Physics
UNIVERSITY OF TORONTO

Spring 2021

INTERACTIONS

The Department of Physics Newsletter

MESSAGE FROM THE CHAIR

Welcome to the Spring 2021 issue of Interactions, the Department of Physics newsletter!

Dear Physics community,

Now that Toronto's April snowfall has melted and spring might finally be here, I am delighted to introduce another issue of the Physics newsletter. Many good things have been happening in the Department, despite the ongoing pandemic and the challenges that it continues to create for our activities and general well-being. I hope the stories in this issue of Interactions provide you with some positive news in these uncertain times.

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We start the newsletter with a reminder of the Welsh Lectures coming up on May 6 and 7. We are looking forward to talks by Subir Sachdev from Harvard University and Juan Collar from the University of Chicago. Both talks will be online, making them accessible wherever you may be. Also, if you missed this year's J. Tuzo Wilson Lecture in February, given by Ron Kwok from the University of Washington, a recording of his talk about Arctic sea ice is available at https://tuzowilson.physics.utoronto.ca/.

Our profiles begin with an introduction to our newest faculty member, Ziqing Hong, whom we welcomed to the Department in January as an Assistant Professor in dark matter and neutrino physics. We are also pleased to profile Post-Doctoral Fellow Jack Setford, PhD Student Mohamed Shaaban, and Physics Specialist Rosalie Cormier. Our second Emeriti Profile features an in-depth interview with Tony Key, who first came to Toronto as a postdoc in 1966; he provides some fascinating insights into how the Department used to function. Our Alumni Profile highlights Danielle Chu, now a lawyer with Osler, Hoskin & Harcourt LLP, who tells us why she pursued a physics degree and how her training in physics has helped with her career in law.

Congratulations to our twelve fall 2020 PhD graduates, particularly well deserved given that they had to finish writing up and defending their theses under pandemic conditions – well done!

This issue's Research Spotlight highlights an intriguing paper by PhD student Aaron Goldberg that mathematically describes the degree to which objects or systems behave in a quantum manner. More of our recent research stories can be found at Physics News.

Physics faculty have been the recipients of half a dozen major awards over the last several months – congratulations to Professors Miriam Diamond, Hae-Young Kee, Jim Drummond, David Curtin, and Paul Kushner on these honours.

We are delighted to announce the establishment of the Xanadu Award for an Outstanding Publication by a PhD Student, thanks to support from Xanadu, a start-up company with close ties to the Physics Department. This $5,000 scholarship will be awarded annually to one or more PhD students in the Department for a peer-reviewed paper on quantum information and quantum optics. Thank-you to Xanadu for their generous donation and congratulations to the inaugural recipient, Ziaoqing Zhong.

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Under the leadership of David Bailey, Chair of the Physics Outreach Committee, and Sheela Manek, Special Projects Coordinator, the Department has been actively engaged in a number of outreach initiatives. New this year, in collaboration with the Office of Student Recruitment and Leadership by Design, Physics is leading the “Pursue STEM” program to encourage Black and Caribbean students to pursue studies in science, technology, engineering and math. The first cohort of 38 grade 10 students joined the program at a launch event in March and had lots of great questions for keynote speaker Dylan Jones. Our students and faculty have also been running virtual physics workshops for Girls SySTEM and the Youth Enrichment Academy, and participated in a virtual Fall Campus Week. We will also be involved in Science Rendezvous, being held as a virtual street festival on Saturday, May 8 – please join us!

Our 2020-21 Physics Career Accelerator Program (physCAP) recently wrapped up with a closing event in early April. This year, we had 52 mentor/mentee pairs, with the virtual format allowing interested mentors to join whether or not they were in the Toronto area.

We celebrate three staff anniversaries this spring: 25 years for Helen Iyer (Administrative Assistant for the theoretical physics group), 20 years for Robert Morley (Senior Instrumentation Specialist), and 20 years for Galina Velikova (System Administrator). We also welcome three new staff members: Hala Larizza-Ali joined the Department in December as our new Undergraduate Coordinator, while the ATLAS project welcomed Andrea Leung as Project Coordinator and Michael Vansteenkiste as Assembly Technician.

Finally, we mark two retirements in this issue and have a growing list of recent retirees whom we will celebrate in person when that becomes possible. Ruxandra Serbanescu retires on June 30 after more than 20 years in the Department, where she has been a key member of our teaching group, making many important contributions to our undergraduate courses and labs. Also, Ana Sousa is retiring on April 30 as Administrative Assistant of the Earth, Atmospheric and Planetary Physics Group (formerly of the Atmospheric Physics Group), a position she has held since 1982; she has been a fixture on the 7th floor for many of us and will be greatly missed.

Although not mentioned in the newsletter, a big focus of activity over the last six months has been preparation for the external cyclical review required every eight years under the University of Toronto Quality Assurance Process. Consultations for this have involved the Department’s faculty, administrative and technical staff, students, postdoctoral fellows, and research associates, and included a five-part faculty retreat, five town halls, and surveys of our undergraduate and graduate students. A detailed self-study report has been written and we will be hosting a two-day virtual visit for the external reviewers in June.

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As the winter term winds down and we navigate the third wave of the pandemic, I would again like to thank our faculty, staff, teaching assistants, students, postdocs, and research associates, for all your efforts to keep the Department's courses, research, and operations on track. I remind you that COVID-19 resources and information for the Department can be found at https://www.physics.utoronto.ca/physics-at-uoft/covid-19-resources-physics/.

To conclude, I'd like to announce an upcoming change on the "third floor". Young-June Kim's three-year term as Associate Chair for Graduate Studies comes to an end on June 30. He has done a magnificent job, in a quiet and understated way, particularly in navigating our graduate program through the pandemic and in contributing to the UTQAP self-study process and report. I thank him for all of his work for the Department and wish him a well-deserved and rejuvenating research and study leave. Happily, Joseph Thywissen, a Professor in the Experimental Quantum Optics Group, has agreed to serve as our next Associate Chair for Graduate Studies. I look forward to working with Joseph when he takes up his new role on July 1.

As always, we welcome your feedback on Interactions – please contact our Editor, Sheela Manek, at newsletter@physics.utoronto.ca with your comments and news.

Best wishes for a safe and healthy summer.

Kimberly Strong

Professor & Chair

McLennan Physical Labs. (credit: University of Toronto)

Welsh Lectures in Physics
May 6, 2021
6:15-9:00pm

A simple model of many-particle entanglement: how it describes black holes and superconductors

6:15 - 7:30pm

Subir Sachdev
Department of Physics, Harvard University

Nuclear recoils: little things that go bump in the dark

7:45 - 9:00pm

Juan Collar
Department of Physics, University of Chicago

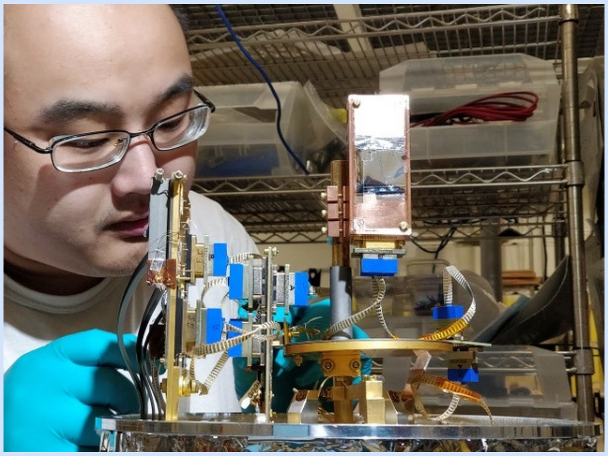
For more information visit:
welsh.physics.utoronto.ca

Faculty Profile

Ziqing Hong

Assistant Professor

Experimental Dark Matter and Neutrino Physics



Welcome to the Department of Physics Professor Hong!

You received your PhD from Texas A & M University. Can you tell our readers about the research you were involved in?

I did collider physics for my PhD thesis. I joined the CDF experiment at the Fermilab Tevatron and did a data analysis related to the top quark-antiquark differential production cross-section.

I joined CDF a bit late, as the experiment ceased operation in 2011 and I joined one year later. At the time, there were a lot of unresolved data analyses to be finished; one outstanding one was the anomaly in the top quark “forward-backward production asymmetry”. The experimental results departed from the theoretical predictions with the “Standard Model of elementary physics”, in some cases by as much as 3 standard deviations. I cleaned up the last bit of the CDF data and performed a statistical analysis with the then best knowledge about top quarks. In the end, with more data and with theorists refining the predictions, we brought the differences down to about 1 standard deviation, at which point we no longer consider it an anomaly. We hoped we had signs of new physics at the beginning and put up a good chase for it. In the end, we didn’t find new physics, but a better understanding of the Standard Model.

Why did you pursue Dark Matter after completing your PhD? What made you interested in it?

Chasing for physics beyond the Standard Model has always been a long-time interest for me. The Standard Model is great in explaining elementary particle physics. But it has its own challenges. Particle physicists are pushing in all directions where a potential deviation could be identified and hoping that’ll lead to a series of realizations of where physics beyond the Standard Model would go. The evidence of the existence of dark matter, something not predicted by the Standard Model, has been around for decades now, although the direct interaction of dark matter in a terrestrial detector is yet to be observed. It is a direction that could tell us what nature is hiding beyond the current model we have. I thus joined the work force to directly search for hints of dark matter.

