Physics Department Special Seminar

Chiara Mingarelli
School of Physics and Astronomy, University of Birmingham, United Kingdom

Date: Tuesday, September 3, 2013

Time: 3:30pm

Location: HP4351

Abstract:

DESCRIBING ANISOTROPY IN THE GRAVITATIONAL WAVE BACKGROUND WITH PULSAR TIMING ARRAYS

Pulsar Timing Arrays are currently the only way to search for gravitational radiation in the nanohertz band. The main sources of interest are gravitational wave backgrounds generated by supermassive black hole binaries or processes in the early universe. Several limits on this background have been set in recent years and searches of increasing sensitivity are currently ongoing. All the searches so far have only been done for isotropic backgrounds. However, a level of anisotropy may be present in the background radiation, and if a stochastic signal is detected it is important to characterise its power at different angular scales. We decompose a generic anisotropic background into spherical harmonics and compute and characterise the overlap reduction functions for any pulsar pair, which is an essential element for the evaluation of the likelihood function used in searches.

Joint Ottawa-Carleton Institute for Physics (OCIP) Seminar

Dr. Robert Boyd
Professor of Physics
University of Ottawa and University of Rochester

Date: Tuesday, September 17, 2013

Time: 3:30pm

Location: HP4351

Abstract:

Research in Quantum Nonlinear Optics

Nonlinear optics is a venerable branch of photonics and optical physics, dating back certainly to 1961 or even earlier. Nonetheless, the field of nonlinear optics has recently experienced a renaissance by means of its application to problems in quantum information science and quantum optics. In this talk, I first present a very

rapid overview of the development of the field of nonlinear optics and then move on the survey some areas of recent research interest.

One such example is research in “slow” and “fast” light. Research performed over the past several years has demonstrated new methods for controlling the velocity of propagation of light pulses through material systems. Ultra slow velocities (tens of meters per second) and ultra fast velocities (including negative velocities) have been demonstrated. This talk will present an overview of the field of slow and fast light and will include a discussion of some new ideas for applications of fast and slow light based on the use of room temperature solids.

Another topic of great current interest is that of quantum imaging. Image formation making use of quantum states of light allow dramatic new possibilities in the field of image science. We review some of the conceptual possibilities afforded by quantum imaging and describe some recent work that displays some of these features. In addition, we present some new experimental results on the role of coherence and indistinguishability in determining the properties of two-photon interference.

Nelson Miksys, Richard Wassenaar and OMPI social event

Nelson Miksys and Richard Wassenaar

Date: Thursday, September 26, 2013
Time: 3:30 - 5 pm
Location: Room HP4351, Herzberg Building, Carleton University

Abstract:

Presentations:

1. "Patient-specific Monte Carlo dosimetry for permanent implant brachytherapy"

Nelson Miksys – *Carleton University*

Abstract: Dose distributions for permanent implant brachytherapy can be more accurately calculated with Monte Carlo (MC) simulations than with the widely-used TG-43 water-based approach because tissue heterogenieties and inter-seed attenuation effects are considered. However, challenges remain in the application of MC in brachytherapy, e.g., the mitigation of streaking artifacts (due to brachytherapy sources) in CT images and the ambiguous assignment of

tissues and densities when deriving patient-specific MC phantoms from CT images. This work addresses these challenges, presents results on patient-specific artifact-corrected CT- based MC dosimetry for prostate and breast brachytherapy, and paves the way for clinical application of patient-specific MC dosimetry.

2.“Device Design and Security of Radioactive Sealed Sources”

Richard Wassenaar – *Best Theratronics*

Abstract: Radioactive sealed sources are common worldwide, filling a wide variety of roles, including medical usage. Due to the activity of these sources, the potential for harm to the general public is high, should the sources fall into the wrong hands and be used maliciously. Due this potential threat, there has been increased attention, at the international level, related to the security of such sources. In fact, the CNSC has recently issued new regulatory document pertaining to the security of Category 1 and 2 (high risk) sealed sources. Within this framework, manufacturers plan an important role in ensure devices are designed to meet security requirements. Best Theratronics has been actively working with various regulatory and government organizations to redesign their radiation devices with the goal of greater security in mind. In this talk, the results of that work, including the challenges faced by manufacturers and end-users, will be discussed.

The talks are followed by a social gathering at McLauren's Pub: 301 Elgin Street Ottawa, ON K2P 2N9 (**map**) Time: 6-11 pm.

