# Colloquia Abstracts 2010-11

SUBJECT TO CHANGE! Be sure to check back often.

## Friday August 27

**Dr. Bob Gehrz** University of  Minnesota The Stratospheric Observatory For Infrared Astronomy (SOFIA)

## Friday September 10, 10:00 am, AT 101

**W. Beslin, D. Roberson, A. Mott, S Campbell, A. Valencik, P. McLeo** d Saint Mary's University *Undergaduate Symposium*

## Friday September 17, 3:00 pm, AT101

**Dr. Eduard Vorobyov**  Saint Mary's University

*Embedded protostellar disks around (sub-)solar stars. The Dark Ages of disk evolution and the planet formation perspective.*

I will present my vision of the earliest stages of the evolution of protostellar disks which are difficult to probe with modern telescopes due to obscuration of light by natal cloud cores. To take a glimpse at these Dark Ages of disk evolution, I employ numerical hydrodynamic simulations that start from a starless cloud core and terminate when the core has accreted onto a forming star+disk system. I show that the path along which a young stellar object moves is largely determined by the initial properties of the parent cloud core. Objects formed from low-angular-momentum and low-mass cores proceed along a rather calm path showing a low-amplitude variability caused by mild disk instability. On the contrary, objects formed from high-angular-momentum and high-mass cores exhibit high-amplitude variability, disk pulsations, and fragmentation. Most of the forming fragments are quickly driven into the disk inner regions and (likely) onto the star, triggering intense FU-Orionis-like luminosity outbursts. If dust sedimentation in the fragments is fast enough, some of them may survive the rapid inward migration and form terrestrial planet cores on close orbits. A small fraction of the fragments may form gas giants and settle on wide orbits around the central star.

## Friday September 24, 3:00pm, AT101

**Dr. Brigitte Vachon** McGill University

The ATLAS experiment is a complex detector designed to study the fragments from the highest energy particle collisions in the world. The Large Hadron Collider (LHC) at CERN has recently started producing proton collisions at a high center-of-mass energy thereby recreating extreme conditions thought to have existed a mere fraction of a second after the Big Bang. The data collected by the ATLAS detector allow physicists to study the fundamental constituents of nature and their interactions at an unprecedented distance scale where new physics phenomena are expected to appear.

The current status of the Large Hadron Collider and the ATLAS experiment will be described. Recent results from the investigation of these high energy proton collisions will be presented. Future work will also be described.

## Friday October 1, 3:00pm, AT101

**Dr. David Gray** University of Western Ontario *Some History and Understanding of Spectral-Line Asymmetries*

When we seek to understand stars, where the surface is not resolved, spectral-line asymmetries prove to be a powerful tool. Starspots and patches, pulsation, granulation, and giant convection cells all signal us with asymmetric Doppler shifts that result in asymmetric line profiles. You are invited to join me in some sleuthing and detective work into the fascinating world of stellar physics.

## Friday October 8, 3:00pm, AT101

**Dr. Wolfgang Mittig** Michigan State University *Nuclear Power and Global Energy Problems*

Nuclear power plants produce 17% of the electricity worldwide. Nuclear energy production is discussed in the global context of world oil peaking and concerns about green house gas (GHG) emission and global warming. Possible evolutions of nuclear power plants in this context are described. Besides electricity production, a major challenge is the substitution of the presently used liquid fuel mainly for transportation by other means. Timescales for evolution of production methods are long, in a rapidly changing context of resources and GHG problems. Many subjects need research mostly of strongly interdisciplinary character.

## Friday October 15, 3:00pm, AT101

**Dr. Daniela Calzetti** University of Massachusetts *The quest for SFR measurements from the UV to the Infrared*

Nearby galaxies are the benchmark against which we compare the properties of distant galaxies and the best laboratory for learning about the physics of star formation and the gas-stars cycling. Star formation is the prime mechanism driving the evolution of the luminous component of galaxies across cosmic times, yet much of the underlying physics governing it is poorly understood. One of the current problems is understanding how to measure star formation rates on sub-galactic scales. I review the current issues, covering from the UV to the infrared, including recent progress enabled by the Spitzer Space Telescope, by the GALEX mission; I will also present some preliminary results from the Herschel Space Telescope. I will place these results in the context of future developments in the field, where the exploitation of existing and new/future facilities like HST, JWST, the Large Millimeter Telescope and ALMA, will be key to address some of the extant issues.

