scattering with a solid hydrogen target

Julia Purcell

The IRIS project is focused on investigating unstable isotopes that are neutron-rich or proton-rich. The first radioactive beam experiment at IRIS started this summer, investigating the two-neutron halo nucleus ^{11}Li. Because of its unique structure, lithium-11 is a Borromean system, where if one piece is disturbed, the whole system falls apart. One of the interests is to understand if the strong force, which governs the existence of elements, is capable of keeping lithium-11 momentarily in an excited state. To study this phenomenon, we will search for soft-dipole resonance(s) in lithium-11. The prediction of a soft dipole resonance postulates that the halo neutrons oscillate against the core ^{9}Li giving rise to excited state(s) of ^{11}Li. This will be done by inelastic scattering using the newly developed solid hydrogen target. In order to extract the excitation spectrum from the data we need to define the energy calibration of our detectors accurately.

In this talk, I will describe the experimental setup that was used to measure the excitation energy and how we identify the reaction channel of interest. I will discuss the importance of elastic scattering of neon-22, a stable nucleus, in the experiment and how I used it to calibrate the silicon and CsI detectors. The analysis results will show how the experiment exhibits excitation of ^{22}Ne. The success of explaining ^{22}Ne is necessary to demonstrate for understanding all features of the more challenging ^{11}Li spectrum accurately.

B18 The Use of AdS/QCD Form Factors in Rare Dileptonic $B \to K^*$ decays

Robyn Campbell

Theoretical physicists are working to model the results obtained at facilities like the Large Hadron Collider in hopes of predicting further advancements to help direct studies of fundamental particles. A critical area of research is currently in B physics; the decay of the B meson is the most promising mechanism to provide insight into some of the larger unanswered questions of the universe, like CP violation. The mathematical model used in my research, called AdS/QCD (Anti-de Sitter Quantum Chromodynamics) is derived from the relationship between the theory of the strong force and a dual gravitational theory. Using this model, form factors can be constructed, which contain all the unknowns within a bound state of quarks. These can be used to calculate differential rates of decay and ratios that can be directly compared with experimental values. After successfully testing the semileptonic and radiative decays of the form $B \to \rho$, I now study the dileptonic decay $B \to K^*$. This particular decay has very recently been supplemented with experimental data. Thus far, testing has shown AdS/QCD to compare well with both this data and lattice QCD.

B19 Spectroscopy of Luminescence Materials for Approximating Down-Conversion Efficiency.

Wesley Smith

This research project explores improving the current efficiencies of silicon photovoltaic (PV) cells by using a spectral adaption technique to overcome the Shockley-Quessier limit of 30% efficiency. In theory, this approach minimizes the amount of energy lost primarily due to a mismatch between the solar emission spectrum and spectral response of crystalline silicon to achieve efficiency nearing 40%. The reduction of these energy losses can be realized by the process of down-conversion (DC), which converts a single photon of relatively high-energy into two photons of lower energy to increase the generation of electron-hole pairs in the semiconductor. Inorganic phosphorescent materials with intentional impurities can be administered to modify pre-existing silicon PV cells. This modification increases the absorption and emission of near-infrared photons. The luminescence compounds synthesized were gadolinium vanadate and yttrium vanadate with varying dopant concentrations of ytterbium using a solid-state reaction procedure. By analyzing powder x-ray diffractions, crucial information is obtained regarding the crystal structure for comparison to accepted and theoretical crystal lattice parameters. Additionally, the effect of introducing dopant ions as replacement for the lanthanide ions in the crystal lattice can be examined. Using spectroscopic techniques, the change in quantum cutting efficiencies as a function of dopant concentration can be observed to determine which concentration yields the highest quantum efficiency (QE). Furthermore, these techniques provide information on the energetic positions of the optical transitions leading to emission of light and the energetic positions of absorption transitions.

B20 The Forms of Beauty

Sébastien Lord

High energy particle physics is a rapidly advancing field and a fertile ground to discover new-physics phenomena. In particular, the many research groups and projects surrounding the B meson, such as the LHCb, BABAR and BELLE collaboration, makes the study of the various decays of this particle very appealing to many physicists.

In this work, we examine two particular decays: the radiative B to rho gamma decay and the semileptonic B to rho lepton muon decay. This work differs from the others presented in the literature by using the AdS/QCD (Anti de-Sitter/Quantum Chromodynamics) correspondence to model the distribution amplitudes of the rho meson. The AdS/QCD correspondence maps the strong interaction between the quark and the antiquark in the rho meson to the interaction between strings in a 5 dimensional curved space. This allows us to complete the necessary perturbative calculations. Using this alternate model, we provide numerical values for the various form factors that appear in these two decays. Using our form factors, we also test the Isgur-Wise relation that relates the form factors characterizing the semileptonic decay mode to the one characterizing the radiative decay mode.

Finally, we pursue our study of the semileptonic decay by providing theoretical predictions for the total decay width in units of the CKM matrix element Vub. We then compare our results to the experimental data provided by the BABAR collaboration and various other theoretical predictions. We observe that our model does agree with experiment.

B21 Bayesian Statistics: Past to Present

Derek Hilchie

Through the years Bayesian statistics have been used in a wide variety of ways. For example, during WWII they were used to decipher the German enigma code and in the 1990's to eliminate spam email. Bayesian statistics have been around since the 1740s but only recently have they begun to be used in science. At issue has been the use of "prior knowledge", either previously-obtained data or constraints on the solution (otherwise known as "bias") in Bayesian statistics. Bayesian statistics use all the information available to identify the most probable applicable theory. This type of data analysis injects the notion of confidence levels into past data while taking in new data in to see if it fits a hypotheses.

