Message from the Chair

This newsletter is one of the ways in which we try to connect regularly with our alumni and friends. Those of you who are regular readers will notice some changes in the department, as I have taken on the Chair position for a year while David Venus enjoys a well-deserved leave at the end of his first term. Alan Chen has taken over the position of Associate Chair from Kari Dalnoki-Veress, who was in charge of the graduate program for the previous five years. John Berlinsky has been appointed Academic Program Director for the Perimeter Institute, where he is managing the institute’s graduate and undergraduate programs as well as developing educational partnerships with other Canadian institutions.

The past year has been a very productive one for the department in many different ways. We had our largest graduating class for many years, with 30 students receiving their B.Sc. in Physics at the June 2010 convocation. It has been another excellent year for awards won by our undergraduate and graduate students and by our faculty. I want to particularly highlight the two medals from the Royal Society of Canada that were awarded to Kari Dalnoki-Veress and Doug Welch this past November.

On the research side, faculty member Sung-Sik Lee describes his work to understand the properties of strongly correlated electron systems, which obey the laws of quantum mechanics, by studying a black hole living in a space of one higher dimensions and obeying the laws of classical mechanics. This newsletter also highlights graduate student Kate Ross’s research into the properties of geometrically frustrated materials using x-ray and neutron scattering with her supervisor Bruce Gaulin. Many of us had the opportunity to enjoy Sue and Jim Waddington’s collection of photographs tracing the original locations for many Group of Seven paintings, which were exhibited at the McMichael Canadian Art Collection.

In the near future, we are looking forward to hosting the annual meeting of the Ontario Association of Physics Teachers in May 2011. We look forward to catching up with our physics teacher alumni at that meeting. Perhaps it will soon be time to hold another alumni reunion day; I would be interested to hear your thoughts and comments on how we can connect better with our alumni.

With best wishes,
Christine Wilson
Professor and Acting Chair

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Alumni - Where are they now?

Adam Aczel (PhD 2010) is a postdoctoral fellow at Oak Ridge National Laboratory.

Wenqi Ran (PhD 2010) is a postdoctoral fellow at the National Centre for Biotechnology Information (NCBI), National Institute of Health.
Faculty Profile

I'm very pleased to have joined the Department as a teaching professor, working with the new Integrated Science (iSci) program. I have an interdisciplinary background, with a BSc in Mathematics and Astronomy from the University of Leicester. My interest in history of science led me to a PhD in ancient Egyptian astronomy, also at Leicester.

After completing my studies, I moved into the area of educational project management, beginning with a project to introduce problem-based learning (PBL) into university physics education. From there, I became involved in curriculum development in the sciences more generally, and ran teaching and learning projects for physics, chemistry, and interdisciplinary science, working with groups of university departments across England. One project involved designing and implementing a new three to four year degree program at the University of Leicester called Interdisciplinary Science, which is based entirely on PBL. My experience as PBL advisor, instructor and (later) Deputy Director of this program is very useful for my present work with McMaster's iSci program.

My main interests in pedagogical design and teaching are active learning techniques, aligned assessment, and integration and interdisciplinarity. In the classroom, I enjoy using topics from history of science as interesting and illuminating contextual material.

iSci is an program which prides itself on bringing research experience to undergraduate students. Currently, I teach mathematics and science literacy within the program, as well as leading research projects on the themes of space exploration and history of Earth Science. The iSci teaching professors (myself and Chad Harvey, Biology) were appointed on the teaching track to emphasise our roles in curriculum development and delivery, but we also both retain an element of discipline-based research. I work in two areas: ancient Egyptian astronomy and complex adaptive systems. Ancient Egyptian astronomy is an area which sheds light on early scientific endeavours. I look at descriptive texts (written in hieroglyphs), astronomical tables, depictions of the sky on the ceilings of temples and tombs, and small instruments such as sundials. One of the unique features of Egyptian astronomical activity is the construction of "star clocks", tables of star names charting the position of constellations through the nights of the year. My interest is in trying to deduce the way these tables were developed and the observational methods used to construct them.

I am also interested in agent-based modelling environments. I am primarily working on modelling early civilisations, including urbanisation, trade, and the information dissemination processes, as complex adaptive systems. Beyond research and teaching, I enjoy aspects of science communication, and have recently taken over from Doug Welch as director of the William J. McCallion Planetarium. The planetarium runs public and private shows every week, presented by a very competent and enthusiastic team of (mainly) post-graduate students. The planetarium is an exciting and valuable link between our department and the wider Hamilton community and I'm delighted to be involved with it.