## Friday October 22, 3:00pm, AT101

**Dr. Matthew Browning** CITA *Convection and Magnetism in Stars: problems, perspectives, and predictions*

Magnetic fields are ubiquitous in astrophysics. In stars, they help govern spindown and mass loss; in accretion disks, they probably play a critical role in facilitating angular momentum transport; for some planets, they can act as partial shields against potentially harmful radiation. But a comprehensive theory of how astrophysical magnetic fields are built, through the action of a magnetic "dynamo," remains elusive. I will talk about how recent 3-D MHD simulations, together with observations of stellar magnetism, are providing powerful new clues about the operation of astrophysical dynamos.

## Friday October 29, 3:00pm, AT101

**Dr. Dipankar Maitra** University of Michigan *New evidence for relativistic jet outflows even from the faintest black holes*

The mode of accretion onto black holes and neutron stars with extremely low luminosities is still an open and hotly debated question. At lowest luminosities, e.g. below 10^{-6} times the Eddington luminosity, it is not even clear whether the observed emission from the immediate vicinity of the black hole is originating in an inflow or an outflow. A full understanding of the accretion flow at lowest luminosities is required to understand X-ray binaries and active galactic nuclei. It would also provide crucial constraints on the formation and propagation of relativistic jets, and would generally enable us to test physics in the regime of strong-field relativity. I will discuss results of recent radio and mm-wave VLBI experiments which strongly suggest the presence of a relativistic outflow in Sagittarius A*, the Galactic Center black hole. Moving down the mass ladder, I will present results from Spitzer and long term ground-based optical/near-IR monitoring data of the stellar black hole X-ray binary system A0620–00, which also points toward the presence of a jet at luminosities ~10^{-8} of the Eddington luminosity. Finally, I will present new results from an ongoing project to model the broadband spectral energy distribution of the Seyfert-1 galaxy NGC 4051 in an effort to constrain disk–jet coupling in moderately luminous active galactic nuclei.

## Friday November 5, 3:00pm, AT101

**Dr. David Gilbank** University of Waterloo *Cosmic star-formation as a function of galaxy stellar mass since z~1*

Motivated by suggestions of ‘cosmic downsizing', in which the dominant contribution to the cosmic star formation rate density (SFRD) proceeds from higher to lower mass galaxies with increasing cosmic time, we have recently completed a survey aimed at directly exploring for the first time the star-formation activity in low mass galaxies (8.5< log Ms <9.5) at z~1. I will present results from ROLES (the Redshift One LDSS-3 Emission line Survey) which, combined with other higher mass surveys, has measured the cosmic star-formation rate density (SFRD) as a function of stellar mass at z~1. By comparison with a local sample drawn from the SDSS (which is also used to assess the calibration of our SFR indicators), we find that the SFRD has decreased equally for galaxies of all stellar masses over half the age of the Universe.

## Friday November 12, 3:00pm, AT101

**Dr. Elizabeth Griffin** HIA *Investigating the Earth's ozone using almost-abandoned astronomical data*

Learning about the history of the Earth's ozone and firming up on the causes of its recent decline can be half the battle to repair the damage done. However, historic ozone measurements lack the high precision of today's experiments, nor do they provide a very global view of the overall situation. Any fresh sources of information that may strengthen that aspect of our knowledge are therefore in demand. Archives of stellar spectra represent a substantial, and in some ways highly usable, ozone resource but have to date been almost entirely neglected for that purpose (and even for astronomical research too). The talk will describe a first major effort to apply almost-abandoned astronomical data to ozone research, and will outline an initiative to grapple with problems of neglected data ("data at risk") in other fields of science as well.

