Physics
UNIVERSITY OF TORONTO

Spring 2023

INTERACTIONS

The Department of Physics Newsletter

McLennan Physical Labs
(credit: University of Toronto)

MESSAGE FROM THE CHAIR

Welcome to the Spring 2023 issue of Interactions, the Department of Physics newsletter!

Dear Physics community,

My fourth spring term as Chair has been notable for being my first nearly normal one, with most classes, labs, and events now back in person, making a welcome change from the last three years. On the third floor, we have been busy with developing a five-year Academic Plan and a new Memorandum of Agreement for our Tri-Campus Graduate Program. Many other activities have also been happening in the Department and I hope you enjoy reading about them in this issue of the Newsletter.

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It's springtime, which means that it's time for our annual Welsh Lectures, which were held on May 11 and 12. We were delighted to have Marcia J. Rieke from the University of Arizona tell us about early results from the James Webb Space Telescope, while Omar Hurricane from the Lawrence Livermore National Laboratory reported on the recent breakthrough in laser-fusion. If you missed the public lectures, recordings are available at https://welsh.physics.utoronto.ca/.

We have welcomed quite a few new people to the Department this term. Our two newest faculty, Sergio de la Barrera and Xiang Li, are both interviewed in this Newsletter. Sergio joined us in April as Assistant Professor Tenure Stream in Experimental Quantum Condensed Matter, and Xiang joined us in May as Assistant Professor Tenure Stream in the Physics and Chemistry of Quantum Materials, a joint appointment with the Department of Chemistry.

We also have four new staff. Eva Cheung started as Graphic Designer and Print Operator in October, and during one busy week at the beginning of February, three people joined the administrative team on the third floor: Supreet Randhawa as our Outreach, Facilities and Special Projects Coordinator; Diane Nguyen as our Research Grants and Finance Assistant; and Jean Xu as Physics Finance, Purchasing and MasterCard Program Administrator. All four bring new energy and expertise to the Department.

On February 24th, we held a Farewell Luncheon at the Faculty Club to celebrate six people who have retired or departed since the start of the pandemic: Raul Cunha, Dylanne Dearborn, Ana Sousa, Lisa Jefferson, Aloma Namasivayam, and Daisy Yuan. For the several staff who were unable to attend, there will be another opportunity to celebrate at the end-of-year party in June. The most recent departures were Aloma and Lisa in February, and Sheela Manek in March; between them, they had more than 80 years of experience at UofT and will be greatly missed.

The Newsletter includes profiles of biological physics Post-Doctoral Fellow Spencer Farrell, quantum condensed matter physics PhD Student Emily Zhang, and Physics Specialist Tony An. Our Emeriti Profile features Jim Drummond, who retired from the Department in 2006, but remains active in atmospheric physics. Our Alumni Profile introduces Jonathan Gotfryd, Set Designer with the Directors Guild of Canada, whose Physics and Philosophy Specialist degree provided him with foundational knowledge relevant to computational design.

The Research Spotlight in this issue is on Barbara Zemskova and her use of machine

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learning techniques to assess changes in the uptake of atmospheric carbon by the Southern Ocean over the past three decades. Many more research stories can be found at Physics News.

Congratulations to our fourteen November 2022 PhD graduates and to Batuhan Yilmaz and Noah Lupu-Gladstein, who received the 2023 Xanadu Award for an Outstanding Publication by a PhD Student for their paper "Negative Quasiprobabilities Enhance Phase Estimation in Quantum-Optics Experiment". It was also great to see the Physics' Student Union (PhySU) receive ASSU's Sanjeev Dewett Course Union of the Year Award in recognition of their very active year organizing academic and social events and initiatives.

Under awards and announcements, we are happy to report that Anton Zilman has been promoted to the rank of Professor Tenure Stream effective July 1st, while Tahir Shaaran started a one-year appointment as a Visiting Scholar in January. Recent awards include the McLean Award for David Curtin, the 2022 CAP-INO Medal for Outstanding Achievement in Applied Photonics for Hoi-Kwong Lo, a 2022 Dean's Research Excellence for Kaley Walker, and the 2023 Chancellor's Leadership Award in the Distinguished Leader category for CAO Peter Hurley. John Sipe's 50 years in the Department were celebrated by mentees and colleagues at a 'Siposium' held in February. We also mark Information Systems Specialist Julian Comanean's twenty years working in Physics.