Bayes' theorem is used in this analysis which gives the relationship between two probabilities, A & B, and the conditional probabilities of A if B happened, or B if A happened. In nuclear physics it may be possible to use this tool to determine whether a proposed theory fits obtained data. The data in this case being angular distributions of gamma rays from a nucleus and the theory of which transition the nucleus made to emit its energy. The Author will present a program, with the guidance of Dr. Austin at Saint Mary's University, to explore the possibility of combining these two areas of study and the results look promising.

B22 Digital In-line Holographic Microscopy: Obtaining and Reconstructing Holograms

Wesley Bowman

Digital In-line Holographic Microscopy (DIHM) is a type of digital holography that is one of the simplest realizations of the holographic method. This simplicity allows for inexpensive construction of a holographic microscope, and an easily obtainable hologram. In this presentation, I discuss some of the optical components needed to construct a digital in-line holographic microscope, display the holograms obtained from such a microscope, and present the numerical reconstruction of those holograms.

B23 Orbital-Free Density-Functional Theory for an Inhomogeneous Two-Dimensional Fermi Gas

Wyatt Kirkby

In this talk, I will discuss the average density approximation (ADA) as a technique to construct an orbital-free, nonlocal, kinetic energy (KE) functional for an inhomogeneous two-dimensional (2D) Fermi gas. I will demonstrate that the 2D ADA KE functional does not admit additional parameters in its denition, in contrast to the situation in 1D and 3D, where there is considerable freedom in specifying the form of the functional. I will also discuss how the ADA naturally allows us to go beyond the local-density approximation, which is otherwise not possible in 2D on the basis of a systematic gradient expansion. Finally, I will present some new ideas for improving the construction of a more accurateKE functional to be used in an orbital-free density-functional theory scheme.

B24 Ultrafast adiabatic rapid passage in single InAs quantum dots

Eric Dilcher

In the field of quantum information processing, fast quantum gates are im- portant because operations on quantum bits must be performed within their respective decoherence times. Faster qubit operations also benefit several other applications, such as decoherence control via dynamical decoupling, entan- glement operations to generate cluster states, and probabilistic gates. Optical state inversion of the p-shell exciton in an InGaAs quantum dot via adiabatic rapid passage was demonstrated using ultrafast optical pulses. We extend previous work done on the s-shell exciton by utilizing shorter optical pulses (2 ps), which provide up to a 7 fold improvement on operation speed.

The control laser pulses are resonant with the p-shell transition in InAs quantum dots. The pulses were chirped using a pulse shaper incorporating a dual-mask spatial light modulator optimized for infrared femtosecond pulses. The quantum dot sample was mounted on a nanopositioning stage inside of a continuous-flow optical cryostat, which cools the sample to 10 K during the experiment. The occupation of the final quantum state was observed from the time-averaged photoluminescence, which was detected using a monochromator and a CCD array.

B25 Quantized Magnetic Structure on the Smallest Scales: Unwinding of Nanoscale Magnetic Helices in MnSi Thin Films

Simon Meynell

The short-range interactions in MnSi produce a magnetic field that spirals up around a single direction determined by the crystal structure. Though MnSi in bulk is well understood, we have found that confining the crystal to nanoscale-sized films yields behaviour that is quite different. An applied magnetic field to this spiralling magnetic helix will cause an unwinding that occurs in discrete jumps. The quantized number of twists can be read electronically, a result that has potential applications for information storage.

B26 Determining the Stability of Pressure-Induced Interdigitated Phase in Bicellar Mixtures Containing Anionic Lipids

Collin Knight

Deuterium nuclear magnetic resonance (2H-NMR) spectroscopy experiments were performed on bicellar mixtures consisting of long and short chain phospholipids over a range of temperature and pressure conditions. These mixtures were composed of long chain lipids:deuterated 1,2-dimyristoyl-sn-glygero-3-phosphocholine (DMPC-d54) and 1,2-dymyristoyl-sn-glycero-3-phosphoglycero (DMPG); and short chain lipid 1,2-dihexanoyl-sn-3-phosphocholine at a molar ratio of 3:1:1 respectively. 2H-NMR spectra were obtained at temperatures between 8°C to 60°C and pressures up to 137.8 MPa to investigate the stability of the hydrostatic pressure induced interdigitated phase. This phase is characterized by the acyl chains of phospholipids in a bilayer crossing the midplane and becoming enmeshed within the opposing layer. Isothermal pressure cycling of a sample at 37°C and 46°C up to pressures of 125.4 MPa did not show any signs of interdigitation. Isobaric temperature cycling of a sample once at ambient pressure, then twice at 83.7 MPa produced spectra characteristic of interdigitation upon cooling the third time, demonstrating that hysteresis has a significant effect on the phase of a bicellar mixture. Increasing the temperature once the interdigitated phase had been found, the lamellar phase was reinduced. Upon slowly cooling, it was found that once the sample had interdigitated again, it did not show a perceptable amount of diffusion back to the lamellar phase, indicating metastability. By isothermal pressure cycling at 52°C up to 137.8 MPa and subsequently increasing the temperature up to 60°C, a stable interdigitated phase was found. A small decrease in pressure at these conditions showed a transition into the lamellar phase which diffused back to an interdigitated configuration over time.