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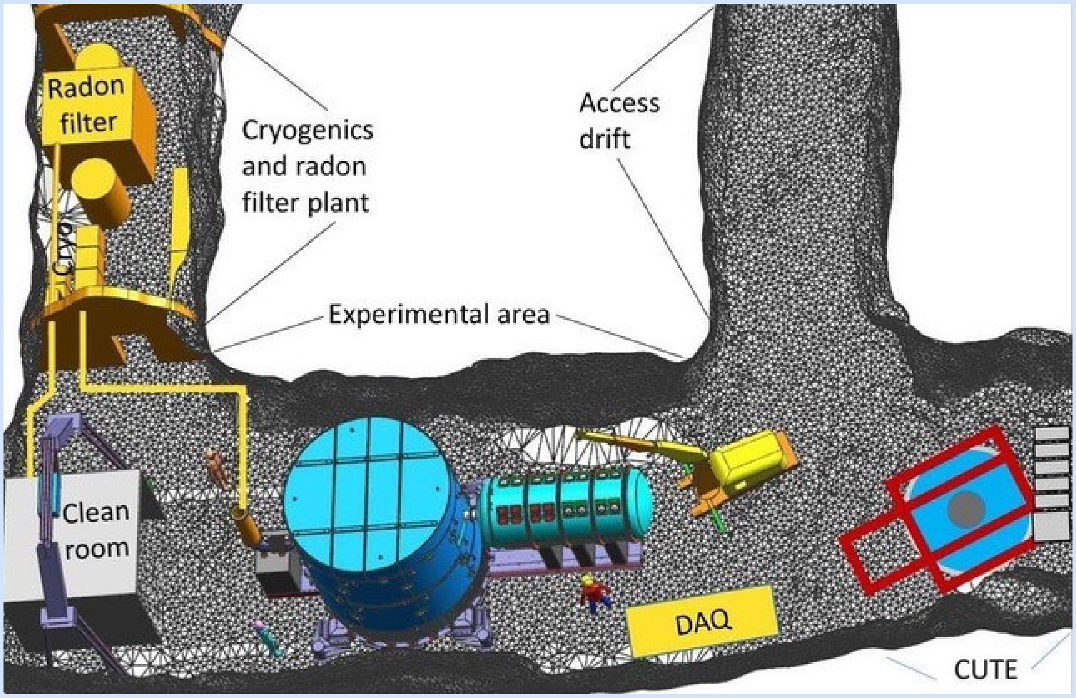
Can you tell our readers a little bit about the "SuperCDMS" experiment and your role it that?

The SuperCDMS experiment is a dark matter direct search experiment. "CDMS" is short for Cryogenic Dark Matter Search, while the prefix Super speaks about the quality of our experiment. The kernel of SuperCDMS is its ultra-pure silicon and germanium detectors equipped with cutting-edge technology called Transition Edge Sensors. These detectors work at temperatures below 50 milli-Kelvin, thus they require a world class cryogenic facility to cool them down to proper working temperature. On top of the cryogenic requirement, the experiment also needs to be well shielded from the outside world, including the cosmic ray and radiogenic contaminations. We are in the process of constructing such a facility at the SNOLAB, Canada's world-leading astroparticle physics laboratory located 2 km below the surface in the Vale Creighton Mine near Sudbury. My business line in the SuperCDMS experiment lies in detector testing and calibration. Before putting detectors in the SuperCDMS SNOLAB experiment, they need to be thoroughly tested. The detector testing happens at three places, at SLAC where they are fabricated, and at two underground facilities, NEXUS@FNAL and CUTE@SNOLAB. I joined forces with other SuperCDMS collaborators in operating the two underground facilities, NEXUS and CUTE. In addition, I am leading the detector nuclear-recoil calibration program, Ionization Measurement with Phonons At Cryogenic Temperatures (IMPACT), aiming at calibrating the detector response with neutron beams.

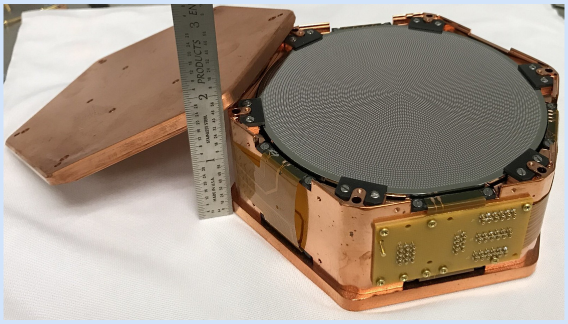


Schematics for the SuperCDMS and CUTE at SNOLAB.

Your other research interest is in neutrino coherent scattering detection, why?
Neutrino coherent scattering is interesting to me both because it will soon be an intrinsic background for any dark matter search experiment, and because it can provide possible hints to deviations from the Standard Model. As dark matter detectors are becoming more and more sensitive, the underground dark matter search experiments will start seeing, or have already seen, neutrinos from the sun. This is through the Coherent Elastic neutrino-nucleus scattering (CEvNS) process. To push the dark matter search further we need a good understanding of the CEvNS process, in order to model this intrinsic background. One good way to gain this knowledge is to deploy a dark matter search type detector next to a nuclear reactor and measure the CEvNS signal from it. At the same time, there are anomalies seen with other ongoing reactor-based neutrino experiments. Measuring CEvNS signals from reactors would serve as a complementary measurement to independently probe what is going on, and hopefully, jointly we can understand the neutrinos from reactors better, or confirm hints beyond the Standard Model.

Can you tell our readers what the Ricochet experiment is?
The Ricochet experiment is a reactor-based CEvNS experiment. It employs cutting-edge cryogenic detector technology to measure the neutrinos from a nuclear reactor. The current experimental site is at Institut Laue-Langevin in Grenoble, France. We are just starting the experiment construction phase and the first data are expected in 2023.

What is your role in this experiment?
I'm involved in the effort of designing and optimizing part of the Ricochet detector payload. The cryogenic detectors to be deployed in Ricochet require a slightly different optimization than the SuperCDMS detectors. They need to be smaller in size individually, to not be too sensitive to the muon flux in an above-ground laboratory environment. To accumulate enough mass for a sensible measurement, we need tens to hundreds of them forming a detector array. We are in the process of taking what we have learned in optimizing dark matter detectors and coming up with a novel idea of a thermal TES sensor chip. We can then couple these sensor chips to our choice of target easily. This new detector scheme reduces the requirement on the detector fabrication process, and makes it easier to build a large payload.



The new-style SuperCDMS SNOLAB detector.

What are some real world implications of neutrino scattering?
Comparing to the other neutrino detector technologies, CEvNS process requires a very sensitive cryogenic detector to make observations, but not a ton-scale detector. Detecting CEvNS signal with cryogenic detectors, once realized, would have a big impact on nuclear reactor monitoring and nuclear non-proliferation.

What are your research plans at the University of Toronto?
I plan to keep collaborating with the SuperCDMS and Ricochet members, both locally at UofT and internationally, to pursue the two scientific goals: dark matter search and CEvNS detection. I am in the process of building up a hardware-orientated research group to complement the existing SuperCDMS effort at UofT led by Prof. Miriam Diamond and Prof. Pekka Sinervo, who focus on simulation and analysis efforts. We will establish a local cryogenic lab, with detectors running at below 50 milliKelvin. The local lab would be focusing on fast-turnaround detector R&D, testing and calibration efforts. Once the new detectors are produced, we would calibrate them in neutron beams and deploy them either at SNOLAB to detect dark matter, or at ILL in Grenoble to detector neutrinos.

What are you most excited about being in Toronto?
Toronto is fairly close to Sudbury, where SNOLAB resides. I am excited to the possibility of traveling to SNOLAB frequently to contribute to the SuperCDMS SNOLAB and CUTE@SNOLAB experiments. The department here is also very large, with experts on all topics of physics. I am excited to learn more from my colleagues and collaborate on various fronts to find physics beyond the Standard Model. I have heard good words about the students at UofT and am looking forward to working with the talented younger generation. Beyond research, the restaurant density around the university also makes me excited...

Noah Kurinsky (left), Ziqing Hong (right) and Brian Nebolsky (in the back) installing a SuperCDMS-type detector at a SuperCDMS test facility.

Post-Doctoral Fellow Profile

Jack Setford

Theoretical High Energy Physics

Dr. Jack Setford has been a Post-Doctoral Fellow at the University of Toronto since September 2018, working in Theoretical High Energy Physics in Professor David Curtin's research group. In September 2020, Jack was awarded a competitive Faculty of Arts & Science Postdoctoral Fellowship. Jack is interested in the overlap between particle physics and astrophysics; his research uses stars, white dwarfs, neutron stars and black holes as laboratories for testing fundamental physics.

Jack is particularly interested in dark matter and dark complexity: "Dark Complexity is the notion that dark matter might be more than just one kind of particle the universe of dark matter could be just as rich and complex as the world of ordinary matter that we see around us. I'm particularly interested in finding new, unconventional ways of searching for dark matter."

Jack has spent much of the last couple of years trying to understand how to detect "Mirror Stars" — stars made entirely of dark matter that would shine in dark light. These would be almost completely invisible to us, but could be seen by state-of-the-art space telescopes, potentially appearing as extremely dim spots of light in the sky, accompanied by a distinctive X-ray signal.

Jack obtained his undergraduate MPhys degree from the University of Oxford, and his PhD from the University of Sussex in the UK. He spent some time during his PhD as a visitor at UC Berkeley in the US, and at DESY in Hamburg, Germany. He says, "It's been weird adjusting to working from home; I really miss traveling to different places to give seminars and attend conferences. Zoom presentations just aren't the same!"

Besides his work he enjoys creative writing — although writing a novel while trying to do a postdoc in physics is proving challenging. He also enjoys taking part in outreach activities: while at the University of Sussex he developed a particle physics game as a teaching tool for kids, in which complex particle interactions can be built from simple jigsaw-like puzzle pieces.

Graduate Student Profile

Mohamed Shaaban

PhD Candidate

Observational Cosmology & Instrumentation

Shaaban's interest in physics began as a naive childhood dream. His earliest memory of wanting to be a physicist dates back to when he was 4 years old when his uncle explained to him that air and oxygen are not the same thing and that there are other components to air beyond oxygen, that fact served as an example of humanity's ability to learn about the physical world. Since then, Shaaban has developed an obsession with trying to understand the nature of the world we live in. This obsession only grew with time, so when he was lucky enough to be presented with the opportunity to pursue a formal education in physics he took it. Naturally an interest in understanding the world resulted in Shaaban gravitating towards the field that studies the universe as a whole: Cosmology.