## Friday November 19, 3:00pm, AT101

**Dr. Ranjan Vasudevan** University of Maryland *New Perspectives on the Luminous Power Output of AGN*

Active galactic nuclei (AGN) are amongst the most powerful objects in the Universe, powered by accretion of matter onto supermassive black holes at the centres of galaxies. Understanding their energy output provides valuable insight into accretion processes and the AGN environs. X-rays are produced from the hottest, innermost regions close to the black hole and are thus an excellent probe of strong gravity. Additionally, the X-ray background is made up of emission from AGN and therefore provides a useful signature of past supermassive black hole (SMBH) accretion responsible for producing the mass buildup seen in SMBHs today. However X-rays only represent a few per cent of the total accretion output of AGN, which peaks in the optical/UV so knowledge of the broad-band spectral energy distribution (SED) is important in determining the full energy budget. Dusty gas surrounding the AGN absorbs part of the optical-to-X-ray accretion emission and re-emits it in the infrared; this further complicates scaling between X-rays and the bolometric output. I will present numerous studies addressing these issues, touching on related fields such as the effect of AGN radiation pressure on the immediate surroundings and host galaxy, determining the absorption distribution in the AGN population as a whole and the observed relationships between UV and X-ray emission in AGN.

## Friday January 7, 3:00pm, AT101

**Dr. Rob Thacker** Saint Mary's University *A Vision for Canadian Astronomy 2010-2020*

Canadian astronomy has come far in the first decade of the new Millennium. But will this success be continued? What facilities do we need to maintain the level of research excellence achieved in the past? What space missions should we be involved in? Could Canada even lead a large-scale space telescope development? To address these questions the Canadian Astronomical Society commissioned the development of the 2010 Long Range Plan (LRP) for Canadian astronomy. LRP2010 was lead by Chris Pritchet of the University of Victoria and outlines the priorities for Canadian astronomy over the coming decade. LRP2010 was released for community comment in December 2010 and will be presented to the government early in 2011. In this colloquium I'll outline the priorities chosen by the panel for Canadian astronomy, and compare them to both the European "ASTRONET" plan and American decadal plan "Astro2010". If funded, LRP2010 will usher in an entirely new era of discovery in Canadian astronomy.

## Friday January 14, 3:00pm, AT101 (Cancelled)

**Dr. Evgenya Shkolnik** Carnegie Institute of Washington *Star-Planet Interactions: The Tidal and Magnetic Influence of Hot Jupiters on their Host Stars*

A giant planet orbiting its star within 10 stellar radii lies within the star's Alfven radius, allowing direct magnetic interaction with the stellar surface. According to our observations and models, these interactions strongly affect both the stellar and planetary magnetic fields, possibly influencing the magnetic activity of both bodies and modifying irradiation and non-thermal and dynamical processes. In addition, strong tidal interactions between the hot Jupiter and its star will increase the stellar rotation rate as well as the global stellar activity level, provided that the planet migrated early on in the system's history. Studying the tidal and magnetic interactions in such planetary systems builds our understanding of the formation, migration and evolution of both large and small planets in these systems, and provides the best-available probe of exoplanetary magnetic fields.

## Friday January 21, 3:00pm, AT101

**Dr. Robert Rutledge** McGill University *Observations of Neutron Stars and the Cold Dense Matter Equation of State*

Our Universe offers no laboratories to study cold, dense matter at and above nuclear density, save one: the neutron star. In precisely the same way that black hole horizons are unique sites to study strong gravity, the cores of neutron stars are unique sites to study cold dense matter. Much progress has been made recently by observational astrophysicists in inventing and refining techniques toward characterizing the matter in the core of the neutron stars. I will describe this progress, and describe the future work which can lead in the next decade to a holy grail of nuclear physics: the cold dense matter Equation of State.

## Friday January 28, 3:00pm, AT101

**Dr. Luigi Gallo** Saint Mary's University *Astro-H: the mission, the science, and Canadian participation*

Astro-H is a Japanese-led X-ray observatory set to launch in early 2014. The Canadian Space Agency has just recently committed to participating in the mission by developing the metrology system. During this talk I will discuss the mission, science objectives, and the Canadian contribution.