Physics Department Seminar

Dr. Alain Bellerive

Professor of Physics
Carleton University

Date: Tuesday, October 1, 2013

Time: 3:30pm

Location: HP 4351

Abstract:

A personal historical perspective on the Sudbury Neutrino Observatory

The Sudbury Neutrino Observatory (SNO) was a water Cherenkov detector dedicated to investigate elementary particles called neutrinos. It successfully took data between 1999 and 2006. The detector was unique in its use of heavy water as a detection medium, permitting it to make a solar model-independent test of solar neutrino mixing. In fact, SNO conclusively showed that solar neutrinos oscillate on their way from the core of the Sun to the Earth. This groundbreaking observation was made during three independent phases of the experiment. Even if data taking ended in the mid-2000, the Carleton SNO group has been in a mode of precise determination of the solar neutrino oscillation parameters for several years thereafter. All along SNO had developed several methods to tell charged-current events apart from neutral-current events. This ability is crucial for the final and ultimate data analysis of all the phases. The physics reach of a combined three-phase solar analysis will be reviewed together with results and subtleties about solar neutrino physics. The publication of the three-phase paper has been finalized in July 2013, thus making the three-phase analysis the conclusion and the final results from the Sudbury Neutrino Observatory. This presentation will give a personal historical perspective of the involvement of the Carleton group in the SNO program.

Physics Department Seminar

Dr. Philippe Di Stefano

Associate Professor of Physics
Queen's University

Date: Tuesday, October 15, 2013

Time: 3:30pm

Location: HP4351

Abstract:

CDMSLite and the Search for Dark Matter

The mystery of dark matter - most of the matter in the Universe only appears through its gravitational interactions - has been open since 1933. Particle physics may provide a solution in the guise of exotic new particles beyond the Standard Model. Since the 1980s, efforts have been under way to detect such particles directly in detectors on Earth. Over the past decades, sensitivities of these experiments have improved thanks to detectors able to identify the majority of the radioactive background masking the very rare expected signal. As various experiments report intriguing events

that could be interpreted as low-mass dark-matter particles, we present recent results from the CDMSLite experiment (**http://arxiv.org/abs/1309.3259**), and describe work to understand possible backgrounds coming from mechanoluminescence in solid-state devices (**http://arxiv.org/abs/1305.3644**).

Matt Rodrigues and Dan La Russa

Date: Thursday, October 24, 2013
Time: 3:30 pm
Location: Room RPB 205B (boardroom), Health Canada, 775 Brookfield Road
Abstract:

1. "An automated high-throughput method of the cytokinesis block micronucleus (CBMN) assay for dose estimation in radiation biodosimetry"

Matthew Rodrigues - Carleton University

Abstract: The cytokinesis-block micronucleus (CBMN) assay is employed in biological dosimetry as a method for determining the dose of radiation to an exposed individual from the frequency of micronuclei (MN) in binucleated lymphocyte cells. The assay is typically performed using manual microscopy but it would be advantageous to automate the method to allow for increased throughput. With the development of new technologies such as the ImageStreamX, an imaging flow cytometer, it is now possible to adapt the CBMN assay to an automated imaging cytometry method. The ImageStreamX has adequate sensitivity to quantify radiation doses to within ~0.5 Gy while adding the increased throughput of traditional flow cytometry. The protocol and analysis which adapts the CBMN assay for use on the ImageStreamX will be presented as well as recent results which indicate that binucleated cells (BNCs) and MN can be identified, imaged and enumerated automatically using the ImageStreamX, allowing for dose estimation.

2. "Quality and safety initiatives in radiation therapy at the Ottawa Hospital Cancer Centre"

Daniel La Russa - *The Ottawa Hospital Cancer Centre*

Abstract: This presentation will review some of the recent updates to the quality management of the Radiation Medicine Program at The Ottawa Hospital Cancer Centre (TOHCC). Emphasis will be put on the use of Failure Mode and Effect Analysis (FMEA) and the use of Statistical Process Control (SPC) in the context of a modern radiation therapy treatment process. Examples of the use of these

techniques at TOHCC will be presented along with a overview of some device-centric quality control tests of our IMRT/VMAT treatment processes. A project underway to develop free, open source software for quality control of radiation therapy treatment plans will also be described.

Physics Department Seminar

Dr. Robert Brandenberger

Professor of Physics
McGill University

Date: Tuesday, November 5, 2013

Time: 3:30pm

Location: HP4351

Abstract:

Searching for Cosmic Strings in New Observational Windows

Cosmic strings are predicted in many models beyond the Standard Model of particle physics. In models which admit strings, a network of strings will inevitably be formed in a phase transition in the early universe and will persist to the present time. Strings leave behind distinctive features in cosmology. Searching for these signatures in new observational windows provides a way to constrain particle physics at the high energy scale and is thus complementary to searches for new physics at the low energy end, for example at the LHC. Specifically, I will discuss signatures of cosmic strings in cosmic microwave background polarization maps and in 21cm redshift surveys.