During Shaaban's undergraduate studies, as he began to fall in love with another aspect of the technical world, he found himself attracted to the worlds of software development and hardware machining. So when it came time to choose a graduate institution he knew that he ideally wanted to pursue a program that will allow him to combine his obsession with cosmology with his passion for "building cool things". This naturally led him to U of T's state-of-the-art custom balloon spacecraft integration facility run by Professor C. Barth Netterfield and his observational cosmology group.

The most revolutionary discovery in cosmology since Edwin Hubble observed that the universe is expanding is that this expansion is accelerating. This revelation that was awarded the 2011 Nobel Prize for its profound implications. An accelerating universe implies that either our understanding of gravity is flawed, or that a mysterious negative pressure known as Dark Energy is driving the expansion of a universe filled with an equally mysterious substance known as Dark Matter. Together, Dark Energy and Dark Matter account for over 95% of the contents of the observable universe, however their origin and physics are presently unknown. As a result, the nature of Dark Energy and Dark Matter are considered two of the greatest mysteries of modern science.

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High-resolution astronomical imaging is a powerful tool to probe the nature of Dark Energy and Dark Matter. Images with sufficient resolution for cosmological applications are traditionally obtained using space-based observatories, as ground-based imaging suffers from limited resolution due to the random refraction of light by the turbulent atmosphere. The demand for near-infrared to near-ultraviolet space-based imaging cannot be met by existing and planned space missions. This overwhelming and increasing demand can be directly addressed by utilizing scientific balloon-borne platforms that provide access to space-quality imaging without the prohibitive cost and long development timescale of traditional space missions. The low cost and repeatability of a balloon launch enable the platform to fly annually to meet the high demand, while the short development time scales ensure that the platform remains state of the art. Such a platform permanently reduces the cost of astronomical observations, which will improve the accessibility of astronomy to a wider and more diverse range of research groups, thus increasing the field's research output. Shaaban is currently working on SuperBIT. This Canada-led project is the first of its kind, allowing the Canadian scientific community to compete and collaborate with multi-billion dollar experiments, such as the Hubble Space Telescope, at extremely low cost. Shaaban's research focuses on building, and utilizing low cost spacecrafts such as balloon-borne payloads and small satellites to probe the nature of Dark Matter and Dark Energy.

Shaaban is native to Alexandria, Egypt. Growing up he moved a lot and he has lived in multiple cities across Egypt, United Arab Emirates, Italy, Canada, and Germany. He has also had the privilege to visit over 130 cities in over 30 countries trying at least one ice-cream store per city. His favourite place on earth is Vancouver, BC but he is now forced to pretend it is Toronto! Besides his interest in physics and mathematics, he is passionate about the outdoors. He is a very active individual with a love for sports, especially long-distance running and weightlifting. In his free time, he enjoys reading about mysterious things, especially with regard to psychology, history, computing, philosophy, and finance. He is very involved in leadership development, public speaking, and debate. He is also a foodie who enjoys cooking as well as an avid lover of anime, Japanese animated series.

SuperBIT, on the launch pad preparing for its final engineering test flight in September 2019 out of Timmins, Ontario.

Undergraduate Student Profile

Rosalie Cormier

Program: Physics Specialist:

Year of Study: 3

Why did you decide to major in Physics? What was your inspiration?

I have always been passionate about science and was particularly drawn to astronomy for its ability to answer big questions about the universe. When I had the opportunity to take my first physics course in high school, I was immediately hooked and decided it was what I would rather pursue. I love the rigor of physics and the challenge of applying abstract mathematical principles and logic to complex real-life problems.

What do you enjoy most about the physics program?

I appreciate the breadth of courses that are offered by the Department and the flexibility in the Physics Specialist program that allows me to take courses in a wide variety of subjects. Through the program, I've been exposed to areas of physics that I had previously known very little about, which has helped me contextualize my main interests and discover new ones. I enjoy having the freedom to explore diverse branches of physics and to choose to learn more about the fields that are of personal interest to me. I am also grateful for the many extra-curricular opportunities that the department runs in parallel to their academic programming. For example, my first research experience was through a Departmental fellowship (SURF) and, more recently, I have been involved in the Department's mentorship program as a student mentee. Both of these programs have been very impactful parts of my degree.

What other extra-curricular activities are you involved in during your degree?

I have been on the executive team of the Physics Student Union (PhySU) since my first year, serving first as the First-Year Representative, then the Communications VP, and now as President. I have made great friends through my involvement with PhySU and have made meaningful connections with members of the Physics Department. I value having a sense of community among physics students and believe it is important to give back to the community as much as possible. This year, PhySU has made all our programming completely virtual and is offering many online events to enrich our students' university experiences. We are also focused on advocating for effective pedagogy that prioritizes students' well being.

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What are your research interests?
I am most interested in experimental nuclear and particle physics.

What is your favorite course and why?
I love PHY357, which I am currently taking. Prof. Ziqing Hong is a fantastic instructor who is clearly very knowledgeable and passionate about his work. The course's curriculum is very well designed, including information about nuclear and high-energy theories as well as their interplay with modern experimental endeavors.

What are your future plans?
I plan to spend the next several years completing my undergraduate studies and gaining more exposure to physics research, then pursue graduate studies in nuclear physics or engineering.

Where do you see yourself in 10 years?
Ideally, in 10 years, I will be conducting physics research professionally. Beyond that, I don't know what the future holds for me!

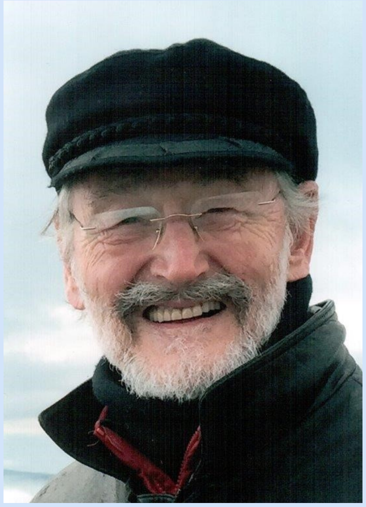
Tell me something interesting about yourself.
I love animals and have done volunteer work with them for many years. Currently, I have two pet rats (both named after physicists!) and a young chinchilla.

McLennan Physical Laboratories at night.
(credit: Joseph Thywissen)

Emeriti Profile

Tony Key

Welcome to our second Emeriti Profile where we ask one of our emeriti faculty questions about their careers and what they have been doing since retirement.
Is there a faculty member that you recall from being a student and are you wondering what they are up to? Do you have fond memories of a certain instructor?
Tell us who they are and we will try and connect with them for an update.



Thank you Professor Key for speaking to Interactions. How many years were you a faculty member at the Department of Physics?
I feel flattered that you think the ramblings of an octogenarian professor emeritus would be of much interest to your readers but thank you for asking!

I was a postdoctoral fellow here from 1966 to 1968, returning in 1970 as an assistant professor after two years at what is now called Fermilab, the particle accelerator in Illinois: I retired in 2004.

Can you tell me about your educational background from your undergraduate degree to your PhD?
I obtained my M.A. at the university in Aberdeen where my family had settled after World War II and went on to do graduate work at the University of Oxford.

What was your PhD in and why?
The field of elementary particles was taking off and I wanted to see what happened at the highest energies, when a beam of particles from an accelerator smashed into nuclei. The Oxford group, led by my thesis advisor Mani Lokanathan, used the beams at CERN (Centre de Recherche Nucleaire), the international laboratory in Geneva. We detected the collisions by placing a stack of photographic emulsions in the particle beam; when developed, the tracks made by the particles could be studied under microscopes by technicians. The technology was at the end of its life and is now obsolete. Living in Geneva for the experimental run, my very first, very modest expense account allowed me to woo Mervyn, the beautiful young woman I met there; mistakenly impressed, she returned with me to Oxford and we married a year later.

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I finished my D.Phil. in three years, not because of any brilliance on my part, but because all graduate grants provided by the Department of Scientific and Industrial Research lasted only that long. I had to let the University know when I would defend my thesis, and there was a stiff fine for failure to appear. My daughter, Michelle, ignorant of this tight deadline, elected to be born on the scheduled day. However, I was magnanimously granted a month-long extension on compassionate grounds; by working non-stop, with a few hours of sleep between Michelle's 2 am and 6 am feed, I managed to complete my thesis. I then had to have it professionally typed, and 5 copies printed: one for each of my two examiners, one for the University archives, one for the Physics Department, and a personal copy. Since copies were made by interleaving the pages with others that were coated with carbon – the original carbon copies – my copy is almost unreadable.

The examination was conducted by the head of department, the famous Professor Denis Wilkinson, and the external examiner, the equally well-known Professor Eric Burhop from University College, London. Neither had anything to prove, so I passed without revisions.

What did you do before you came to Toronto?

Upon graduating, we three sailed for South Africa, where I had obtained a lectureship at the University of Natal in Durban. I taught undergraduates and my one M.Sc. student and I did research with John Martin, also an Oxford graduate. Together we produced what was almost certainly the first cold cesium plasma in Africa. My contribution was to design a system that produced a homogeneous magnetic field to contain the plasma. The computers I used were more sophisticated than the one I had used in Oxford; the long rolls of punched paper tape had been replaced by stacks of punched cards.

While we had a wonderful time in South Africa, the horrors of apartheid and the way our African and Indian friends were treated persuaded us to leave after two years. Jim Prentice and Dick Steenberg had made the sensible decision to abandon the nucleus for its constituents, and I was offered a position as a NSERC postdoc to join their new High Energy Physics group at Toronto. The technology had advanced to the use of the bubble chamber and, helped by the more established group at the University of Wisconsin, we obtained film from experiments at Argonne National Laboratory in Illinois. I had the largest office of my career in the basement of the Sandford Fleming building, where the Department was housed awaiting the construction of the McLennan Laboratory.