### Friday February 4, 3:00pm, AT101

**Dr. Kipp Cannon** CITA *Gravitational-Wave Astronomy and LIGO*

Gravitational waves are a prediction of general relativity, they are distortions of spacetime emitted by the movement of mass and energy. One of the strongest sources of gravitational waves today is likely to be the collision of a pair of black holes or other massive compact objects. Although the existence of this form of radiation has been inferred indirectly, the direct detection of a gravitational wave has not yet been achieved. LIGO is one of several observatories around the world that have been constructed to search for gravitational waves. 4 km long and yet capable of measuring displacements of their test masses of just 10^{-19} m --- less than 1/1000th the diameter of a proton --- the LIGO antennas live at the boundary between classical and quantum mechanics. In this talk I will give an introduction to what we hope to learn from the observation of gravitational waves, I will talk about the detectors we are using to search for them, and how the effort to find these faint signals is leading to advances in digital signal processing that you might even find on your own cell phone.

## Friday February 11, 3:00pm, AT101

**Dr. Helen Russell** University of Waterloo *X-ray observations of shock fronts in merging galaxy clusters*

Shock fronts generated by galaxy cluster mergers provide a key tool for studying the intracluster medium. X-ray observations of these fronts reveal the kinematics of the merger and can be used to study the transport processes and conditions in the cluster gas, including electron-ion equilibrium and thermal conduction. Combining X-ray observations of merging clusters with weak gravitational lensing has also produced crucial evidence for the existence of dark matter. However, unambiguous detections of shock fronts are rare and only two have previously been found, those in the Bullet cluster and Abell 520.I will review these discoveries and present Chandra observations of the galaxy cluster Abell 2146 which has revealed two Mach 2 merger shock fronts and a gas structure remarkably similar to the Bullet cluster. The subcluster is preceded by a bow shock, indicating it passed through the primary core only 0.1-0.3 Gyr ago, and in addition, there is a slower upstream shock propagating through the outer region of the primary cluster. Based on the measured shock Mach numbers and the strength of the upstream shock, I will argue that the mass ratio between the two merging clusters is between 3 and 4 to one.

## Friday March 4, 3:00pm, AT101

**Dr. Robert Deupree** ICA, Saint Mary's University *Model Comparison to the Oscillation Frequencies of the Rapidly Rotating Star Alpha Oph*
The rapidly rotating, nearby, delta Scuti star Alpha Oph has been observed interferometrically with the CHARA array and photometrically with MOST. The interferometric data substantially reduce many of the uncertainties related to the star¡¦s rotation, such as the amount of rotation and the inclination between the rotation axis and the observer, while the 56 oscillation frequencies should provide significant constraints on the internal structure of the star. I will discuss some aspects of the data, along with one model which best fits the data. Despite the complexity of the oscillation solutions, some scaling relationships exist, and it is possible to glean some basic information from the computed oscillation spectrum.

### Special CAP Lecture
### Monday March 7, 2:30pm, AT305

**Dr. James Stoltz** Queens University *Controlling Quantum States using Earthquakes*
The high quality of nanostructured materials enables the routine fabrication of systems in which the dynamics are particles is governed by quantum mechanics. Not only can a great deal of physics be probed in a robust solid state environment, but the possibility of using these materials for quantum information processing has sparked a great deal of research worldwide. One caveat of such systems is that once they are fabricated, the system itself becomes a static structure that cannot be changed. To make a dynamic structure, nano-earthquakes in the form of surface acoustic waves (SAWs) can be applied resulting in time-varying fields to control the motion and dynamics of particles in quantum structures. In particular, I will discuss how SAWs can control and enhance the coherence of electron spins in semiconductor systems as well as how SAWs can control the emission of single photons from quantum dot structures.

## Friday March 11, 3:00pm, AT101

**Dr. Alfredo Estrade** Saint Mary's University-GSI *Studying neutron stars in the laboratory with unstable isotope experiments.*

One of the main driving forces behind the study of exotic isotopes is the important role they play in several astrophysical scenarios. This talk will describe experiments to measure masses and nuclear density distribution of neutron rich isotopes, and their application to the physics of neutron stars. Nuclear process in the crust of accreting neutron stars represent a heat source for the star that influence observables such as cooling curves or the so called carbon superbursts. The masses of very neutron rich isotopes determine the location of these electron capture transitions, and partially the energy they release. I will present results from a time-of-flight mass measurement of neutron rich isotopes in the Sc to Ni region that allowed us to put experimental constraints on the location of all heat sources in the outer crust of systems exhibiting superbursts. In the second part of the talk I will describe our recent experimental effort to study nuclear density distributions by proton elastic scattering from unstable Ni isotopes. Such measurement can be used to constrain the equation of state of nuclear matter, which is essential to understand the mass-radius relation of neutron stars. In particular, we expect to constrain the density dependence of the symmetry energy (parameter L) in the equation of state.