Joint Ottawa-Carleton Insitute for Physics (OCIP) Seminar

Dr. Alan A. Madej

Researcher, Frequency and Time Group, Measurement Science and Standards Portfolio
National Research Council of Canada

Date: Tuesday, November 19, 2013

Time: 3:30pm

Location: HP 4351

Abstract:

Moving Beyond the Current Limits of Time: Single Ion Optical Atomic Clocks and the Quest for the Ultimate Isolated Quantum System

The last few years have seen a revolution in ultra-accurate measurements of optical atomic transitions using highly coherent laser light. By gently holding a single atomic ion using an electro-dynamic trapping field, we can approach as close as possible the ideal situation of an isolated and unperturbed quantum system. Our team has realized an optical frequency reference at 445 THz (674 nm) based on a single atomic ion of strontium. In this talk, we will describe our results that include the resolution of spectral features at the 4 Hz level (1 part in 10^{14}) together with the evaluated accuracies of this system that exceed by an order of magnitude the best current realizations of the SI second. At this level of accuracy, it is possible to measure the distortion of local time due to Earth's gravitational field by changes of the clock height at the sub-meter level. Some comments will be made as to what we expect these improvements to yield in terms of sensitive tests of relativity and the ultimate limits of measuring time in the laboratory.

Frank Marshall and Tong Xu

Date: Thursday, November 21, 2013
Time: 3:30 pm
Location: Conference room A&B, Room C2362, 2nd floor, Cancer Centre South , The Ottawa Hospital (General Campus)

Abstract:

1. "Reconstruction of a Distributed Radioactive Source with a Directional Spectrometer"

Frank Marshall - *Carleton University*

Abstract: The Emergency Response Group at Natural Resources Canada is responsible for developing innovative techniques of reconstruction for localizing and mapping radioactive sources. In one area of research, the group is has been in joint collaboration with Defense Research and Development Canada (DRDC) to determine novel techniques for mapping radioactive distributed sources (RDDs). Over the past two years, Medicine Hat in Suffield, Alberta has provided the testing grounds for several experiments, in which lanthanum-140 sources were detonated. In these experiments, a directional spectrometer was used to record the spatial variation of the source intensity. It consists of four, tightly-packed, NaI detectors. It was mounted on a truck and driven around the source distribution. From this survey, the limited data of points along the truck path leave much information to be extracted regarding the true source distribution. This talk will review some of

the methods that are employed to approximate the local intensity in the vicinity of the trucks path. In particular, there will be a review of the method used to determine a factor that converts the measured signal into an intensity measurement for the case of the detector overlying an infinite disc source. This method makes use of a curve of counts versus disc radius, which is called the detector footprint. Results of EGSnrc simulations will be presented for this calculation, as will results of detector parameter simulations.

2. **"A GPU implementation of EGSnrc"**

Tong Xu - *Carleton University*

Abstract: As an effort to enable accurate and fast Monte Carlo simulation for potential clinical use, the physics core of the well accepted Monte Carlo simulation package, EGSnrc, was implemented on the parallel computing platform based on GPU, Graphics Process Units. With hundreds of processors integrated in one cost effective board, GPU has recently shown great potential on high performance computing, including Monte Carlo simulations. An introduction to the concept of GPU computing will be given. The simulation structure of EGSnrc was changed to achieve better performance on GPU. Through the simulation of PDDs and dose profiles, the newly developed GPU based system was benchmarked and validated against the original EGSnrc.

Physics Department Seminar

Dr. Jeff Lundeen

Assistant Professor
University of Ottawa

Date: Tuesday, November 26, 2013

Time: 3:30pm

Location: HP 4351

Abstract:

The search for Fock: Generating, manipulating, and detecting single photons Over the past fifteen years, experimentalists have made great progress in producing modes of light that contain a single photon. These photons have been used to test the foundations of physics, carry information for quantum algorithms and communication, and reach the fundamental bounds of measurement. This talk will describe improvements we have made in these photons in order to create the next generation of experiments and devices. Specifically, I will discuss two methods for generating single photons: Spontaneous Parametric Downconversion and Quantum Dot Photoluminescence. I will

then give an example of quantum metrology, in which we manipulate these photons to build multiphoton entangled states useful for enhanced precision measurements. Lastly, I will tackle the other end of the equation, photon detection, and describe new kinds of photon detectors and a method for completely characterizing them without needing to know how they work: Detector Tomography.