Graduate Profile

I have always been fascinated by the night sky. As a senior high school student, I knew I had to major in physics so that I could continue with astronomy. By the time I was a fourth year undergraduate student, I had taken two introductory courses in nuclear physics, and had learned that I have an even stronger passion for nuclear physics. So, I moved to Canada to pursue my studies in nuclear physics on a graduate level. Shortly after my arrival, I heard how McMaster is one of Canada’s leaders in research, and was extremely lucky to be able to work on a small project with Dr. Alan Chen during the summer of 2005. He introduced me to nuclear astrophysics, where nuclear physics and astrophysics are united. I was then delighted to hear that Dr. Chen was going to accept me as his graduate student. Working as an experimental physicist with Dr. Chen has been a valuable experience. Dr. Chen sends his team all around the globe to participate in various experiments and present their work in workshops and conferences. This could not be possible without the support from the Department and the University. Thus, young researchers in his team not only get the chance to meet the experts in the field, but they also have the advantage of making better decisions of where to go after they graduate. His kind and regular supervision and support enabled me to pursue my research goals, one of which was fulfilled when I learned that our work was recently published in Physics – spotlighting exceptional research journal.

Jiajia Zhou (PhD 2010) is a postdoctoral fellow at the Institute of Physics, Johannes Gutenberg University Mainz in Germany.
Undergraduate Profile

I have been interested in science for as long as I can remember. I attended high school at Westdale Secondary School, just down the road from McMaster. My physics teacher sometimes brought his class on field trips to Mac. On one such trip, we were shown Dr. Graeme Luke’s model superconducting maglev train and I can remember thinking that it was extremely cool. Solid state physics must have been on my mind; I wrote my grade 12 Chemistry term paper on the crystal structure of superconductors. Little did I know that several years later, I would be working on similar materials for an undergraduate physics thesis under the supervision of Dr. Luke!

I am in my final year of Arts & Science & Physics—within the Arts & Science program; I am using my electives to take what amounts to an Honours Physics degree. My time as a physics student has so far been exciting, challenging, and rewarding. I have found the students, staff, and professors in Physics & Astronomy to be very welcoming and supportive, and I have been privileged to have had opportunities to participate in summer research.

I received NSERC summer research awards in 2009 and 2010. Under the supervision of Dr. Luke, I prepared and grew crystals in the optical floating zone crystal lab and performed various x-ray and magnetic measurements of our materials. This past summer, I had the opportunity to attend and give demonstrations at the Brockhouse Institute’s 2010 summer school on crystal growth. I was also fortunate to attend a week-long summer school in June 2010 on “New Phenomena in Quantum Matter,” held in Rio de Janeiro, Brazil. In addition to attending daily lectures, I met professors and graduate students from Canada, the US, and South America, and even got to explore some of the city. In all, it was a fantastic experience.

With the support of my supervisor and the department, I attended the Canadian Undergraduate Physics Conference in October 2009 (University of Alberta) and 2010 (Dalhousie). In both years I gave a talk based on my summer research. At the 2010 conference, I was awarded first place in Condensed Matter and first place overall for my talk “Crystal Growth and Muon Spin Relaxation Measurements of Dy2Ti2O7.”

When I entered university, I knew that I liked learning about science, but I did not know if I would like doing real scientific research. To my delight, I have found that I enjoy experimental physics research very much, and I am planning on continuing my studies at the graduate level.

Student Awards

Congratulations to our graduate students, Kate Ross, Patrick Clancy and Clare Armstrong for their research presentations at the Canadian Association of Physicists Congress, June 2010 in Toronto. Kate Ross and Patrick Clancy (both working under the supervision of Professor Bruce Gaulin) won 3rd and 1st place in the division of Condensed Matter and Materials Physics. Clare Armstrong (supervised by Professor Maikel Rheinstadter) won first place in the division of Medical and Biological Physics. The first place winners then went head-to-head in the finals with Clare claiming first place and Patrick second.

Congratulations to Scott Geraedts who was awarded the Governor General’s Academic Medal at the June 8, 2010 Faculty of Science Convocation where he graduated with a BSc in Honours Physics. This award is given to the student from a first baccalaureate degree program who has attained the highest standing throughout the program.

Allison MacDonald, a fourth year Honours Physics Coop student, has been selected as one of only five Canadian students to receive special funding from the Institute for Particle Physics to spend part of Summer 2011 at CERN. Allison will be able to take full advantage of this opportunity as she has also been awarded an NSERC USRA from Simon Fraser University to work under the supervision of Professor Dugan O’Neal, a researcher on the ATLAS project at CERN. Allison will participate in the renowned CERN Summer Student Lecture Program as well as active research.