B27 Studying Polymer Translocation with Dissipative Particle Dynamics

Taylor Dunn

Nanopore sequencing is a method of determining the order in which nucleotides occur on a strand of DNA, and could eventually lead to faster and cheaper sequencing of the human genome. The goal of this work is to contribute to the understanding of the dynamics of a polymer translocating through a nanopore. To accomplish this, a method called dissipative particle dynamics (DPD) was used. Unlike conventional molecular dynamics (MD) simulations, which can be very computationally expensive, DPD incorporates hydrodynamic interactions through the use of dissipative and random forces. Additionally, DPD is a coarse-grained simulation method, meaning each particle represents a group of molecules rather than single molecules. Consequently, soft conservative inter-particle interactions can be used, as opposed to the hard Lennard-Jones potential typically employed in these studies. The main focus of this project is on how the translocation time varies with different pore frictional strength and solvent quality.

B28 Measuring Arsenic in Tissue using X-ray Fluorescence

Mark LeBlanc

In the West Bengal and Bangladesh, there are currently dangerously high concentrations of arsenic in the drinking water. To deal with this environmental health crisis, we need to be able to efficiently assess the extent to which individuals have been exposed to arsenic. We have developed a low cost, time efficient method of detecting arsenic levels in tissue using a portable x-ray fluorescence (XRF) unit. We've been testing and developing this method on tissue samples of hamsters to determine its level of accuracy and efficiency. Because there is evidence that selenium interacts with arsenic and aids in its excretion from the body, we have designed our technique to measure both arsenic and selenium levels. Testing the reproducibility of measurements using this technique, we measured arsenic and selenium concentrations in the same hamsters for which a set of measurements had been obtained in the past. Between the two sets of data, we found the correlation to be 0.6–0.2 for arsenic and 0.6–0.1 for selenium. Differences in calibration between the two instances of analysis are likely to have caused a large part of the discrepancy between the two sets of data. In the future, we will use more similar calibrations in order to increase the reproducibility of measurements. The regions of the hamster which had been analyzed are currently under chemical testing in order give more accurate measurements of arsenic and selenium concentrations. Comparisons to this new data will allow us to determine the accuracy of measurements made this XRF technique.

B29 Spectro-angular signatures of gold nanoparticles in Intralipid-based biological phantoms

Kristen Callaghan

The field of biomedical optics is rapidly advancing, providing alternative methods for use in human tissue diagnostics and treatment. The effectiveness of optical imaging modalities is based upon the detection of optical properties of tissues, and the changes that occur in these properties due to disease or treatment. The current method under investigation is point radiance spectroscopy, a technique that collects light from a single direction within a small, well-defined angular cone. Consequently, radiance measurements yield information about the angular distribution of photons that cannot be obtained by the more common fluence measurements, providing point radiance spectroscopy with the potential to be used as a minimally invasive method for imaging tissues. An application of interest is imaging the prostate gland to allow for the early detection of cancerous tumours and the monitoring of tissue during therapeutic treatment. In order to have clinical relevance, the method must be able to identify as well as locate inhomogeneities in tissue. This study involves the use of point radiance spectroscopy in an Intralipid phantom, which has similar optical properties to the human prostate, to detect an inclusion consisting of gold nanoparticles. Previous research has demonstrated that the inclusion can be both identified and located in the angular domain; the current project focuses on using spectro-angular maps to analyze the distance-dependent signature of the inclusion.

B30 Using Point Radiance Spectroscopy to Map Gold Nanoparticle Inclusions in Porcine Tissue Phantoms

Logan Montgomery

Point Radiance Spectroscopy is a novel technique being implemented in the Biomedical Optics Lab at UPEI which makes use of the scattering properties of white light in biological tissues. This requires use of a source fiber which emits spherically diffuse white light and a detecting fiber which collects light in a well defined angular cone. These fibers may be placed into a biological tissue sample, in which the detecting fiber is rotated to collect light over a full 360 degree range. This technique has produced promising results which may lead to its eventual implementation in a clinical setting for prostate diagnostics and treatment monitoring. Another key component of this technique is use of gold nanoparticles which can selectively bind to cancerous lesions, and enhance the detectability of such a target via surface Plasmon resonance.

Much work has been done on liquid phantoms composed of Intralipid 1%. In this study, similar experiments were performed on solid phantoms composed of porcine muscle tissue. Basic characterization measurements were performed on several unique phantoms to determine average values of standard optical properties for porcine muscle tissue. The next step was to create a series of contours which outline the detectability of various gold inclusions inserted into a porcine muscle tissue phantom. A suite of inclusions were created using both gold nanorods and nanocages at an array of concentrations. This presentation will display this preliminary data, and explain how these results will help to inform similar experiments to be done in actual prostate samples.

B31 The effects of crowding on polymer translocation

Xiaojun Su Polymer translocation is a process in which a polymer crosses through a small channel from one side of a barrier to other side.This study not only connects to a technique for DNA sequencing, but also relates to very common process in cellular biology. For biopolymer, translocation often occurs between crowded environments. My project is to study theeffects of crowding on polymer translocation, using Monte Carlo method. The model is about a flexible and hard-sphere polymer chain cross a nanopore which is a cylindrical hole in a hard flat wall. On each side of the pore fills in crowding of obstacles which are also hard spheres. Then measured the variation of the free energy with the degree of translocation. Studied the effect of varying obstacle density on each side of the pore, found density difference causes the polymer biased in the direction of lower density which behaves like an entropic "force" effect it.The free energy functions will be used in a subsequent theoretical dynamics study of polymer translocation.