Physics Department Seminar

Dr. Jens Dilling

Research Scientist
TRIUMF

Date: Tuesday, December 3, 2013

Time: 3:30pm

Location: HP4351

Abstract:

Understanding the universe, one rare isotope at a time

Many questions in understanding the universe remain at the centre of forefront research; such as how and where the chemical elements in the universe are created? the life and death of stars, or the nature of stability (why are some atoms stable and some decay ?), what is the nature of neutrinos? These questions are intimately related to our fundamental understanding of the atomic nucleus, and the interactions of the particles within. Recent progress in theory as well as experimental techniques and access to rare isotopes are at the very center in getting closer to answering these questions.

One of the premier facilities for rare isotopes is the ISAC complex at TRIUMF, Vancouver, Canada. The isotopes are produced, often only in minuscule quantities, and with half-lives as short as few milliseconds, hence the name rare. To overcome the research obstacles of rare isotopes and extract information about the atoms and their fundamental interactions dedicated instruments are required. We have developed very sensitive and fast methods using ion trap techniques at TITAN (TRIUMF's Ion Trap of Atomic and Nuclear science). The ion traps are employed to measure atomic masses, using one single ion in as short as a 1/100 of a second with 10 parts per billion precision, breaking a world-record for precision mass spectroscopy. From the atomic mass, the binding energy of the constituents can be extracted, via $E= mc^2$ which entails all effective forces in the nucleus. In this talk I will report on theses measurements and how they relate to answering the big questions, what we have

learned, and where we stand. I will also give an overview of the science program at ISAC, its status and future plans.

Special Department Seminar

Dr. Dave Besson

Professor
University of Kansas

Date: Thursday, December 5, 2013

Time: 3:30pm

Location: HP4351

Abstract:

Ultra-High Energy Cosmic Ray Detection

I'll introduce experiments recent and techniques which seek to measure ultra-high energy cosmic rays (E>100 PeV). Since the flux of these particles is so small, techniques require large instrumented areas in obscure corners of the globe, far from the backgrounds caused by "civilization" (Siberia, Antarctica, and Utah in the US)

Martin Martinov, Peter Raaphorst

Date: Thursday, December 19, 2013

Time: 3:30 pm

Location: Foustanellas Auditorium (room H-2367), second floor, The University of Ottawa Heart Institute. 40 Ruskin st, Ottawa, On K1Y 4W7

Abstract:

1. "Recent developments with BrachyDose"

Martin Martinov - *Carleton University*

Abstract: This presentation will review the work done for and with BrachyDose in CLRP recently. It will look over a Graphical User Interface (GUI) made for the upcoming distribution of BrachyDose. The GUI has the same functionality as most of the other EGSnrc user-code GUIs wih some additional features. It will give an overview of a graphical reimplimentation of StatDose with additional functionality as well. Then it will cover an analysis of several different eye plaque models used in ocular melanoma treatments, building on the work done creating an eye model in CLRP this previous year.

2. "The Physics and Quality Control of Clinical Bone Mineral Density Programs"

Peter Raaphorst - *Carleton University*

Abstract: A serious problem in the aging process is the loss of bone minerals resulting in osteoporosis. This causes the bones to become weak a brittle and susceptible to fracture and breaking. Spinal and hip fractures can lead to severe debilitation and to death in the elderly. The rate of bone mineral loss varies between genders and amongst individuals. Early detection of bone mineral loss can lead to intervention and the delay of osteoporosis. Differential x-ray absorptiometry (DXA) can be used to detect bone mineral loss. This is a quantitative x-ray procedure that requires a high level of precision. In order to achieve this precision a quality control process has been developed to allow detection of bone mineral loss in the spine and the hip with precision as low as 0.5%. The physics and quality control of DXA will be described and examples of serious errors that were incurred when a QC program is not followed will be presented.

Physics Department Seminar

Dr. Paul Corkum

Professor
University of Ottawa and National Research Council

Date: Tuesday, January 21, 2014

Time: 3:30pm

Location: HP4351

Abstract:

Attosecond Pulses and High Harmonic Spectroscopy

The talk will introduce the extreme nonlinear optics that underlies attosecond pulse generation, pointing out ways that isolated attosecond pulses can be selected from the train of attosecond pulses that constitute high harmonics. It will then show how we can characterize attosecond pulses in both space and time. Finally, drawing on the close connection between optical and electron measurements, the talk will show how measurement can be generalized from measuring attosecond XUV pulses to characterizing molecular orbitals and their changes during a photochemical dissociation.