2010 Canadian Undergraduate Physics Conference (CUPC) Awards – see page 5

Faculty Awards

Cliff Burgess has been awarded the 2010 Canadian Association of Physicists Prize in Theoretical and Mathematical Physics. Cliff was cited for "his prolific and influential work in theoretical physics, which covers many different topics ranging from condensed matter theory to particle physics and string theory. Professor Burgess made seminal contributions in all these fields."

The citation goes on to note especially Cliff’s recent pathbreaking work in string theory and its connections to the very early evolution of the universe. As the most highly cited theoretical particle physicist in Canada, Cliff has also been awarded a prestigious Killam Research Fellowship, and been elected a Fellow of the Royal Society of Canada.

Jules Carbotte, University Professor, was awarded a Honourary Degree, Doctor of Science at the Faculty of Science Convocation on the afternoon of June 8, 2010.
Doug Welch was awarded the prestigious McNeal Medal by the Royal Society of Canada. Awarded for demonstrating an outstanding ability to promote and communicate science to students and the public within Canada, Doug joins previous medal winners that include David Suzuki, Jay Ingram, and Bob McDonald.

Kari Dalnoki-Veress received the Rutherford Memorial Medal in Physics with the Royal Society of Canada citing Kari Dalnoki-Veress as "a dedicated young scientist with a genius for simple but profound investigation. In an era dominated by large funding initiatives and complex instrumentation, Dalnoki-Veress is an inspired scientist and research supervisor who can find deep insight from brilliant direct experiments."

Bruce Gaulin was named as a Fellow in the Royal Society of Canada with the following citation: "Bruce Gaulin’s neutron and x-ray scattering work established new low temperature properties in exotic magnets, especially those related to geometrical frustration. He is also recognized for leadership in North American neutron scattering." Being elected a Fellow is considered the highest honour that can be attained by scholars, artists and scientists in Canada.

An-Chang Shi has been elected a Fellow of the American Physical Society for "outstanding contributions to the theoretical study of phases and phase transitions of block copolymers." APS Fellowships are awarded after an extensive review and reflect the respect of one's professional peers.

Research News:

Working with Neutrons to Explore Novel Magnetic Phases of Matter
by Kate Ross

As a member of Bruce Gaulin’s group, I’ve been exposed to aspects of solid state chemistry and crystallography, as well as neutron and x-ray scattering. Bruce’s group is focussed on scattering experiments on hard condensed matter systems that have unusual magnetic and/or structural properties. Within this realm, my specialty is in applying scattering techniques to examine the properties of “geometrically frustrated” materials. Such materials exhibit large residual entropy at very low-temperatures, due to a macroscopic degeneracy of their magnetic ground states. I use neutron scattering, which effectively performs the task of taking a Fourier transform of real-space correlations in crystal lattices, to probe the magnetic correlations that develop at extremely low temperatures (as low as 30mK) in such frustrated systems.

The first step towards doing our experiments is to prepare the material of interest. When possible, we prefer to study single-crystalline samples, because this gives us essential information about anisotropic correlations and dynamics in the system. For example, we can use neutron scattering to measure the dispersion through momentum space of magnetic excitations (i.e. spin waves or magnons), and this information can later be used to determine the microscopic components of the relevant magnetic Hamiltonian. In order to obtain large enough single crystals to perform such a neutron scattering experiment, we put a lot of work into “growing” and characterizing these crystals. We do this work through the Brockhouse Institute of Materials Research (BIMR) here at McMaster, which is home to some excellent crystal growth facilities and expertise.

We perform our neutron scattering experiments at large-scale national laboratories in Canada, Europe, and the United States. To get beam-time at these facilities, we must submit research proposals in order to gain approval to do the experiment, which is not always an easy task! Some of the instruments we apply to use are oversubscribed by a ratio of 6 proposals submitted for every 1 accepted. Once we get permission to do the experiments, we travel to the facilities for roughly 1 or 2 weeks. In the past three years I have frequented such places as Washington DC, Tennessee, Chalk River, Chicago, Los Alamos, and Zurich. We spend quite a lot of time in Tennessee due to the new Spallation Neutron Source (SNS) which is currently the brightest source of neutrons in the world. Bruce’s group has been involved in developing an instrument there, SEQUOIA, which is now in full operation. I’m excited to be working on the development of new neutron scattering technique at SEQUOIA that incorporates extreme sample environments (pulsed magnetic field neutron scattering, with fields up to 30T).

Here at McMaster we have the unique ability to perform sample characterization and experiments with neutrons, using our recently installed spectrometer at the McMaster Nuclear Reactor, called MAD (the McMaster Alignment Diffractometer). I am involved in developing this instrument such that it can be used by researchers from McMaster and beyond.