These were the most difficult years of my career. I needed to catch up on a very fast-moving field, Toronto seemed large and cold, and Mervyn had her hands full looking after Michelle and our newly adopted son, Adrian.

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The US Congress had recently approved what was to be the last large accelerator to be built in the US, and a group of Canadian physicists from the University of Toronto, Carleton University, and McGill University wanted to join the action, so they created the Institute of Particle Physics to produce a report that would encourage the government of Canada to chip in. I was asked by this group to be the Canadian representative at Fermilab, as it was soon to be called, to show the flag and produce the report. As it turned out, international accelerator culture welcomed physicists around the world, so Canadian financial input was not required, no doubt to the relief of the government.

We scientists were housed in tiny bungalows in the small village of Weston, lying in the plains of Illinois to the West of Chicago, that had been appropriated by the US government. The Americans were delightful and friendly, though all of our friends had guns; the culture in the 'junior executive suburb' where we lived was Wonder Bread bland, and we escaped each weekend to the delights of Chicago.

While designing particle beams for the future accelerator and writing reports of progress to my Canadian employers, a colleague and I joined groups from the Universities of Wisconsin and Chicago to do an experiment at the nearby Argonne Laboratory. A Swiss group had reported an anomaly in the profile of an obscure meson, and after two years of work, by examining a rare decay of the meson, we showed that the Swiss result was incorrect. That work produced my one and only Physical Review Letter. Ultimately, however, the US culture was too foreign for us to contemplate settling there; the love of guns was incomprehensible, and the bottom line on most things was money. When my work was done at Fermilab, I was offered an Assistant Professorship by Jim Daniels, who had succeeded Harry Welsh as Chair of Physics. I was delighted to accept.

What are your memories of being a faculty member in the U of T Physics Department?

The bubble chamber group was still going strong, and we were collaborating with the Universities of Wisconsin and Purdue with experiments at the Stanford Linear Accelerator in Palo Alto. The resultant film was returned to Toronto, and scanned by technicians and, later, by a semi-automatic scanner. As out-of-towners we were assigned to the midnight shift.

I had always had difficulty balancing the demands of research and teaching and after many years I began to lose interest in continuing my research. The bubble chamber technique was becoming outdated, my last graduate student had graduated, and my Research Associates had left to continue their careers, so I determined to concentrate on my teaching, my true love. This was long before tenure track teaching positions were even imagined.

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I arranged for our bubble chamber measuring machines to be gifted to the University of Jammu in North India, and I spent some enjoyable time in India, helping the physics department set them up.

I became even more interested in psychology and pedagogy and, over a three-year period, I obtained a diploma in a form of psychotherapy called Gestalt Therapy. What had started as a hobby became a very minor secondary career, and I spent many Reading Weeks teaching in Europe and the Far East. I also spent a sabbatical teaching undergraduate physics at the Albi campus of the University of Toulouse.

I spent about fifteen years in departmental administration, serving as the Associate Chair (with Chairs Robin Armstrong and Dick Azuma), Associate Chair for Graduate Studies (with Chair Michael Walker) and was Acting Chair for a term until Derek York was able to take over as Chair. I thoroughly enjoyed my time in administration, where I had the power to solve many of the bureaucratic problems brought to me by worried students.

What kind of physics did you teach? And why?

Throughout my career I taught at all levels. Two of my favourite subjects were quantum physics and electromagnetism. Perhaps my favourite courses were those to first year students, whose pre- and misconceptions I enjoyed confronting. I especially enjoyed teaching Physics for the Life Sciences in Convocation Hall. I loved the performance aspect, and the fascinating demonstrations provided by the department's outstanding technical team. This excellent course had been created by Kenneth McNeill, and I was fortunate enough to teach with team David Harrison, John Pitre, Jason Harlow, Kim Strong, William Trischuk, Salam Tawfiq, and a huge team of Teaching Assistants. Sadly and coincidentally, the year that Kenneth McNeill died, this course was replaced by a standard physics course, taught to all new comers, thus confirming its main purpose – to keep idiots out of medical school. I taught the section on Nuclear and Radiation Physics, about which I initially knew little; Pierre Savaria came to my rescue when required. I introduced and taught several courses for non-science students that were a delight to teach.

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Sundog from the roof of McLennan Physical Labs. (credit: Orfeo Colebatch)

I served many years teaching the First and Second Year Laboratory courses. The instructions for students had been written by Malcolm Graham whose terse style bordered on incomprehensibility, so I rewrote the manuals with more detailed instructions and a more verbose style; the students did not seem to enjoy the laboratory any more or perform any better. David Harrison subsequently re-designed the first year laboratory to better accommodate the increasingly poorly prepared students.

I developed training courses for our many Teaching Assistants, and gave several workshops for different audiences across campus, laterally under the auspices of the Teaching Assistants Training Program. At Woodsworth College, I took over the course Teaching in Higher Education developed by John Kirkness from the French Department to meet the needs of senior Ph.D. candidates who wanted to become academics; evidence of a commitment to good teaching was finally becoming necessary to obtain an academic position. I also introduced the graduate course, Communication for Physicists, to help physics graduate students develop their writing and presentation skills.

How has the Physics Department changed since you were a faculty member?
When I joined the Department, all decisions were made by Full Professors, who held regular faculty meetings, to which Assistant and Associate Professors were not invited; the idea that students should be allowed to attend was too extreme even to be contemplated. In later years, once all faculty were allowed to attend, the Chair, notably Robin Armstrong, would bring the large store of liquor kept in his office, to the lounge for an informal post-meeting drink with no need for University-provided baristas.

After each lecture, a technician would clean the blackboard in preparation for the next. If slides were required, a technician would operate the projector; however, for most lectures, the slides could be written out on sheets of transparent plastic and fed as required into an overhead projector.

All computing was done on the IBM 7094 that occupied the 12th floor of the McLennan laboratory. The programs were fed to the machine on cards, and the data was stored on massive magnetic tapes loaded into rows of tape decks the size of refrigerators. Time had to be booked on the computer, and, as large users, we often processed overnight. Users' research grants were charged by the second. George Luste, another particle physicist, became more interested in computing and purchased the first departmental computer. In addition to making a fortune investing in IBM stock, George ran the computer with an iron hand, and his work made a huge contribution to the department.

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Many rooms in the McLennan tower were used as experimental laboratories for faculty, as the now inoperative DC outlets attest. These were gradually turned over to lecture or seminar rooms as their inhabitants retired or moved to the basement.

All papers were written out by hand and handed to typists. Corrections were literally cut – using scissors – and paste – using Sellotape – until the number of errors generated by the typist equaled the number of errors in the manuscript. The IBM Selectric electric typewriter with its innovative ball was a huge step forward, and the days of professional typists began to be numbered. Nowadays with word processors, text or diagram changes are so easy that few theses escape without several, required by examiners who want to show they have read the student's work.

What have you been doing during your retirement?
I was among the last Ontario professors who had to retire at age 65; now there is no age limit. For a good decade I continued to teach the Woodsworth course and the Communication course, and extended my teaching in Gestalt Therapy in Japan and China. For several years, I volunteered at Princess Margaret Hospital, and have become somewhat active in canvassing for the Green Party. We continue to spend time with our growing family, our summers at our small farmhouse in the Tarn, our weekends at our log cabin in the Kawarthas, and our winters in Rome. I took up golf again but can report no improvement. I have been educating myself in politics and economics, corresponding with friends close and far, and I continue learning Italian at the School of Continuing Studies. As a member of Senior College, I attend functions and talks, and several courses at the Academy for Lifelong Learning.

Anything else you would like us to know or share?
Too long already, hope you got this far.

U of T Clock Tower. (credit: Joseph Thywissen)

Alumni Profile

Danielle Chu

Class of 2013

HBSc Physics and Philosophy Double Major, Mathematics Minor

Link to bio: https://www.osler.com/en/team/danielle-chu

I am currently a lawyer with Osler, Hoskin & Harcourt LLP in Toronto, Ontario. I practice Competition/Anti-Trust, Foreign Investment and International Trade law. I moved to Toronto from Calgary, Alberta in October 2019, where I was previously practicing with Osler's Litigation – Regulatory, Environmental, Indigenous and Land Law Specialty Group. In my spare time, I enjoy camping, whitewater kayaking, outdoor rock climbing, hiking, cooking, watching reruns of The Simpsons, and spending time with my loved ones.

Interactions asked Danielle some questions about her career path.

Why did you choose Physics for your undergraduate degree?

I had originally planned to fall squarely in the "Arts" side of Arts & Science with a Philosophy specialist degree. While I had always loved engaging with concepts in my high school physics and chemistry courses, especially quantum physics, I was told that I did not possess the natural talent in mathematics to seriously pursue the sciences. One day as I was walking down St. George debating between a History or English minor, I passed by the McLennan Physics Building. I'm not entirely sure what happened but I stopped in my tracks, looked at the building and thought to myself, "this is where I belong". I went to the registrar that day to change my major to the double major I have today in Physics and Philosophy and minor in Mathematics.

What did you love most about your physics degree?

I owe much to my physics training, but in particular two things: 1) the physics degree taught me how to think; and 2) the physics degree taught me how to be resilient. In terms of learning how to think, your physics and math courses require you to problem solve at a very high caliber and grapple with very difficult concepts. Being challenged with such difficult problems requires you to learn how to spot patterns, learn how to learn, learn how to work smart (rather than only working hard), and learn how to problem solve in a team with your peers.

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These skills and ways of thinking are material to success in a physics degree, and are skills that have followed me into all my endeavors beyond. Related to this was learning how to be resilient. I frequently tell people that the physics degree at U of T was one of the hardest things I had ever done. As I have experienced, so much of success in any pursuit is not about talent, but rather about how quickly you dust yourself off, take a fresh look at the problem and keep going. It is not an exaggeration for me to say that often when I feel like I am faced with a challenge that is too much, I think to myself “If I could succeed in my physics degree, I can do this!”. This mantra has gotten me through many tough situations!