Elizabeth Orton, Sangeeta Murugkar and winter special event

Elizabeth Orton and Sangeeta Murugkar

Date: Thursday, January 23, 2014

Time: 3:30 - 5 pm

Location: Room RPB 205B (boardroom), Health Canada, 775 Brookfield Road

Abstract: Presentations:

1. "Automated detection of extra-cardiac interference in Rubidium-82 PET myocardial perfusion imaging"

Elizabeth Orton - *Carleton University*

Abstract: In nuclear cardiology, myocardial perfusion imaging, MPI, is used to reflect the heart muscle's regional blood supply and it is widely applied for diagnosis and risk stratification of coronary artery disease. MPI studies produced with PET and the radio-labeled cardiac perfusion tracer rubidium-82 chloride, Rb-82, frequently show tracer uptake not only in the myocardium but also in the stomach wall and spleen. When the proximity of these structures to the myocardium is combined with local cardiac and respiratory motion and the spatial resolution of the imaging modality, the result can be an unknown amount of extra-cardiac signal contributing to the area of the image designated as myocardium. An estimated 10% of Rb-82 PET MPI studies suffer from extra-cardiac interference that impacts clinical image interpretation. An algorithm for quickly and consistently detecting extra-cardiac interference in Rb-82 PET MPI will be presented, along with validation of the algorithm against 100 expert-read studies, and finally, algorithm-based prevalence results from 2560 Rb-82 PET MPI studies from the 2011 - 2012 University of Ottawa Heart Institute database.

2. "Optical Molecular Imaging in Biomedicine"

Sangeeta Murugkar - *Carleton University*

Abstract: Optical molecular imaging (OMI) couples optical imaging with different methods of enhancing chemical contrast at the molecular level. It promises to revolutionize the field of medicine due to its comparatively lower cost, high sensitivity and resolution combined with minimal toxicity. The development and applications of a label-free OMI technique based on coherent anti-Stokes Raman scattering (CARS) will be discussed in this talk. I will describe the design and implementation of the first fiber-optic miniaturized multimodal CARS microscope for the in vivo study of spinal cord disorders in small animals. I will share my vision of label-free OMI based on this technology for early disease detection in the clinic.

The talks are followed by an evening skate on the Rideau canal, ending with a social gathering at the Royal Oak at pretoria bridge (**map**). Please RSVP to Elizabeth Orton (Eorton [at] ottawaheart [dot] ca) if you'll be joining us for skating and/or meeting us at the pub.

Physics Department Seminar

Dr. Nathan Churchill

Research Fellow
Rotman Research Institute, Baycrest Center for Geriatric Care

Date: Tuesday, February 11, 2014
Time: 3:30pm
Location: HP4351

Abstract:

Optimizing image processing pipelines in BOLD fMRI

BOLD fMRI (Blood-Oxygenation Level Dependent functional Magnetic Resonance Imaging) measures the changes in blood oxygenation that are correlated with neuronal activity. This versatile technique is widely used in experimental neuroscience, and shows potential as a clinical tool. However, fMRI is a relatively noisy imaging modality, with complex, subject-dependent noise sources, including the effects of head motion and physiology. This poses a significant challenge for fMRI analyses, particularly for studies involving complex tasks, and aging or clinical populations, as these groups require brief scanning times to ensure compliance, and tend to have increased noise effects.

Researchers typically apply a fixed sequence of image processing algorithms to fMRI data (a “pipeline”), to control for noise effects. However, there is no literature consensus on the optimal processing choices, and few studies provide benchmarks to justify their pipelines. Moreover, there is a growing body of literature demonstrating that signal and noise effects vary as a function of subject and experimental task; hence, a single fixed pipeline will produce sub-optimal signal detection for many subjects. In this talk, I will review some of the issues that underlie preprocessing in fMRI and standard preprocessing techniques. I will then discuss our approach for optimizing preprocessing choices in BOLD fMRI, which uses data-driven statistical criteria of (1) spatial reproducibility of activated brain regions, and (2) prediction accuracy on independent datasets. This

approach significantly improves signal detection in fMRI data, particularly in brief clinical task designs.

Physics Department Seminar

Dr. Gerd Leuchs

Professor
Max Planck Institute and Visiting Professor University of Ottawa

Date: Tuesday, February 25, 2014

Time: 3:30pm

Location: HP4351

Abstract:

Evidence at low energies for high energy particles?

– a speculation on the quantum vacuum –

We speculate about a so far unexplored link between the experimental parameters governing the propagation of light in vacuum and the properties of the quantum vacuum. These thoughts may also be

relevant for the running fine structure constant.