Bruce also has a very productive x-ray facility in ABB, which currently houses two diffractometers that can be used to examine structural effects in crystals to temperatures as low as 300mK, with extremely high resolution. The structural information that we can gain using x-rays often complements the magnetism we explore using neutrons, allowing us to present a full picture of the low temperature properties of these unusual materials.

Can We Understand Metals from Black Holes?
by Sung-Sik Lee

For centuries, scientists have been trying to understand our macroscopic world from smaller building blocks. In condensed matter physics, one goal is to understand physical properties of materials, such as the electric conductivity of a metal, by understanding the motion of electrons in materials. Although the mass and the charge of the bare electron are universal constants of nature, these are modified by the condition created by ions and other electrons that are present inside materials. Depending on the
modified mass and charge, electrons can behave very differently in different materials.

In certain metals such as Copper, the environment reduces the electric charge so significantly that electrons behave as if they don't interact with each other through the Coulomb interaction. In this case, electrons do not care much about what other electrons do, and we can more or less understand the behavior of the whole system made of approximately $10^{23}$ electrons by understanding the motion of one electron. In other metals, such as the family of materials that can conduct electric current without any resistivity below relatively high critical temperatures Tc ~ 100K, this is no longer the case. These are more complex materials, containing Copper mixed with other elements, and are called “high temperature superconductors”. In these materials, one can not ignore interactions between electrons. In order to predict the motion of one electron, one needs to know what all other electrons are doing. This strong correlation between electrons, in combination with the uncertainty principle in quantum mechanics, makes it much harder to understand the behaviors of such systems, and this still remains an open problem after much intense research for the past twenty five years.

Recently, a new tool has been developed to attack the problem of strong correlations. The basic idea is to map a difficult problem to an easy problem that is dual to the original problem. It is like extracting the DNA information of a suspect who is at large by examining the blood of his identical twin brother who can be easily caught. According to this duality, one can understand the dynamics of strongly interacting particles, which obey the laws of quantum mechanics, by studying a black hole which lives in a space of one higher dimension and obeys the laws of classical mechanics. The duality is very useful because the black hole problem is much easier to solve than the strong correlation problem. It is yet to be seen whether this duality can really help condensed matter physicists to understand high temperature superconductors. What is clear is that the new development has already provided us with surprising new insights into the strong correlation problem that may lead to its solution in the future.

Sue and Jim Waddington

During their retirement Sue and Jim Waddington have continued their hobby of searching for the places that inspired the Group of Seven painters. Jim taught physics at McMaster University from 1970 to 2006 and his wife Sue is a retired nurse and homemaker. Sue is an artist - a traditional rug hooker. In 1977 she was making a rug hooking based on A.Y. Jackson’s painting “Hills, Killarney, Ontario (Nellie Lake).” During a canoe trip in Killarney Provincial Park, Sue and Jim paddled with their family to Nellie Lake and were surprised to find that they could locate the exact spot where Jackson had sat when he did the painting. After this initial success, they have continued to search for other painting locations. Although the Group of Seven worked throughout Canada and produced many of the iconic images that we have of the north, there are very few photographs of the actual scenes that inspired them. Since the artists did not keep detailed records of where they worked, finding the location of each painting represents a puzzle to be solved. For all of the 180 places that Sue and Jim have found, they have recorded what the view looks like now and have compared it with the artist’s impression of the same scene. They particularly like searching for sites that may only be reached by canoe.

Recently many of their photographs were displayed at the McMichael Canadian Art Collection in Kleinburg alongside the corresponding artworks. This summer they will publish a book about some of the paintings done in the beautiful La Cloche hills near Sudbury.

The Department of Physics & Astronomy sent sixteen of our Physics undergrads to the Canadian Undergraduate Physics Conference 2010 held at Dalhousie this year. In particular, five of our students were recognized for their talks or posters as follows:

1st Place, Best Talk Overall: Hilary Noad, Level 5 Arts & Science and Physics (Supervisor Dr. Graeme Luke).

2nd Place, Best Talk Overall: Evan Sinukoff, Level 5 Physics Co-op (Supervisor at NASA).

2nd Place, Best Poster Overall: Kathleen Nelson, Level 4 Physics Co-op (Supervisor at SFU).

1st Place, Best Condensed-Matter Talk: Hilary Noad.

2nd Place, Best Condensed-Matter Talk: Rob D’Ortenzio, Level 4 Physics (Supervisor Dr. David Venus).