How did your training in physics help with your career path in law?
How the physics degree has helped with my career path boils down to three major themes: 1) in substance; 2) in how to think; 3) in establishing credibility. In terms of substance, my prior legal practice in Regulatory and Environmental work mainly focused on energy projects including mines, oil and gas, and renewable energy projects. Many of these files involved working closely with scientists and engineers, including reading scientific reports and technical material. Since many of our clients had a science background, they were eager to have a lawyer who spoke their language and who could easily grasp the concepts they had to deal with. Similarly in my current Competition practice, our files involve working with economists and often require substantive work with economic theory and formulas. It is an advantage to be a lawyer that isn’t afraid of numbers! In terms of the physics degree having trained my ability to think, much of this relates to the question above. The problem solving, critical thinking and teamwork skills you learn in physics are transferable in every area. In particular, these skills are material to being a good lawyer and I have my physics degree to thank for honing them. Lastly, one thing I was surprised to find was that having a physics degree comes with a level of cachet and serves to bolster credibility. I suspect this stems from the fact that a lot of people had their own tough experiences with physics and know that it is an inherently difficult subject. In my experience, having a physics degree is a nice little shortcut to establishing your capabilities. People know you’re smart and no further proof is required. It’s definitely a pleasantly surprising bonus! All that being said, while the physics degree certainly was challenging, it was also deeply rewarding and continues to pay dividends.

To everyone who is currently pursuing their physics degree – I know it’s difficult but the difficulty makes the success all that much sweeter; and the lessons you learn will carry you far into whatever you choose to do next. You can do it!

Interactions encourages all alumni to reach out and tell us what they are up to.
Email: newsletter@physics.utoronto.ca
Let us know where your physics degree took you!

November 2020 PhD Graduates

Abidi, Syed Haider - Precision Higgs Boson Measurements using the H → ZZ*→ 4l Decay Channel. (Supervisor R. Teuscher)

Bhatt, Nishant - Spectroscopy of Ions in Cryogenic Neutral Plasmas. (Supervisor A. Vutha)

Fajber, Robert - Understanding the Role of Latent Heating in the Heat and Mass Transport of the Global Atmospheric Circulation. (Supervisor P. J. Kushner)

Guerrero, Josuha - The Influence of Curvature on Mantle Convection Featuring a Temperature-Dependent Viscosity. (Supervisor J. P. Lowman)

Hartley, John - The SuperBIT Hardware Design and a Constraint of the Tensor to Scalar Ratio r from the Spider I Polarized CMB Maps. (Supervisor C. B. Netterfield)

Hay, Stephanie - Pattern Scaling Methods for Understanding the Response to Polar Sea-Ice loss in Coupled Earth System Models. (Supervisor P. J. Kushner)

Li, Yi - Mainland Southeast Asia Precipitation: Natural Variability, Teleconnection, and Response to External Forcing. (Supervisor D. B. A. Jones)

Nino, Daniel - On the Molecular Counting and Clustering Problems in Single-Molecule Quantitative Nanoscopy. (Supervisor J. N. Milstein)

Tham, Weng-Kian - Quantum Homomorphic Encryption: Implementation and Application+ SPLICE: A Novel Super-resolution Imaging Technique. (Supervisor A. M. Steinberg)

Tzitrin, Ilan - From the Theory of Entanglement to the Practice of Optical Quantum Information. (Supervisor H. K. Lo)

Woodford, C.J. - Centre-of-Mass Motion and Precession of the Orbital Plane in Binary Black Hole Simulations. (Supervisor N. Murray)

Veloce, Laurelle - Fiducial Inclusive and Differential Cross Section Measurements of the Higgs Boson in the H → ZZ*→ 4l Channel with the ATLAS Detector. (Supervisor R. Teuscher)

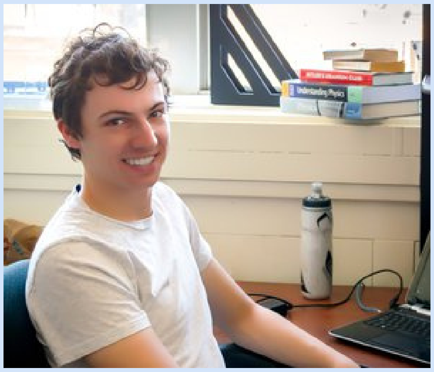
Research Spotlight

Just how 'quantum' is it?

Physicist Aaron Goldberg has an answer

- Chris Sasaki, Arts & Science News.

This article was published in Arts and Science News on January 22, 2021.
It is followed by an interview with U of T Physics' graduate student Aaron Goldberg by Sheela Manek from Interactions.



Aaron Goldberg

A team of physicists have taken a step toward answering a decades-old question: just how quantum is something? The collaborators have developed a way to mathematically describe the "quantumness" of different objects or systems — that is, the degree to which they behave in a quantum manner.

Aaron Goldberg is a PhD candidate in the Faculty of Arts & Science's Department of Physics and lead author of the **paper** published in the journal AVS Quantum Science describing the finding.

"Previously, researchers had measured quantumness in systems that involved light," says Goldberg. "But we can apply our generalized approach to any quantum system — systems involving light, atoms, molecules or even combinations of those things." The subatomic world described by quantum physics is very different from the world described by Newton's classical laws of physics.

In the familiar world of classical physics, we know the position and momentum of objects with enough precision to, for example, make a difficult shot in a game of billiards. We also know the ball won't magically transform into something other than a ball. It won't inexplicably pass through the side of the table. And we know when we strike a ball on our table, it won't affect a ball on another table on the other side of the planet. But in the quantum world, a subatomic particle — unlike a billiard ball on a pool table — has only a probable position and speed. Light acts sometimes like particles and sometimes like waves. Subatomic particles can quantum tunnel through seemingly impenetrable barriers. And particles can mirror each other over vast distances — a phenomenon known as quantum entanglement.

These characteristics define an object's quantumness.

Continued on next page.

According to Goldberg, when quantum theory was first formulated, many believed there was a clear distinction between the classical and quantum — that objects were one or the other. But as our understanding of the quantum realm grew, that idea changed.

“Over the years, scientists conducted more and more sophisticated experiments but failed to see a distinct boundary between the two,” says Goldberg. “And now, the prevailing theory is that quantum mechanics describes everything from photons to billiard balls to planets."

“In fact, there are probably an infinite number of degrees of quantumness.” For example, a billiard ball is in fact a quantum object that could tunnel through the side of the table. But that would only happen if the quantum state of the atoms and molecules in the ball aligned — and the chances of that are as small as the number of atoms and molecules in the ball is large.

Goldberg and his collaborators looked at the quantum end of the classical to quantum spectrum and identified the two highest degrees of quantumness which they labeled as “King” and “Queen.”
“And there are definitely more than just Kings and Queens,” says Goldberg. While the research seems esoteric, there are important applications in our increasingly quantum world.

Knowledge about the degree of quantumness of a system may help in the development of quantum computers, sensing technologies and in the technologies used to measure physical constants and other properties with extreme precision. For example, this research could potentially help in detecting gravitational waves because those observations involve measurements that must be accurate to 1/10,000th the diameter of a proton.

Goldberg and his colleagues are continuing to explore extreme quantum states with the help of teams in labs around the world — including that of Aephraim Steinberg, a professor in the Department of Physics.

“This result feels like a single step down a long road,” says Goldberg. “I think research like this into extreme quantum states has just begun. I expect I’ll be revisiting this quest for a good while.”

Read the U of T Arts and Science News article here:
https://www.artsci.utoronto.ca/news/just-how-quantum-it-physicist-aaron-goldberg-has-answer

Continued on next page.

Hi Aaron, welcome to Interactions. Can you tell me a little about yourself?
Glad to be here! I did my undergrad in Integrated Science down the road at McMaster. Now I'm pursuing my PhD in quantum optics with Professor Daniel James, looking to use quantum properties of light for enhanced quantum sensing. This seems to be one of the main areas in which quantum technology will have the earliest impact. Outside of research, I think I may hold the record for the number of people in the Department against whom I've played squash.

What made you interested in studying quantum mechanics?
I got into quantum through philosophical discussions with friends in high school. We discovered that moot philosophical questions could become empirical through quantum mechanics, we started learning, and the snowball has rolled from there.

This work is getting quite a bit of publicity. Can you tell me what that means to you?
Honestly, I think the biggest lesson is that fame begets fame. We thought this work might be interesting to the research community, but never expected popular science websites to pick it up. This is a cool opportunity for me to expose my research to non-experts and to be nicely surprised by comments on our work from complete strangers.

Can you tell me a little about the team that worked on this project with you?
This work was done during a visit to the Max Planck Institute for the Science of Light in Erlangen, Germany, hosted by Professors Luis Sánchez-Soto and Gerd Leuchs. I was lucky to be part of a dynamic collaboration there – we had experts on group theory, computational physics, and experimental quantum optics all working on various aspects of the project. The team had been working on various related projects for many years, so I feel fortunate to have joined at a time when everything was starting to come together.

Where did the "King" and "Queen" analogy come from?
This nomenclature predates me. I presume that Queens of Quantumness were chosen for alliterative purposes and that Kings of Quantumness were chosen to outshine the former. I know that the Kings were initially referred to as "anticoherent states," to which the founder of coherent states, Roy Glauber, was opposed. The story diverges from there: one branch says that the name Kings was dubbed because our collaborator in Spain has a king; the other branch says that a mispronunciation of the French word for king sounds like Roy. Either way, Kings of Quantumness still preserves some alliteration...

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Can you give our readers some examples where they could see “quantumness” in their everyday lives?

The hard part about this question is seeing: there are lots of important items in our lives whose operating principles can only be described using quantum mechanics, from transistors to lasers to GPS. If you want to actually see quantumness, one of the most straightforward methods is to use a prism to sort the light coming from a fluorescent bulb by wavelength/colour; that only discrete colours show up demonstrates the quantumness of fluorescence. I would argue that the most quantum things are those that are hardest to see every day – that’s what makes them so esoteric.