Simin Razavi, Jason Belec and winter special event

Date: Thursday, February 27, 2014

Time: 3:30-5pm

Location: Carleton University - Herzberg Building - Room HP4351

Abstract:

1. "Distortion and efficiency studies of Positron emission tracking system (Pe-track)"

Simin Razavi - *Carleton University*

Abstract: Following the steps for the development of positron emission based 3D tracking (PeTrack), the co-registration of PeTrack with an x-ray C-arm imaging system showed an uncounted systematic error. Identification of the source of systematic error is essential in order to correct it. One of the possible sources of error could be the spatial distortion of tracking. Several simulations have been done using a Monte Carlo Software (Gate) to investigate the detection efficiency and the spatial distortion. We tracked the raster scanning of a positron source in different detector planes

within the field of view. The results show that the distortion at the edge of the planes is increasing when the distance of the planes get farther from the iso-centre of the modules. Meanwhile an experiment has been done tracking a positron source in the real time, using an X-Y plotter to provide the scanning motion. The results from simulation and experiment were compared.

2. "Modeling continuous motion in radiation therapy using Monte Carlo techniques: from breathing interplay effect to tomotherapy leaf latency"
Jason Belec - *The Ottawa Hospital Cancer Centre*

Abstract: Recent advances in external photon beam radiation therapy techniques include increase in the number of degrees of freedom and continuous change of several machine parameters during treatment delivery (field shape, dose rate, tumor tracking, etc.). In this talk, we will give three clinical examples where the use of Monte Carlo techniques was useful to model continuous motion and overcome limitation of commercial clinical systems. The examples are: 1) total marrow irradiation treated with helical tomotherapy, 2) Head and neck treatments treated with helical tomotherapy and 3) stereotactic ablative lung treatments treated with volumetric modulated arc therapy.

The talks are followed by an evening skate on the Rideau canal, ending with a social gathering at GuadalaHarry's at Dow's Pavillion (**map**). Please RSVP to Elizabeth Orton (Eorton [at] ottawaheart [dot] ca) if you'll be joining us for skating and/or meeting us at the pub.

Physics Department Seminar

Dr. Lothar Lilge
Professor
Princess Margaret Cancer Centre, University Health Network and University of Toronto

Date: Tuesday, March 4, 2014
Time: 3:30pm
Location: HP4351

Abstract:

Photodynamic Therapy applied to brain cancer

Brain tumours (glioblastomas) remain very difficult to treat. Post diagnosis, the life expectancy is about 14 months with the 5 year survival rate being essentially 0. This is despite surgical resection,

chemotherapy and radiation therapy. Photodynamic therapy (PDT) has been investigated as a therapeutic approach to treat cancer since the 1980's with widely varying success only to reemerge as a study object after 2005. The renewed interest is based on the understanding for the need of advanced treatment planning and real time dosimetry using various concepts. Some recent reports have shown that a surprisingly high percentage of patients with glioblastoma, survive past 24 months when treated with PDT, even in cases considered previously inoperable.

In this presentation we will cover reasons for previous failures, recent success stories and the need to develop treatment planning protocols for light based therapies. Additionally technical avenues for the quantification of the PDT dose, dependent on its definition are presented. In the final section of the presentation, co-therapies to improve the therapeutic ration of PDT will be presented.

Physics Department Seminar

Dr. Brooks Thomas
Research Associate
Carleton University

Date: Tuesday, March 11, 2014

Time: 3:30pm

Location: HP4351

Abstract:

Title: "Physics Enters the Dark Age"

Abstract: "Almost all of the matter that we're familiar with in our everyday lives is made of protons, neutrons, and electrons. However, one of the most shocking realizations of the past century is that the vast majority of the matter in the universe is actually made of something else entirely --- something so mysterious it has been dubbed "dark matter." Research in this area sits at the border between high-energy physics, astrophysics, and cosmology, and physicists are very excited that we are now entering a pivotal decade when we will finally be able to "see" this dark matter and understand its properties. In this talk, I will review the history of dark matter, explain why we believe it exists, and the outline the diverse experimental and theoretical approaches that physicists are currently taking towards shedding light on dark matter and finally cracking this mystery."

Department of Physics Seminar

Caroline Boudoux
Associate professor
Department of Engineering Physics, Ecole Polytechnique de Montreal
Date: Tuesday, March 18, 2014
Time: 3:30pm
Location: HP4351

Abstract:

Single fiber endoscopy

Endoscopy has changed modern medicine by allowing physicians explore inner organs with minimal trauma. Single fiber endoscopes offer the potential to further increase patient comfort and increase access to remote organs through miniaturization. Current research focusses on sub-milimeter endoscopy using dedicated optical fibers for imaging large volumes of tissue. One such fiber - a double clad fiber - allows many imaging modalities to be performed simultaneously for greater diagnostic sensitivity and specificity. In this presentation, I will present our latest research in fiber optics for miniature endoscopy and discuss potential avenues, including theragnostics: the capability to treat a lesion as you see it.