B32 Measuring the Sorptivity of Mortars and Concretes Using Magnetic Resonance Imaging (MRI)

Susan Blackmore

Sorptivity, or the tendency of a porous material to absorb or transmit water by capillarity, is crucial to understanding the durability and degradation of concretes and mortars. Gravimetric sorptivity measurements have been frequently employed to study the rate of water uptake by porous media. This method, although informative, is limited and cannot distinguish when two wetting fronts are present and progressing at different rates through the sample or when the sample has unknown initial water content. The use of Magnetic Resonance Imaging (MRI) allows for the spatial resolution of water content in the sample and provides an alternate way to measure the sorptivity. Both techniques were utilized to monitor water intake in traditional sorptivity experiments and in steady state experiments.

C33 Optimization of indium tin oxide thin films for applications in thermochromic coatings

Patrick Cormier

The thermochromic properties of vanadium dioxide (VO2) thin films, i.e. the insulator-metal transition (transparent-opaque transition), allows the creation of multiple new technologies such as temperature regulating (IR blocking) smart windows for vehicles and buildings or homes. To manually control this property, another transparent (visible to near IR), yet still conductive, film is needed. One such transparent conducting film is Indium Tin Oxide (ITO). Optical properties of ITO are controlled via thickness, other conditions of deposition and post-deposition treatment. In this work, the properties of RF magnetron sputtered ITO thin films are studied as functions of the various deposition parameters. VO2 is then deposited on top the ITO layer using the same method. The variation of the optical and electrical properties with temperature was measured by the CARY 5000 spectrophotometer and by the 4-point probe. ITO thin films with high transmittance in the desired spectrum and low resistivity are obtainable using our method. In addition, VO2 films are successfully deposited on these films and the transition of the optical and electrical properties in the desired range is successfully demonstrated.

C34 The addition of nickel to an electroless copper plating solution

Vickie Loosemore

Thin copper films have a variety of applications in modern day industry, acting as a base layer for modern day microelectronics, as such it is necessary to understand and measure the physical properties of plated copper. This experiment examines the effect of the addition of Nickel to a Ni-free electrochemical plating solution. Eight different trials with varying amounts of Nickel in the electroless bath, from 0 to 100 ppm Ni, were performed and analyzed combining both standard X-ray diffraction techniques and a conventional experiment which evaluates the bending of the substrate. Early results show that the addition of Nickel quickens deposition rates and changes the morphology of the copper crystals, as well as changing the overall stress of the copper from compressive to tensile.

C35 Substrate Dependence of Cantilever Stress Measurements for Electroless Copper Deposition

Allison Sibley

Electroless copper deposition plays a key role in the manufacturing process for the printed circuit boards used in much of today's technologies, and any stress in the deposit may cause problems with the device's functionality. In industrial settings, the stress is usually measured by observing the bending of flexible metal substrates, but for the products themselves the copper is usually deposited on insulating substrates. Because of the differences in the thermal expansion rates and the chemical makeup of the substrate types, the results from metal substrates cannot necessarily be generalized for insulating substrates. The goal of this research is to compare in-situ cantilever stress measurements on both metal and insulating substrates. For further validation, these results are both compared to x-ray based strain measurements.

C36 Sifting Through Galactic Fossils: Determining The Mass of The Triangulum Galaxy (M33)

Kevin Lacaille
Comprised of ancient stars and dark matter, the halo of the Triangulum galaxy (M33) is investigated for it's kinematic and photometric properties using both the Keck II telescope and the Canada-France-Hawaii Telescope (CFHT). Contrary to previous results, we find evidence of a low-luminosity, centrally concentrated component that suggests a higher stellar density at low radius than has been previously measured. We discuss the likelihood that our findings represent a genuine halo in M33, rather than extended emission from the disc substructure, or the result of tidal stripping during a previous interaction with the Andromeda galaxy (M31). From the velocity dispersion of the halo stars we measure the dynamical mass of M33 to be $\tilde{1}/10$ mass of M31, consistent with previous estimates.

C37 Monodromy in the Spherical Pendulum

Asmita Sodhi
The classical spherical pendulum — a theoretical system consisting of a mass at the end of a string fixed at the origin, that can move in any direction so long as the string remains taut — was conceptualized by Christiaan Huygens in the mid-1600s, but it was not until 1988 that the idea of a quantum mechanical spherical pendulum was proposed by Cushman and Duistermaat, in which angular momentum values of the system are quantized. We can look at allowed values for energy and momentum, and where we expect to produce a regular lattice, the lattice instead has deformations. These changes are related to the concept of classical monodromy. In this presentation I will introduce the mechanics of the spherical pendulum, the system's energy-momentum map, and discuss the monodromy of the system.

D38 Heterogeneous nucleation of a liquid on a soluble impurity

Sophie McGibbon-Gardner

We use computer simulations of a 2D lattice gas to study the nucleation of the liquid phase from the gas phase as triggered by an impurity particle that is soluble in the liquid phase. This process occurs naturally when, for example, liquid water droplets form in the atmosphere due to the presence of nanoscopic aerosol particles composed of salt or sulphuric acid. Using a simple lattice-based computer model, we evaluate the free energy barrier for nucleation on a single soluble impurity particle. We show that the height of the barrier depends sensitively on the solubility of the impurity, and is significantly lower than for an insoluble impurity.