What is next for Aaron Goldberg?

Next for me is a job at the National Research Council focusing on designing and implementing photonic quantum information protocols. We’ll hopefully be able to demonstrate some useful advantages in sensing and communications with quantum light.

The paper titled Extremal Quantum States was published on November 17, 2020 in AVS Quantum Science.

Read the full article in AVS Quantum Science here:

https://avs.scitation.org/doi/10.1116/5.0025819

Read the article in Live Science here:

https://www.livescience.com/quantifying-quantumness.html

Read the article in AIP Publishing here:

https://publishing.aip.org/publications/latest-content/quantifying-quantumness-a-mathematical-project-of-immense-beauty/

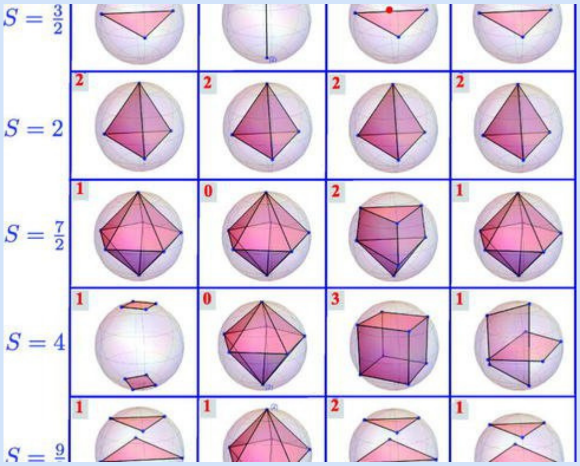


Image: Majorana representation for states that maximize the Wehrl entropy and maximize M∞, which are Kings of Quantumness and Queens of Quantumness. In each row, we indicate the value of S. In the top-left corner of each cell, we indicate (in red) the corresponding degree of unpolarization. The degeneracies at some points of the constellations are indicated in blue.

Awards

2020 John Charles Polanyi Prize

The 2020 Polanyi Prize in Physics was awarded to Professor. Miriam Diamond from the Department of Physics for her new insights into dark matter and the nature of the universe.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/professor-miriam-diamond-recipient-of-john-charles-polanyi-prize/

Fall 2020 Canada Research Chair

U of T Physics Professor Hae-Young Kee was named to a new Tier 1 Canada Research Chair in Theory of Quantum Materials.

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/professor-hae-young-kee-among-the-fall-2020-canada-research-chair-recipients/

2020 CASI Alouette Award

U of T Physics Professor Emeritus James R. Drummond is the recipient of the 2020 Alouette Award from the Canadian Aeronautics and Space Institute (CASI).

More:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/professor-james-r-drummond-receives-the-2020-casi-alouette-award/

2021 Sloan Research Fellowships

U of T Physics' Professor David Curtin among four Arts & Science researchers to receive a 2021 Sloan Research Fellowship.

More:
https://www.artsci.utoronto.ca/news/four-arts-science-researchers-receive-2021-sloan-research-fellowships

Awards

2020 John H. Chapman Award of Excellence

Professor James R. Drummond Recipient of the J.H. Chapman Award of Excellence for his remarkable contribution to the advancement of the Canadian Space Program and a lifetime of achievement in space science and technology.

More:
https://www.asc-csa.gc.ca/eng/events/jhchapman/jhchapman-winners.asp

2019 Patterson Medal

Professor Paul Kushner has been awarded the 2019 Patterson Medal for Distinguished Service to Meteorology in Canada. The award is an acknowledgment of Kushner's contributions through various roles within key national organizations.

More:
https://www.artsci.utoronto.ca/news/atmospheric-physicist-paul-kushner-awarded-patterson-medal-distinguished-service-meteorology

Rainbow from the 11th floor of McLennan Physical Labs. (credit: Geremia Massarelli)

Physics News

U of T Physics Dr. Pierre Fogal featured in Guelph Today

Dr. Fogal leads a team of researchers monitoring the weather and climate change in the Arctic.

More:

https://www.physics.utoronto.ca/news-and-events/news/physics-news/u-of-t-physics-dr-pierre-fogal-featured-in-the-guelph-today/

Stephen Morris' Icicle Atlas

The Icicle Atlas featured in the Chicago Tribune.

More:

https://www.physics.utoronto.ca/news-and-events/news/physics-news/stephen-morris-icicle-atlas/

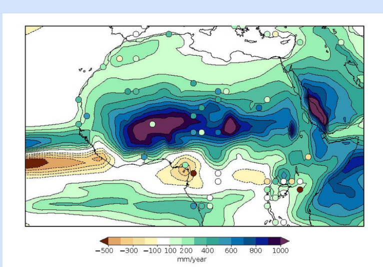
Courtesy: iStock/agsandrew

Quantum tunnelling from the Steinberg group among "quantum highlights" for 2020

Physics World has selected the quantum tunnelling-time experiment as one of their quantum highlights for 2020.

More:

https://www.physics.utoronto.ca/news-and-events/news/physics-news/quantum-tunnelling-from-the-steinberg-group-among-quantum-highlights-for-2020/



The Green Sahara

Dr. Deepak Chandan and Prof. Dick Peltier, who are members of the Department's Earth, Atmospheric and Planetary Physics group, published results in Geophysical Research Letters providing new insights into the mechanisms that could be in play in order to maintain a Green Sahara

More:

https://www.physics.utoronto.ca/news-and-events/news/physics-news/the-green-sahara/

Xanadu Award

Announcing the Xanadu Award for Outstanding Publication by a PhD Student

With support from Xanadu, we are pleased to announce that the Faculty of Arts & Science and the Department of Physics have established the Xanadu Award for an Outstanding Publication by a PhD Student.

This $5,000 scholarship will be awarded to one or more PhD students in the Department of Physics in recognition of the publication of a peer-reviewed article in an academic journal on a topic related to quantum information and quantum optics.

This award is the result of a donation of $25,000 over five years from Xanadu, a Toronto-based start-up company with close ties to the Department of Physics. A number of former post-doctoral fellows, PhD students and undergraduate students are affiliated with Xanadu and Xanadu continues to work through the MITACS program with U of T Physics faculty.

Due to their current and past relationships with the University of Toronto, Xanadu founder and CEO Christian Weedbrook says "we wanted to encourage students in the field of quantum information and quantum optics and to let them know that Xanadu, and many other quantum startups in Canada, exist when they graduate."

Application requirements include a peer-reviewed article on a topic related to quantum information and quantum optics and a cover letter explaining the significance of the paper in one or two paragraphs.

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The 2021 recipient, Xiaoqing Zhong (right) was selected by the Xanadu Award Committee of the Department of Physics in April 2021. She received the award for her paper, "Proof-of-principle experimental demonstration of twin-field quantum key distribution over optical channels with asymmetric losses", published in Quantum Information. She says "I am truly honored to receive the Xanadu Award. The recognition to my publication is deeply appreciated. Special thanks go to my supervisors, Prof. Li Qian and Prof. Hoi-Kwong Lo, and my college Dr. Wenyuan

Wang, all of whom have made important contributions to the publication. Without their effort, I would not be able to receive the award. This award will motivate me to work harder in future research."

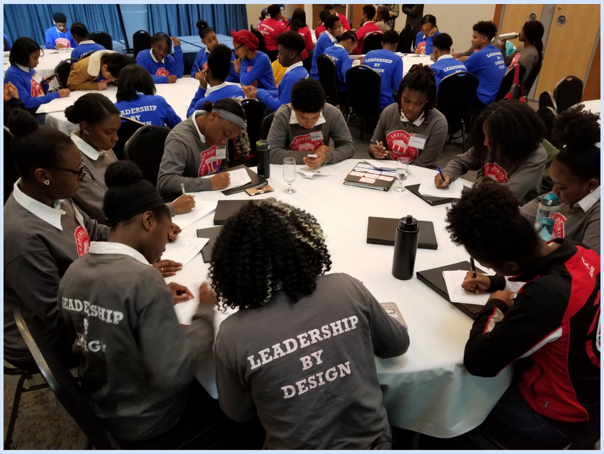
Xiaoqing's research is about Quantum Key Distribution (QKD), which is a fundamental technology in quantum communication. It enables two remote users to share secure keys for encryption and authentication with information-theoretical security. Compared with classical public key encryption systems, the security of which depends on the computation difficulty of certain mathematic functions, the encryption system with QKD has provable security that relies on the foundation of quantum mechanics. She is working on experimentally building and testing different QKD systems, trying to shorten the gap between theory and experiment and making QKD more practical and feasible for real world applications.

Professor Hoi-Kwong on the Xanadu Award: *"Xanadu's CEO, Dr. Christian Weedbrook was a former postdoc of me, Prof. Li Qian and also Prof. Daniel James. I am delighted to see that Dr. Christian Weedbrook's firm, Xanadu, is successful and is giving back to the University of Toronto. I am also delighted that Xiaoqing Zhong, the new generation of graduate students from my group (co-supervised by Prof. Li Qian) has now won the first Xanadu Award. Let the trend of success continue!"*

More on Xanadu:

- https://www.xanadu.ai/
- https://www.theglobeandmail.com/business/article-toronto-quantum-computer-startup-xanadu-eyes-100-million-funding/
- https://whatsyourtech.ca/2020/10/12/all-you-need-is-quantum-cloud-from-canadian-tech-startup-xanadu/

Outreach in Action
Pursue STEM



Pursue STEM, a new outreach program that encourages and supports Black students interested in science, technology, engineering and math (STEM) launched in March 2021.

Pursue STEM is being developed in a partnership between Leadership by Design (LBD), U of T's Office of Student Recruitment, and the Department of Physics.

The following departments from the Faculty of Arts and Science are contributing to this initiative as well: Astronomy and Astrophysics, Chemistry, Computer Science, Earth Sciences, Mathematics, School of the Environment, and Statistics.