Hong Shen, Gerd Melkus

Date: Thursday, March 20, 2014
Time: 3:30 - 5:00 pm
Location: West Foustanellas Auditorium (H-2366) - 2-nd floor - The University of Ottawa Heart Institute, 40 Ruskin Street

Abstract:

1. "The NRC Wide-Angle Free-Air Chamber"

Hong Shen - *Carleton University/NRC*

Abstract: NRC is setting up a national primary standard to calibrate radioactive seeds for low dose-rate brachytherapy. A commercial wide-angle free air chamber (WAFAC), based on the design pioneered by NIST, was introduced recently for measurement of air kerma strength of the seeds. In order to test the performance of the chamber, it was set up in a low-energy X-ray beam (effective energy of 31 keV) where the air kerma rate has been established using the existing NRC air kerma standard. Excellent agreement of the air kerma rate obtained with the WAFAC using the same aperture opening as the primary standard free-air chamber (FAC) validates the proper functioning of

this new instrument. Measurements were also carried out for a range of WAFAC apertures, including the 80 mm aperture used for seed measurements. The results show the importance of including air scatter corrections for large aperture openings. Preliminary measurements with 125I seeds give results that are consistent with the stated seed activity. Work is ongoing to establish the correction factors and uncertainty estimates.

2. "Development and application of biochemical MRI methods for Musculoskeletal Research"
Gerd Melkus - *The Ottawa Hospital*

Abstract: Osteoarthritis and lower back pain are two major diseases which are linked to the degeneration of cartilage and adjacent tissues such as subchondral bone. Non-invasive imaging techniques can help understand articular cartilage and cartilage repair tissue. Recent developments in the field of Magnetic Resonance Imaging (MRI) can be used to characterize these tissues not only morphologically, but also biochemically. In this presentation, the concepts of quantitative MRI methods (gagCEST, T1rho and Diffusion Tensor Imaging) will be discussed. Moreover, pre-clinical and clinical applications will be shown where biochemical MRI can be used to visualize non-invasively the composition of cartilage and adjacent tissues.

CAP Lecture

Dr. Sanjeev Seahra
Assistant Professor
University of New Brunswick

Date: Tuesday, March 25, 2014
Time: 5:30pm
Location: PA133

Abstract:

What's the matter with gravity?

Gravity is probably the most familiar of the fundamental forces: every child learns the consequences of falling from a high place in the playground. So it is bit surprising that it is the force that gives theoretical physicists the biggest headaches. We have a great operational handle on gravitation within the solar system: we can predict the orbits of celestial bodies with great accuracy. But as soon as we look at galaxies we find we need mysterious "dark matter" to explain the dynamics, and if we look at universe as a whole we need "dark energy" to describe why gravity is repulsive on large

scales. At the other end of the spectrum, Einstein's general relativity has stubbornly resisted all attempts to be reconciled with quantum theory, despite many decades of effort. In this talk, I summarize the current status of our understanding of gravity and discuss some of the (many) ideas of how to move forward.

Physics Department Seminar

Dr. Lea Gauthier

Research Associate
Universite de Montreal

Date: Tuesday, April 8, 2014

Time: 3:30pm

Location: HP 4351

Abstract:

Search for strongly-produced superpartners with two same-sign leptons at 8 TeV at the ATLAS experiment

The Standard Model is extremely successful in explaining experimental measurements in particle physics. However it possesses some theoretical problems such as the hierarchy problem or the Higgs boson mass fine-tuning, which have motivated a large number of extensions to the theory. Supersymmetry solves several of these problems such as canceling the quantum corrections coming from Standard Model by the contributions of the corresponding superpartners. Other attractive features of TeV-scale Supersymmetry include the the high-energy unification of the weak interactions, the strong interactions and electromagnetism, and the fact that it provides a candidate for dark matter.

This talk presents a search for supersymmetry in final states with two leptons (electron or muon) with the same electric charge, using 20.7 fb-1 of proton-proton collision data at 8 TeV in the center of mass recorded by the ATLAS experiment at the LHC in 2012. Several signal regions are studied with different selections on the jet and b-jet multiplicities, transverse missing energy, effective mass and transverse mass. They are designed to maximize the sensitivity to several scenarios of strongly-produced superpartners. As no excess above the standard model background expectation is observed, limits are set on the visible cross-section of new physics within the kinematic requirements of the search. The results are interpreted as limits on the parameters of several models such as

gluino-mediated top squark, direct bottom squark and the production of squarks and gluinos decaying to gauginos and sleptons.