D39 Ice Nucleation Near the Widom Line in Simulations of Supercooled Water

Connor Buhariwalla

In order to account for the existence of two distinct forms of glassy water (high and low density amorphous ice), it has been proposed that a liquid-liquid phase transition occurs in deeply supercooled liquid water. A critical point lies at the termination of this proposed line of phase transitions, and as with any critical point, it's effects can be felt as we step towards it by examining the maxima in response functions. The Widom line, a line of maximal isothermal compressibility, is predicted to extend from the critical point into a region of the phase diagram in which supercooled water is notoriously difficult to study experimentally, due to rapid ice crystallization. In the present work, we use Monte Carlo computer simulations of a model of water that displays a liquid-liquid phase transition to examine ice nucleation in the vicinity of the Widom line. Using biasing potentials to drive the formation of ice nuclei, we are able to study how the initial stages of ice nucleation are influenced by density fluctuations associated with the Widom line.

D40 Coexistence of distinct liquid phases in simulations of supercooled water

Siobhan Kathleen Morris

Previous work has provided evidence that the ST2 model of water exhibits a liquid-liquid phase transition in the supercooled liquid regime. The possibility of such a liquid-liquid phase transition in real water rationalizes both the known thermodynamic anomalies of water, as well as the experimental observation of two distinct amorphous solid forms of water. However, simulations of ST2 water that provide a direct observation of coexisting phases, separated by an interface, have not previously been reported. Here we carry out large-scale molecular dynamics simulations of

ST2 water, and demonstrate the occurrence of liquid-liquid phase coexistence under appropriate thermodynamic conditions. We characterize the difference in density and local structure between the two phases. We also observe the initial stages of ice formation, which preferentially occurs in the low-density liquid phase.

D41 Making Stable and Monodisperse Water-in-oil Droplets

Tyler Downey

We wish to create monodisperse and stable water-in-oil emulsions of controllable size on the micron scale using a co-flowing microfluidic technique involving the relative flow of two fluids of different viscosity in a concentric cylindrical geometry. The eventual goal of this is to study dynamics of macromolecules in confined cell-like environments. Various oils, such as silicone oils and hexadecane, have been the subject of experiment. Size and polydispersity can be varied by altering the fluid viscosities and the ratio of flow rates. In addition, the cylinder diameters and surface chemistry are very important. The stability of these droplets (against coalescence into larger drops) is controlled both by the type of oil used as well as the surfactant used. It has been found that the success of a surfactant in stabilizing droplets varies widely, depending on the oil chosen. A combination of oil and surfactant that yields both monodispersity and stability of droplets is the goal of this research.

D42 Do all students of introductory physics benefit from classroom demonstrations?

Amy-Rae Gauthier A well-done physics demonstration is entertaining, however several studies (Crouch et al 2004 [1], for example) have shown that only certain styles of classroom demonstrations help students' understanding. These studies, however, do not consider that students from different disciplines may think and learn differently. In this study, three different physics courses are considered: Physics for the Physical Sciences, Physics for Health and Life Sciences, and Physics for Engineers. In each class, identical demonstrations were presented and students completed identical pre-demonstration and post-demonstration questionnaires. Comparing gains from these questionnaires for each class provides insight into the differences between sets of students. Qualitative data were also collected by conducting interviews and focus group discussions. Combining qualitative and quantitative data paints a more complete picture of whether students in different disciplines benefit differently from classroom demonstrations.