What is Leadership by Design (LBD)?
LBD is the signature program of the Lifelong Leadership Institute (LLI). The LLI is an educational organization that exists to inspire leadership and develop leaders, and dedicates its resources to advancing leadership competence and personal success among Canadian youth of Jamaican, Caribbean and Black heritage.

Screenshot from the Pursue STEM Launch Event that took place on March 18, 2021. The event included a keynote talk by Professor Dylan Jones and a hands-on Arduino activity for the students.

LBD recruited 38 high-achieving Black Grade 10 students from the GTA with an expressed interest in STEM for this program. The program will run from March-August with activities roughly twice a month. Each year a new cohort of Grade 10 students will enroll, and the earlier cohorts will continue in the program from grade 11 to first year university.

More information on LBD can be found here:
https://llileaders.com/leadership-by-design/

Continued on next page.

Outreach in Action

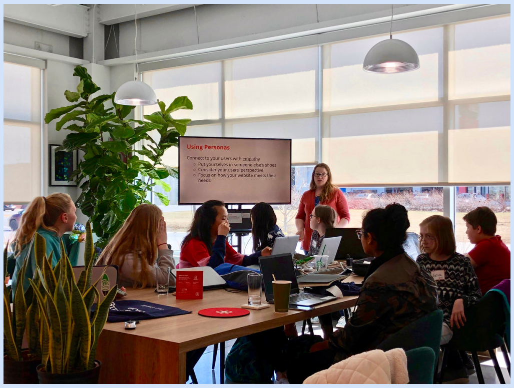
We asked the Chair of the U of T Physics Outreach Committee about the importance of Pursue STEM

"Everyone who is curious about the world should have equal opportunity to learn about the physical and mathematical universe, but this is not always apparent when you look around our university. For example, we have almost 200 Physics graduate students, but in many recent years none of them have been Black, despite being in a city where 9% of the population (and even more young people) are Black. We have a responsibility to reach out to communities that suffer from the effect from past (and current) injustices, and ask how we can help make change for the better. Pursue STEM is a collaborative effort to help Black youth interested in STEM learn more about physical and mathematical sciences, and to encourage this interest and support these students in high school and beyond." - Professor David Bailey - Chair of Physics Outreach Committee

Follow Pursue STEM on Instagram:

pursue_stem

Girls SySTEM



Girls SySTEM is a mentorship program for girls in grades 7-12 that aims to increase diversity in STEM through mentoring, workshops, and other activities..

The Department of Physics, in partnership with the Department of Earth Sciences, is supporting Girls SySTEM by coordinating virtual workshops for girls in the program.

In Fall 2020 and in Winter 2021, the following workshops were provided by the Departments of Physics and Earth Sciences:

Clouds in a Jar (Physics) – Professor Kaley Walker's group
Computational Physics (Physics) – Graduate student Garett Brown
Up, Up and Away (Physics) - Professor Kaley Walker's group
Oceans in Motion (Physics) – Professor Nicolas Grisouard and graduate student Jesse Velay-Vitow
Application of the Physics of Light (Earth Sciences) – Professor Daniel Gregory
Brief History of the Earth (Earth Sciences) – Undergraduate student Zoe Evans

Continued on next page.

The Founder and President of Girls SySTEM (GSM) commented on U of T's contribution:
"At GSM, we believe that elementary and high school years are critical for confidence building as students embark on their journeys towards post-secondary studies. Alongside mentorship, we aim to provide workshops, speaker events, and early workplace exposure to show girls that a career in STEM can align with their interests, values, and desire to make a positive impact. During these uncertain times, U of T Physics has enabled our girls to navigate through the difficulties of online learning by providing an exciting and interactive way to learn virtually. From understanding our oceans to solving equations and building pendulums, U of T Physics' virtual workshops challenged our mentees to think critically, adapt new skills, and explore new avenues within STEM." - Kathryn L. Hong – Founder & President, Girls SySTEM Mentorship Program

More information on Girls SySTEM can be found here:
https://www.girlsystemmentorship.com/

Youth Enrichment Academy

The Youth Enrichment Academy (YEA!) is an after school initiative designed to address the gap in programming for youth (ages 11-14) in the Regent Park and surrounding communities. The program will prepare students for success in high school and beyond. Their mission is to enhance social and emotional strengths and to develop promising young people.

The Department of Physics coordinated the delivery of online workshops to these youth starting in January 2021.

Workshops included Computational Physics from graduate student Garett Brown, Ocean Physics from Professor Nicolas Grisouard and graduate student Jesse Velay-Vitow, Atmospheric Physics from Professor Kaley Walker's group, and Dark Matter by graduate student Mohamed Shaaban.

From Outreach Worker Michelle Pham at Regent Park Community Health Centre:
"As YEA! heavily focuses on enhancing the social and emotional strengths of our young people, UofT's involvement has instilled confidence in our youth. UofT volunteers work hard to curate workshops based on the needs and interests of our youth. The science-based workshops not only fuel curiosity, but also expose our young people to concepts that may not be emphasized enough in one's environment." - Michelle Pham - Youth Enrichment Academy (YEA!) Youth Outreach Worker, Regent Park Community Health Centre

More information on YEA can be found here:
https://joinyea.ca/

Outreach in Action

Fall Campus Week

Photo Credit: *David Bailey*

Fall Campus Week took place in October 2020. Normally, Fall Campus Day is a one-day, in-person event that takes place at the Medical Sciences Building and Hart House, with programs from across the University participating. High school students and their parents come to U of T for the day to explore the many programs offered at the University.

This year, due to COVID-19, the event was virtual, with activities taking place all week from October 17-25, 2020.

The Department of Physics participated by providing recorded testimonials from current undergraduate students, providing virtual talks, and allowing students to drop in to real first-year physics lectures.

Professor David Curtin delivered a Gee Whiz Talk called “Peeling back the next layer of the physics onion: from warehouses full of detectors to alien mirror stars” that was attended by 69 people online.

96 students dropped in on Professor Jason Harlow’s first year physics class “PHY 131 – Introduction to Physics I”.

More information on Fall Campus Week can be found here:
https://future.utoronto.ca/visit/events/st-george/

More information on all the Outreach initiatives at the Department of Physics can be found here:
https://www.physics.utoronto.ca/physics-at-uoft/outreach/

physCAP Recap

In 2020-2021, the Physics Career Accelerator Program or physCAP, was fully virtual. physCAP helps undergraduate students transition to graduate studies or professional careers.

The program provides students with opportunities to plan ahead, experience, and reflect on their personal and professional development. PhysCAP includes, the Mentorship Program, two Career Events, and a preparation program for The Canadian Association of Physicists Professional Physicist exam.

Mentorship Program

Photo from the 2020-2021 Mentorship Launch Event.

The popular Physics Mentorship program matches 3rd and 4th year undergraduate students with a mentor. Mentors include alumni, faculty and graduate students from the Department of Physics.

Normally, students are interviewed in person by the program coordinators at the start of program, this year, Professor Jason Harlow interviewed over 50 students on Zoom in September. After the interviews, the students were matched with mentors whose careers aligned with the interests of the students.

The program had 52 mentor-mentee pairs who met virtually from October to April.

The launch event took place on October 15, 2021 and was attended by over 70 people! For the first time, mentors from outside the GTA were able to attend the launch. For example, we had mentors join from Ottawa, Alberta, Oklahoma and Hong Kong.

The mid-term event took place via Zoom on January 21, 2021 and a networking component was added. With the absence of in-person events, students would miss out on the opportunity to network with other mentors and their peers, and so 12 mentors kindly offered to host breakout rooms, allowing students to talk to a number of mentors.

The closing event was held on April 7, 2021 and was another virtual networking event for mentors and mentees.

Continued on next page.

Thank you to our volunteer mentors who make this program possible.
Want to be a mentor? Contact: mentorship@physics.utoronto.ca
More information on the Mentorship Program can be found here:
https://www.physics.utoronto.ca/undergraduate/physics-career/mentorship/

Career Events

In 2020-2021, two Career Events were held for undergraduate physics students virtually over Zoom.
On November 4, 2020, physCAP held the Professional and Graduate School panel. This event is meant to show students what they can do after their BSc in physics. Physics alumni who attended different professional and graduate schools after completing their physics degrees participated in the panel and answered student questions. The panel was moderated by Rory McKeown from the School of Graduate Studies.
The following alumni were present:
Danielle Chu (HBSc Physics 2013) – Law
Stephanie Lim-Reinders (BSc Physics 2006) – Medicine
Pekka Sinervo (BSc Math and Physics 1980) – Academia
Sarah Torrie (BSc Physics 2002) – Teaching

On March 3, 2021, there was the "Physics Careers Outside Academia" event where students heard from a panel of alumni who pursued careers outside of academia.
These speakers were from a variety of fields as well:
Ginelle Johnston (Msc Physics 2014) – Manager A220 Maintenance Engineering – Airbus
Eisha Patel - Data Scientist (BSc Physics 2016) – BELL Canada
Eric Sjerve (PhD Physics 1996) – Chief Technology Officer – IRISNDT
Andrea Vargas (HBSc Physics 2013) – Systems Test Specialist – Synaptive Medical Inc.

Thank you to our alumni!
Interested in participating in a career panel?
Contact: mentorship@physics.utoronto.ca
More information on physCAP Career Events can be found here:
https://www.physics.utoronto.ca/undergraduate/physics-career/physics-career-fair/

The Canadian Association of Physicists Professional Physicist Certification Preparation Program
The Canadian Association of Physicists (CAP) Professional Physicist (P.Phys.) Certification Information Session took place virtually over Zoom on November 25, 2020 and was hosted by Professor Miriam Diamond.
The purpose of this program is to introduce students to the CAP P.Phys. program and its benefits. It was open to 3rd and 4th year physics students and graduate students.