Paul Prior and Lindsay Beaton

Date: Thursday, April 17, 2014
Time: 3:30-5pm
Location: Conference room A&B, Room C2363, 2nd floor, Cancer Centre South, The Ottawa Hospital - General Campus, 501 Smyth Road

Abstract:

1. "An iterative triple energy window approach for cross talk correction in dual isotope Tc99m & In111 small animal SPECT"

Paul Prior - *Carleton University*

Abstract: Dual isotope SPECT allows simultaneous measurement of two different tracers in vivo. With In111 (emission energies of 171keV and 245keV) and Tc99m (140keV), quantification of Tc99m is degraded by cross talk from the In111 photons that scatter and are detected at an energy corresponding to Tc99m. The Triple Energy Window (TEW) uses counts recorded in two narrow windows surrounding the Tc99m primary window to estimate scatter. Iterative TEW corrects for the bias introduced into the TEW estimate resulting from un-scattered counts detected in the scatter windows. The contamination in the scatter windows is iteratively estimated and subtracted as a fraction of the scatter-corrected primary window counts. The iterative TEW approach was validated with a small-animal SPECT/CT camera using a 2.5mL plastic container holding thoroughly mixed Tc99m/In111 activity fractions of 0.15, 0.28, 0.52, 0.99, 2.47 and 6.90. Dose calibrator measurements were the gold standard. Uncorrected for scatter, the Tc99m activity was over-estimated by as much as 80%. Unmodified TEW underestimated the Tc99m activity by 13%. With iterative TEW corrections applied in projection space, the Tc99m activity was estimated within 5% of truth across all activity fractions above 0.15. This is an improvement over the non-iterative TEW, which could not sufficiently correct for scatter in the 0.15 and 0.28 phantoms.

2. "Astronaut Biodosimetry"

Lindsay Beaton - *Health Canada*

Abstract: Radiation induces damage to DNA which can be measured using cytogenetic endpoints to determine the level of exposure of an individual based on biological markers. This method is termed biodosimetry and is essential for triage in the case of a large scale radiological/nuclear emergency. Cytogenetic endpoints are also routinely used in other research projects, such as the identification of individual radiation sensitivity biomarkers, as well as the cytogenetic analysis of blood samples from astronauts. The biodosimetry of these astronaut samples provides an in vivo measurement of the biological damage from space radiation. This talk will focus on the biodosimetry methods used by Health Canada with a focus on the analysis of Canadian and European astronaut lymphocytes prior to- and post-flight, and will include some of our recent results.

Victor Malkov, Randle Taylor, IRS tour and annual OMPI BBQ

Date: Thursday, May 22, 2014
Time: 3:30 - 5:00 pm
Location: NRC - 1200 Montreal Road, North Campus, Building M-36 - Kelvin Room (please check in at the front desk)

Abstract:

1. "Implementing charged particle transport in electric and magnetic fields in EGSnrc"

Victor Malkov - *Carleton University*

Abstract: The development of coupled MRI-radiotherapy technologies for IGRT necessitates the ability to perform Monte-Carlo calculations which take magnetic fields into account. This allows for better understanding of dose perturbations induced by these fields, including in-phantom effects and the electron return effect, apparent at air-phantom interfaces. An algorithm that takes advantage of the EGSnrc charged particle transport to improve efficiency has been implemented, and a boundary crossing method is proposed to deal with general geometries when using the EM field package. Preliminary calculations, including simple slab geometries and ion chambers with constant magnetic fields, are performed to verify functionality and applicability of the code. These calculations show that even under low field conditions the change in exit surface dose is not negligible, and warrants further study.

2. "Filling the gaps in commercial clinical software"

Randle Taylor - *The Ottawa Hospital Cancer Centre*

Abstract: At The Ottawa Hospital Cancer Centre (TOHCC) the Medical Physics group is currently using and actively developing a number of in house software applications for clinical use. Our in-house software touches on a wide range of clinical areas including our machine quality control program, treatment planning quality control, staff management, incident learning and radiation safety. Bespoke software allows our clinic to fill the gaps in commercial software offerings and create tools that fit well withing our existing clinical workflows and best practices. However, the development of custom software is not without risk and often raises concerns about software quality and ongoing support & maintenance. In this talk I'll present some of the software we've developed and discuss some of the ways we've mitigated the inherent risks of in-house software.

3. Tour and BBQ:

We will be finishing off this season's seminar series with a BBQ at the NRC. To help in organizing this, we would like to have an idea of how many people are planning to come to the seminar and stay for the food afterwards. Please reply by May 19 to guarantee your share : Bryan.Muir [at] nrc-cnrc.gc.ca. We will make every effort to accommodate special dietary needs (e.g. vegetarians) but only if we know in advance.

For interested students there will be a tour of the Ionizing Radiation Standards Group facilities starting at 2:00pm. Please register with Bryan at: Bryan.Muir [at] nrc-cnrc.gc.ca.