3rd Place, Best Condensed-Matter Talk: Dan Thompson, Level 5 Physics Co-op (Supervisor Dr. Duncan O’Dell).

1st place, Best Astro Talk: Evan Sinukoff.

All sixteen students had participated in summer research in the department or at outside institutions (Western, Waterloo, Lethbridge, SFU, NASA) and were supported by the department as well as by their supervisors. All sixteen presented talks or posters at CUPC.
John Berlinsky named Perimeter Institute's Academic Program Director

Canada's Perimeter Institute for Theoretical Physics (PI) named McMaster University's John Berlinsky as its Academic Program Director. Perimeter is an independent research institute, located in Waterloo, which was founded in 1999 with the help of a $100 million donation from Michael Lazaridis, co-CEO of Research in Motion. Perimeter's Director, Neil Turok, is a cosmologist who moved to PI in 2008 from Cambridge University and who is also founder of the African Institute for Mathematical Sciences.

John Berlinsky is currently a professor in the Department of Physics and Astronomy at McMaster, past president of the Faculty Association and a member of McMaster's Board of Governors. He continues to serve on the Board and in the Faculty Association, while being seconded four days a week to Perimeter.

In his new role, Berlinsky puts his academic and research experience to work, managing Perimeter's advanced undergraduate and graduate courses, and developing educational partnerships with other Canadian and international institutions.

Berlinsky's first major task at Perimeter was starting up and directing the new Perimeter Scholars International (PSI) program - a one-year graduate course for exceptional students taught by outstanding international lecturers. The students take classes at PSI for 10 months and earn a master's degree in physics from the University of Waterloo. The first PI class of 28 students representing countries from Canada and the US to Cameroon, Vietnam, and Cuba graduated in May 2010. This year's class has 31 students and the plan is to grow to 40 – 50 students.

Berlinsky's personal goal as director is to retain talented PSI students in Canada. "If PSI can recruit top physics students from around the world and Canadian universities can attract them into PhD programs, Canada's intellectual capital and its strength in theoretical physics will be greatly enhanced."

Installation of President Patrick Deane

On Friday, November 19, Patrick Deane was installed as McMaster's 7th President in a ceremony filled with ritual and significance. The new President was welcomed by representatives of government and other universities, along with faculty, staff and students from McMaster, including MUFA Past-President, John Berlinsky, who assisted in the robing of the new president.

The president's speech focused on education as integrity, academic freedom and civility, global citizenship, and service to the community.

President Deane came to McMaster from Queen's University where he had served for 5 years as Vice-Principal (Academic). His research is in the area of 20th Century English literature, and he is also appointed as Professor in the Department of English & Cultural Studies.

Earlier this year, our department had the pleasure of meeting President Deane when he joined the department at its annual September Retreat.

Alumni - Where are they now?

Sijing Shen (PhD 2010) is a postdoctoral fellow in the Department of Astronomy and Astrophysics at the University of California.

Jacob Ruff (PhD 2010) is a Director’s postdoctoral fellow, Argonne National Laboratory.
2010 Graduating Class

On Wednesday, April 7, 2010, the graduates organized a special celebration at the Marquis Banquet Centre in Ancaster where friends, professors and staff all joined in the celebration of their graduation.

2010 Department of Physics and Astronomy Faculty Annual Retreat at the Royal Botanical Gardens in Burlington.

Front Row: Cecile Fradin, Karen Hughes, Alison Sills, Christine Wilson, Sarah Symons, Laura Parker
Middle Row: Sung-sik Lee, Doug Welch, Ethan Vischniac, Takashi Imai, James Wadsley Erik Sorensen, Duncan O’Dell, An-Chang Shi, Kari Dalnoki-Veress
Back Row: Peter Sutherland, David Venus, Cliff Burgess, Bruce Gaulin, Bill Harris, Ralph Pudritz, Harold Haugen, Hugh Couchman, Graeme Luke, Neil McKay, Reza Nejat, Paul Higgs, Alan Chen
Missing: John Berlinsky, Catherine Kallin, Maikel Rheinstädter
Those who wish to support undergraduate and graduate students in physics and astronomy at McMaster can designate their donations to McMaster Physics & Astronomy, or to one of our funds:

- **The Martin Johns Fund** – this fund is used to provide entrance scholarships to Honours Physics undergraduate students, and to send undergraduates to the Canadian Undergraduate Physics Conference.

- **The Jim Waddington Prize** – this fund supports an annual prize for the student with the highest achievement in Physics 1BA3 who is entering an Honours Physics program.

- **The McCallion Planetarium Fund** – this new initiative will allow a graduate student to be appointed part-time manager of the newly renovated planetarium.

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