Employee Anniversaries

Helen Iyer

Celebrating 25 years

Helen Iyer, Administrative Assistant for the Theoretical Physics group, celebrates 25 years at the Department of Physics. She joined the Department in May 1996 partly working for the Laser Group (now Experimental Quantum Optics) and the Theoretical Physics Group.

Helen provides administrative support to the Theoretical High Energy Physics, Condensed Matter Physics and Quantum Optics Groups and since 2018, is the administrator for the Center for Quantum Information and Quantum Control (CQIQC). She is also the back-up administrative support for the Experimental Physics Group.

Her duties include, but are not limited to, the day to day administrative and financial activities for these groups, for example: processing expenses, updating webpages, monitoring the research accounts of faculty, assisting faculty with grant applications, managing mail, maintaining the photocopier, responding to in person, phone and email requests.

Helen organizes research seminars and talks, she invites the speakers, updates the event webpages, posts seminar notices, sends invitations and more. Most notably, Helen co-organizes the popular annual Welsh Lectures and Welsh Lectures Dinner with the Welsh Lecture Chair.

For the CQIQC group, she organizes CQIQC seminars and their bi-annual conference with the Fields Institute. She assists with collating applications for CQIQC Programs, organizes board meetings as well as other administrative tasks.

Rob Morley

Celebrating 20 years

Senior Instrumentation Specialist, Robert Morley, is celebrating 20 years at the Department of Physics in June 2021.

Robert can be found working away in the Physics Electronic Resource Centre where he designs and repairs electronics used in physics research.

Over the years, Robert has worked on data collection devices such as the BLAST Bus card for Professor Barth Netterfield's BLAST experiments as well as designs for his SPIDER experiment.

Robert has also been teaching the "Introduction to Electronics" course where he enjoys interacting with students and showing them the basics of electronics. Robert says what he enjoys most about teaching this course is "starting a new design and the thrill of finishing the design to hand off after".

Employee Anniversaries

Galina Velikova

Celebrating 20 years

For the second year in a row, Physics Computing Services celebrates twenty years of service by a member of our group.

Galina Velikova joined the Physics Department in the summer of 2001 to provide support for Windows operating systems and applications, with a special focus on administrative computing. Galina's responsibilities over these 20 years have included the technical challenges of deploying and supporting multiple generations of desktops and server operating systems, installation of dozens of distinct (and sometimes refractory) applications, administration of Active Directory services, including client identity/account management and dynamic addressing, and a constellation of associated services such as network file shares, file backups and VPN services.

Her professionalism and pleasant demeanor have made Galina a pleasure to work with whether as a client, as a colleague or as a manager.

We are privileged to have Galina in the Department and I thank her for her 20 years of service.
By Steven Butterworth.

Arrivals and Departures

Arrival

Hala Larizza-Ali
Undergraduate Coordinator

Hala is the new Undergraduate Coordinator, joining us from the Department of Economics where she served in interim roles as the Undergraduate Administrator and, most recently, the Graduate Assistant. Hala's past roles include Undergraduate Administrator/Counselor for the Department of Economics at UTM, and the Department of Geography at the St. George campus.

Arrivals and Departures

Arrival

Andrea Leung
ATLAS Project Coordinator

Andrea Leung will be the ATLAS Project Coordinator. The ATLAS project is just beginning a new phase of instrument development that will involve the construction of a silicon detector that is made up of 1500 silicon detector modules incorporating silicon sensors and application specific integrated circuits mounted on hybrid flex circuits.The collaboration will include CERN, TRIUMF, 7 other universities, and custom manufacturing by several different suppliers. UofT is the Canadian centre for the project, and Andrea will be coordinating all of the different activities.

She comes from the Faculty of Medicine, where she worked as a facilities and lab manager.

Arrival

Michael Vansteenkiste
ATLAS Assembly Technician

Michael completed his Honors BSc in Physics at the University of Waterloo in 2020 where he focused his studies on applied physics. His co-op experiences focused on particle and nuclear physics and he spent time at TRIUMF and the National Research Council.

As an Assembly Technician, Michael is currently assisting with the preparation of the high energy physics laboratories for the pre-production phase of the ATLAS ITk project. In his day-to-day Michael assists with electronic and mechanical designs, testing of laboratory equipment and assuring Toronto meets manufacturing qualifications established by CERN.

In his spare time, Michael loves going hiking and canoeing. He has also recently picked up the hobby of adult gymnastics which he says has "been a very interesting and challenging adventure".

Arrivals and Departures

Departure

Ruxandra Serbanescu

"And though she be but little, she is fierce" – This description of Hermia in Shakespeare's A Midsummer Night's Dream is how Jeanette Pitre captures Ruxandra Serbanescu, and no one who knows Ruxandra could disagree. Students in her courses have described her as an amazing and caring professor, yet firm when necessary, and who "sets an example for the rest of the department". Her colleagues are always impressed by her enthusiasm for teaching and her optimism that things will work out. "Let's do it!" is her catchphrase.

Ruxandra started her scientific career at the University of Bucharest where she received her M.Sc. and Ph.D for research in biological physics. Later she became an Assistant and then Associate Professor there, with much of her research focusing on the physics and chemistry of hemoglobin. After a stint at Université Paris-Sud XI, Ruxandra first came to the University of Toronto in 1997 as a Research Associate in the Department of Chemistry. She joined the Physics Department in 1998, first as Lecturer, then Senior Lecturer, and finally Associate Professor, Teaching Stream.

Ruxandra bridged the period where teaching-intensive faculty members moved from being ad hoc additions, to being fully recognized as integral and essential to the University's undergraduate programs. She started out coordinating the laboratory sections associated with our huge first-year non-specialist physics courses, managing many dozens of Teaching Assistants and thousands of students.

She then taught core lecture courses in both our Physics and Engineering Science programs, and coordinated our 200 and 300 level laboratory courses. She was a regular winner of both the Dean's Merit and Excellence awards for her contributions. When something new needed developing, Ruxandra was often in the lead.

We now have a robust Biological Physics research group, but in the early years of our biological physics programming, it was Ruxandra whom we depended on to provide relevant expertise. She was heavily involved in both the design of the courses and programming for our Biological Physics Specialist, and she was the go-to instructor for all our life science physics courses beyond first year, regularly teaching Physics of Living Systems and Introduction to Biological Physics.

Continued on next page.

Arrivals and Departures

Later, when the Department settled on Python as the standard computing language for our undergraduate program, Ruxandra took on the responsibility for developing PHY224 into the one course where we actually teach Python to students.

In recent years she has thought deeply about Physics Education, being an author on Physics Education Research papers such as “Putting computation on a par with experiments and theory” and “What’s all the Clicking About? A Study of Classroom Response System Use”. In “Threshold Concepts in Physics: Too many to count”, she reflected on how simply spending more time on some topics often doesn’t seem to help.

Ruxandra has always been a linchpin of the teaching focused faculty, organizing weekly lunches to keep us connected – something we have all missed over the last year. Every weekly reminder would come with optimistic – and often weather related - encouragement: “... Let's warm up with good food and a nice chat!”, “After all, it will be a balmy -12C at lunchtime”, ...

Outside the department, Ruxandra loves skiing in the mountains, and is always proud of her family’s accomplishments and modest about her own. She will be missed.
Mulţumesc frumos, Ruxandra, a fost o plăcere să lucrăm împreună. La revedere!

By David Bailey, with input from Jason Harlow, Jeanette Pitre, John Pitre, and Brian Wilson

McLennan Physical Labs from Ursula Franklin St. (credit: Joseph Thywissen)

Arrivals and Departures

Departure

Ana Sousa

Mrs Ana Sousa Retires as Administrative Assistant of the Earth, Atmospheric and Planetary Physics Group

Ana joined the EAPP Group, then the Atmospheric Physics Group, as Group Secretary on January 11, 1982, and has since served not only as a key member of the group but in many ways as the centre around which all of our activities have been organized. Prior to her joining us, it would be a considerable understatement to say that our organizational structure was somewhat “chaotic”. Those bad old days, some others might yet remember, were the pre-word processing days of typewriters and sno-paque white out. So Ana has been a colleague and friend to all members of our group, both students and faculty, for almost 40 years. Speaking for myself, one who has worked closely with Ana for all of this time, her departure from our daily lives is an event anticipated with more than a little trepidation.

I have been forced to accept this impending reality by a recent message from Peter Hurley requesting that I serve on an appointment committee to find a new EAPP Administrative Assistant. The first task was to consider what might be an appropriate job description. Of course HR has plug and play text with which all jobs are supposed to be describable; one only has to choose from among the extensive list of possible phrases. I noticed immediately that the four pages of possible descriptions did not contain any of the adjectives that have made Ana such an important member of the EAPP community, kindness and integrity being two of the characteristics which have made her so effective in her position. Other characteristics have also been crucial ingredients of her success, technical ability in processing the words and symbols, being one of these, but even more important has been her willingness to pitch-in with extra effort when unanticipated deadlines loomed, and always with good humor.

Among our activities there is one in which Ana has taken special pleasure, one in which she has been involved for more than 15 years. When the Centre for Global Change Science (CGCS) was first established by the Faculty of Arts and Science in the early 2000's, it included administrative support which has since been employed to cover a portion of Ana’s salary. She took immediately to the work involved in operation of the Centre as this required direct interaction with large numbers of undergraduate students as well as graduate students from multiple departments across the University who are affiliated with the CGCS. For all of these students Ana became the face of the Centre, the person to whom they turned, not only for information concerning our programs, but also for encouragement when this was required.

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Her advocacy for these students has been extremely important to the success of these programmes. Again those qualities of kindness and integrity mentioned previously have helped immeasurably to ensure the continuing success of this important UofT activity in the area of climate and environmental science.

In her retirement Ana will be much missed by her friends and colleagues in the Earth, Atmospheric and Planetary Physics Group that she has so ably, and with such good humor, served for almost 40 years.

Dick Peltier

Falcon on the balcony of McLennan Physical Labs.
(credit: Nasrin Pak)

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