Graduate Fair Participants

Dalhousie University

Guelph Waterloo Physics Institute

Nova Scotia Community College

McGill University

McMaster University

Memorial University

Ottawa Carleton Institute for Physics

Queen's University

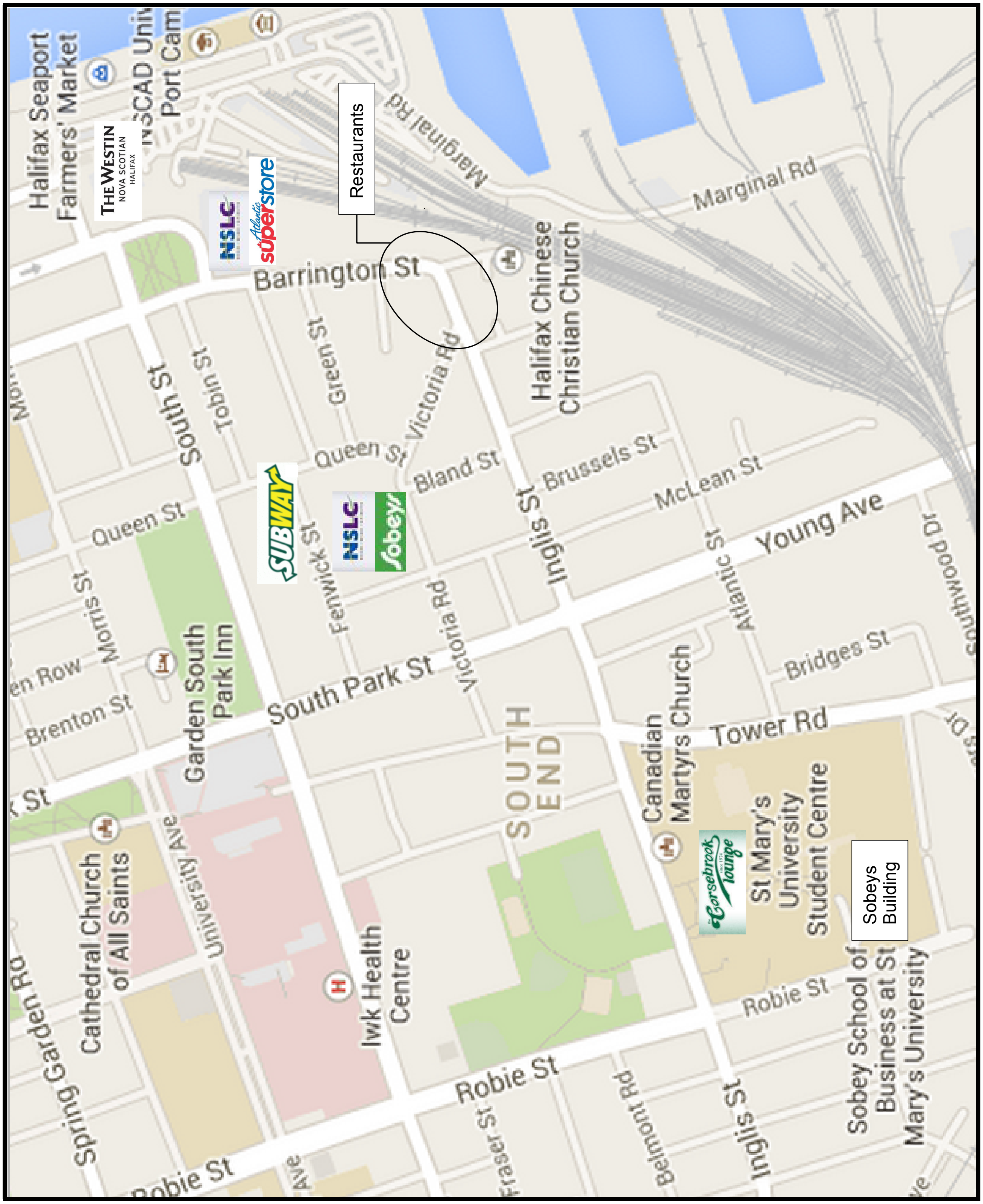
Saint Mary's University

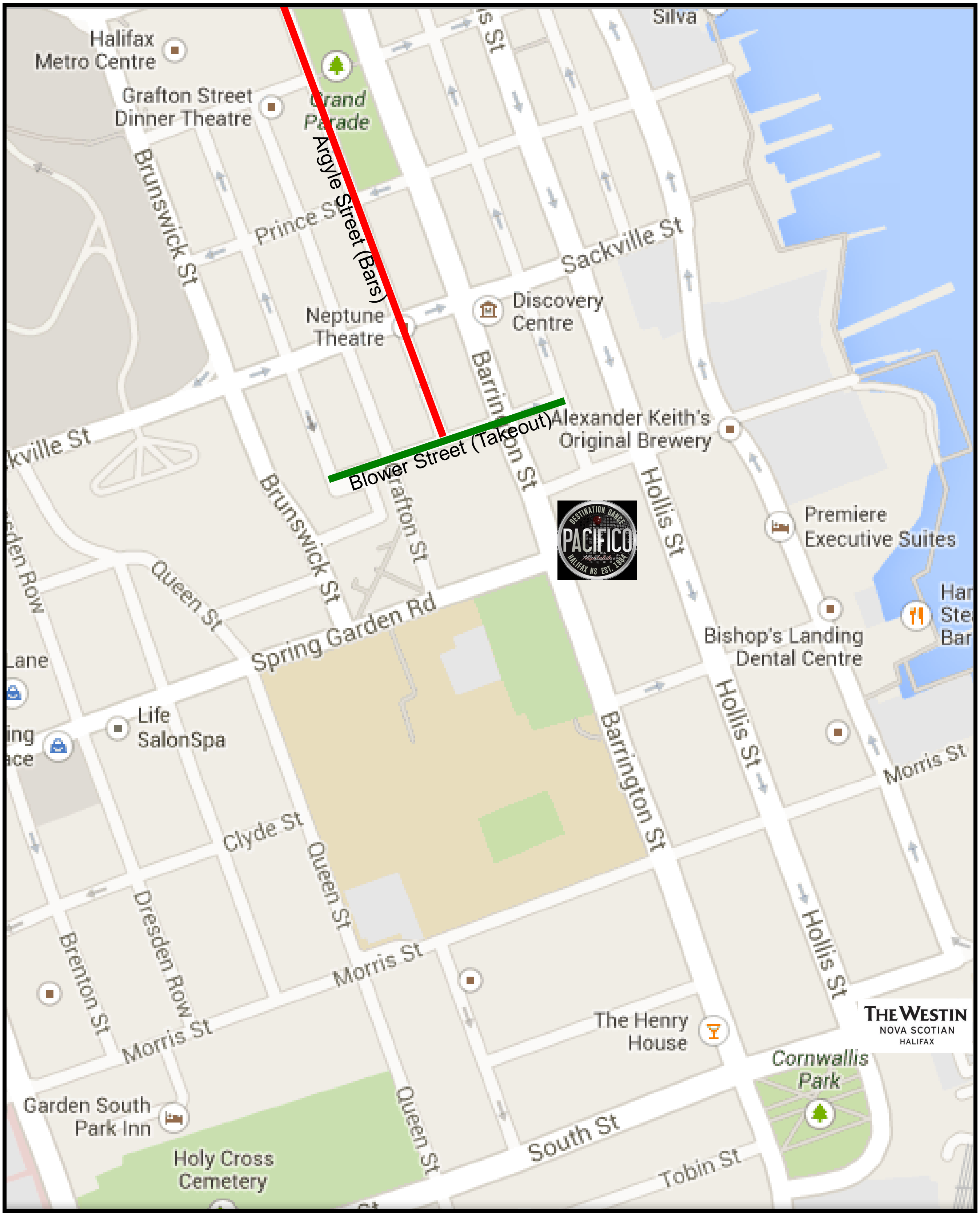
University of Saskatchewan

University of Toronto

Western University

Maps


Restaurants
Sobeys Building
Halifax Seaport Farmers' Market
The Westin Nova Scotian Halifax
Barrington St
Marginal Rd
Halifax Chinese Christian Church
South St
Tobin St
Green St
Victoria Rd
Queen St
Bland St
Brussels St
McLean St
Inglis St
Young Ave
Atlantic St
Fenwick St
Morris St
Garden South Park Inn
South Park St
Brenton St
Bridges St
Tower Rd
Southwood Dr
SOUTH END