## Friday March 18, 3:00pm, AT101

**Dr. Richard Townsend** University of Wisconsin *Ghostly Impostors: The Magnetospheres of Massive Stars*

On the main sequence, massive stars lack the envelope convection zones that generate magnetic fields in the Sun and other cool stars. Nonetheless, since the 1970s it has been known that a small subset harbor global-scale, kG-strength fields. Driven by the advances in instrumentation over the past three decades, this subset continues to grow.

Although the origin of the fields remains a mystery, significant progress is being made in understanding how they interact with massive stars' hypersonic, radiation-driven winds. At sufficiently high strengths, the fields channel wind streams into violent collisions, in which shock-heated gas generates the characteristically hard X-ray emission seen in Chandra and XMM-Newton observations. The subsequent centrifugal confinement of the post-shock gas in a co-rotating magnetosphere naturally explains much of the periodic variability seen in magnetic massive stars across the entire electromagnetic spectrum.

In this talk, I will present some recent highlight of my group's ongoing theoretical and observational research into massive-star magnetospheres. Topics shall include new magnetohydrostatic and magnetohydrodynamic models for the distribution of magnetospheric plasma, capable of reproducing a wide variety of observables; the direct detection of magnetic braking in two specific objects; and progress in understanding the mechanisms responsible for setting an upper limit on magnetospheric masses.

## Friday April 1, 3:00pm, AT101

**Dr. Doug Johnstone and His Amazing Balloon Animals**
HIA *Contemplating the Low Mass Star Formation Road Map to ALMA*
Coordinated multi-wavelength surveys of nearby molecular clouds provide strong constraints on the physical conditions within low-mass star-forming regions. In this manner, Perseus and Ophiuchus have been exceptional laboratories for testing the earliest phases of star formation. Highlights of these results are (1) most of the mass of the cloud is at low column density, (2) dense cores form only in high column density regions, (3) the mass distribution of the dense cores is similar to the IMF, (4) dense cores contain only a few percent of the cloud mass, (5) the more massive cores are most likely to contain embedded protostars, and (6) the kinematics of the dense cores and the bulk gas show significant coupling. In this talk, I will mention each of these important results and attempt to place them in context with theoretical models and simulations of star formation. I will then consider how ALMA might be utilized to further our understanding, and the route between the present and planned molecular cloud surveys and the start of ALMA observing.

## Friday April 8, 3:00pm, AT101

**Dr. Guy Savard** Argonne National Lab *CARIBU: a new facility to study isotopes along the astrophysical r-process path*

The r-process is responsible for the formation of roughly half of the heavy chemical elements. It occurs in explosive astrophysical scenarios and proceeds via neutron capture on short-lived neutron-rich radioactive isotopes. The properties of these isotopes are critical to understanding this process but they have been essentially non-amenable to study up until now. The just completed CAlifornium Rare Ion Breeder (CARIBU) upgrade to the ATLAS superconducting linac facility is providing improved access to these isotopes. It utilizes newly developed technology to provide low-energy and re-accelerated beams of neutron-rich isotopes obtained from 252Cf fission. The fission products from a 252Cf source are stopped in a large gas catcher, thermalized and extracted through a radiofrequency quadrupole cooler, accelerated to 50 kV and mass separated in a highresolution separator before being sent to either an ECR charge breeder for post-acceleration through the ATLAS linac or to a low-energy experimental area. This approach gives access to beams of very neutron-rich isotopes, many of which have not been available at low-energy previously, and provides unique opportunities for key studies along the r-process path.

The various components of CARIBU were initially tested using a weak Cf source and the final commissioning of the whole facility with a 100 mCi source was recently completed. A brief description of the facility, insisting on the new technical developments that have made possible the rapid and efficient species-independent extraction and preparation, will be presented together with commissioning and first physics results. An overview of the planned nuclear structure and astrophysics physics programs will also be given.