Canadian Martyrs Church
St Mary's University Student Centre
Gorsebrook Lounge
Cathedral Church of All Saints
University Ave
Spring Garden Rd
Iwk Health Centre
Robie St
Fraser St
Belmont Rd
Sobey School of Business at St Mary's University

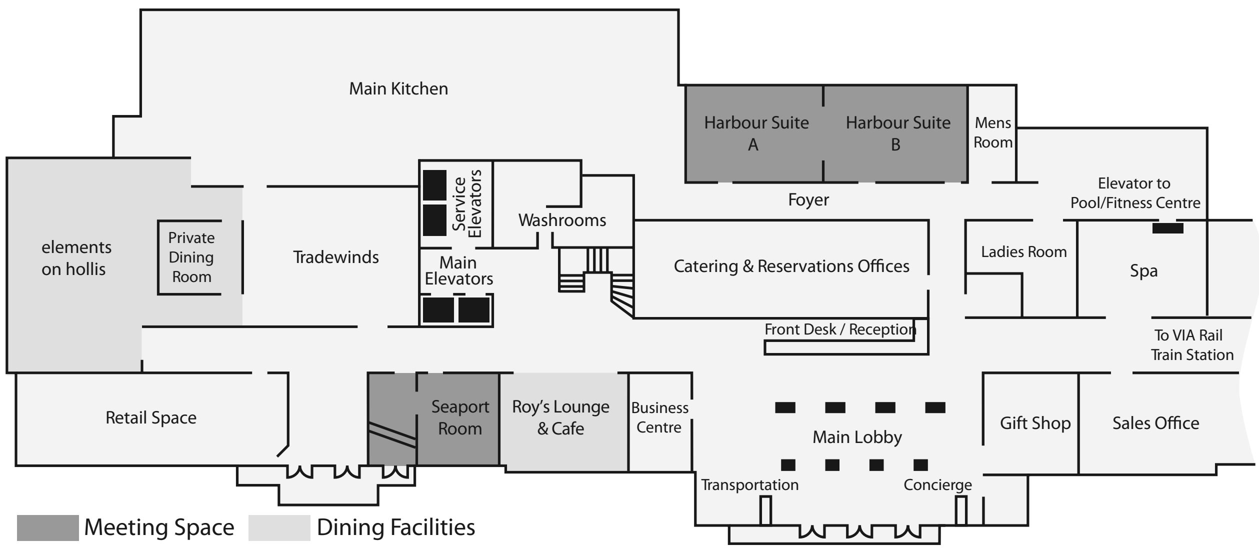


Argyle Street (Bars)
Blower Street (Takeout)
PACIFICO
Halifax Metro Centre
Grafton Street Dinner Theatre
Grand Parade
Brunswick St
Prince St
Sackville St
Discovery Centre
Neptune Theatre
Barrington St
Alexander Keith's Original Brewery
Hollis St
Premiere Executive Suites
Queen St
Spring Garden Rd
Bishop's Landing Dental Centre
Life SalonSpa
Clyde St
Morris St
Dresden Row
Brenton St
The Henry House
Cornwallis Park
Garden South Park Inn
Holy Cross Cemetery
South St
Tobin St
Silva
THE WESTIN NOVA SCOTIAN HALIFAX

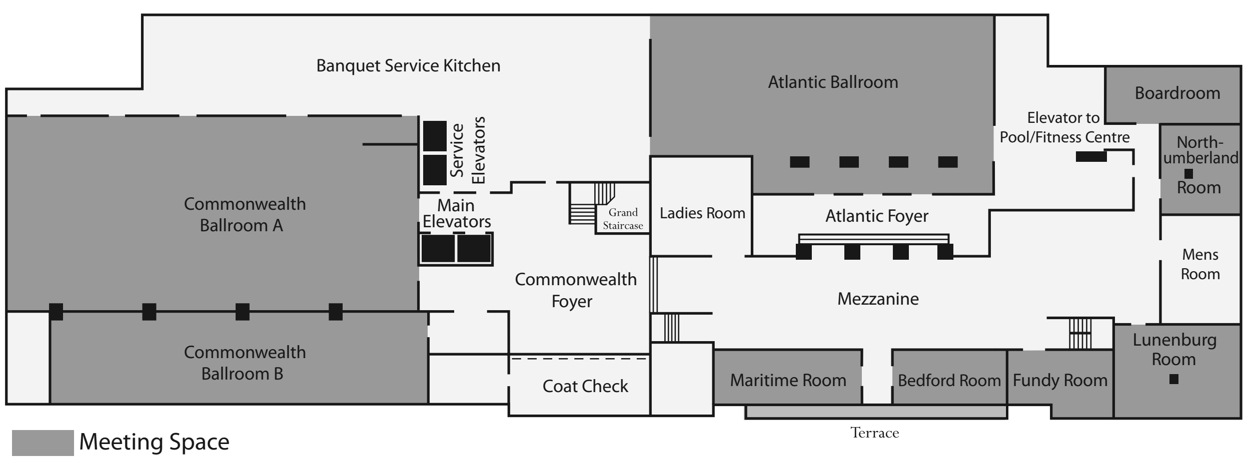
westin nova scotian

property floorplans

lobby level
ground floor



conference level
first floor

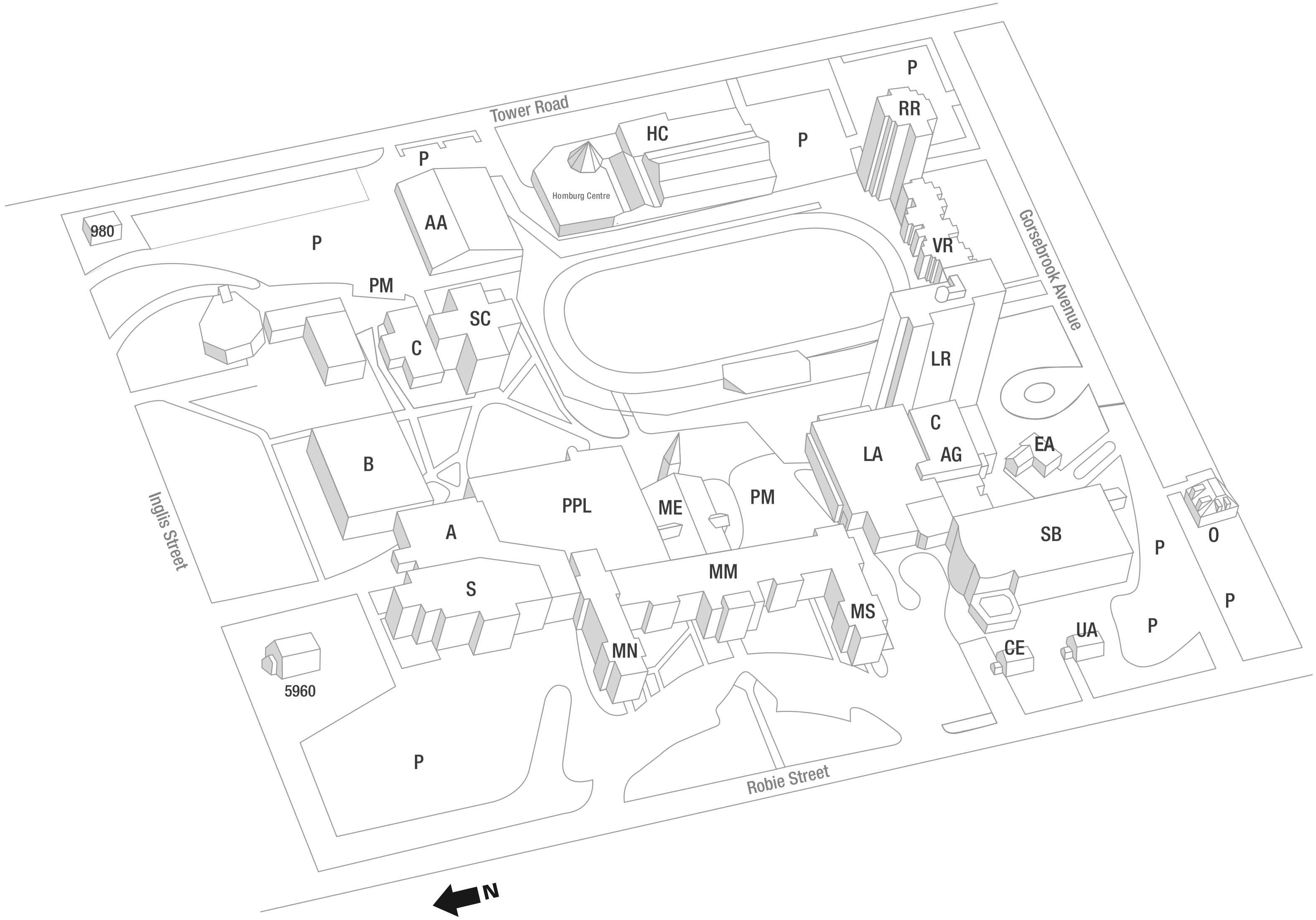


THE WESTIN
NOVA SCOTIAN
HALIFAX
thewestinnovascotian.com
902.421.1000

Saint Mary's University Since 1802

One University. One World. Yours.

CAMPUS MAP



NE Campus Construction

A	Atrium	**LA**	Loyola Academic Complex	**P**	Parking	**HC**	Homburg Centre for Health and Wellness
AA	Alumni Arena	**LR**	Loyola Residence	**PM**	Parking Meters	**UA**	Development/Alumni
AG	Art Gallery	**ME**	McNally East Wing	**PPL**	Patrick Power Library	**VR**	Vanier Residence
B	Burke Building	**MM**	McNally Main	**RR**	Rice Residence	**980**	TESL Centre
C	Cafeteria	**MN**	McNally North Wing	**S**	Science Building	**5960**	Gorsebrook Research Institute for Atlantic Canada Studies
CE	Continuing Education	**MS**	McNally South Wing	**SB**	Sobey Building		
EA	External Affairs	**O**	The Oaks/International Activities	**SC**	O'Donnell Hennessey Student Centre		

All main buildings are wheelchair accessible and most are connected by tunnels or walkways.

Acknowledgements

SAINT MARY'S UNIVERSITY SINCE 1802

One University. One World. Yours.

ASTRONOMY & ∫MU PHYSICS SOCIETY

Science Atlantic Atlantique