The Newsletter also highlights our 2022-23 Physics Career Accelerator Program and various Outreach in Action activities, including our Pursue STEM program to encourage Black and Caribbean students to pursue studies in science, technology, engineering and math, which is now in its third year, as well as the School Visit Program and the CAP High School Exam Workshop. The Department is participating in two major outreach events in May, providing demos and activities for Science Rendezvous on Saturday, May 13, and Doors Open Toronto tours of some areas of the McLennan Physics building on May 27 and 28.

I'm delighted to report that our appeal for donations to establish the Momentum Builders Scholarship to support Black and Indigenous undergraduate students in Physics has raised an endowment of more than $100,000! We now have sufficient expendable funds to begin awarding scholarships and a call for applications was recently sent to our undergraduate students. We look forward to awarding the inaugural scholarships soon. Meanwhile, donations can still be made to the endowment via this link. A sincere thank-you to everyone who has supported this initiative.

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

Wishing you an enjoyable summer.

Kimberly Strong

Professor & Chair

Sunset from McLennan Physics Labs, 11th floor
(credit: Geremia Massarelli)

McLennan Physical Labs Walkway
(credit: Daisy Yuan)

THE WELSH LECTURES
IN PHYSICS 2023

PROF. MARCIA J. RIEKE
Regents' Professor of Astronomy, Astronomer and Elizabeth Roemer Endowed Chair, Steward Observatory

PUBLIC TALK
THURSDAY, MAY 11, 1:30 PM
The Webb Telescope's First Year: A Treasure Trove of Results
EARTH SCIENCES CENTRE
Auditorium ES1050, 5 Bancroft Ave.

COLLOQUIUM
FRIDAY, MAY 12, 2:00 PM
The Webb Telescope: Twenty Years in the Making but Worth the Wait
KOFFLER HOUSE
Auditorium KP 108, 569 Spadina Cres.

DR. OMAR HURRICANE
Distinguished Member of the Technical Staff, Chief Scientist for the ICF Program, Lawrence Livermore National Laboratory

PUBLIC TALK
THURSDAY, MAY 11, 3:30 PM
The Ignition Venture and Gain
EARTH SCIENCES CENTRE
Auditorium ES1050, 5 Bancroft Ave.

COLLOQUIUM
FRIDAY, MAY 12, 11:00 AM
How Ignition and Target Gain > 1 was Achieved in Inertial Fusion
KOFFLER HOUSE
Auditorium KP 108, 569 Spadina Cres.

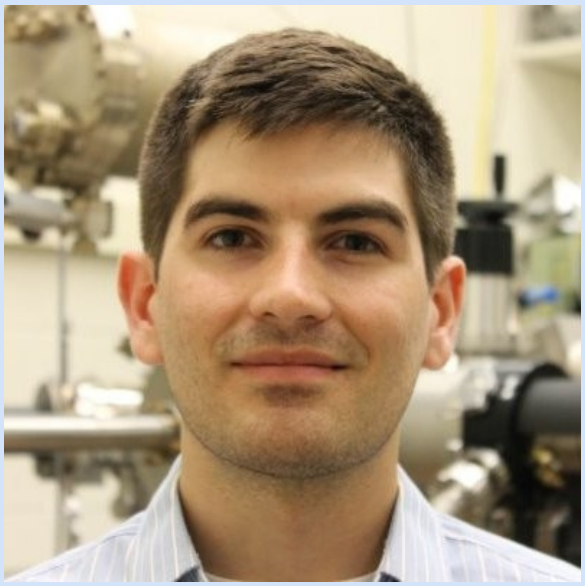
Sponsored by the Department of Physics. For further information, call (416) 978-7135, visit https://welsh.physics.utoronto.ca/ or email: iyer@physics.utoronto.ca

Image Credits: NASA and Lawrence Livermore National Laboratory

Faculty Profile

Sergio de la Barrera

Assistant Professor, Experimental Quantum Condensed Matter Physics



Dr. Sergio de la Barrera joined the Department on April 1, 2023.

Welcome to U of T Physics Dr. Barrera!

What is your area of research or expertise?

My areas of expertise include 2D materials, low-temperature physics, and superconductivity. My experimental background includes nano-fabrication, moiré materials assembly, quantum transport, electronic compressibility measurements, and planar tunneling spectroscopy. The latter two methods are uncommon and set me apart from other researchers in the field.

How did you get introduced to research on 2D materials?

I began my career in condensed matter physics in 2011, as graphene and other 2D materials were beginning to take center stage. While pursuing my Ph.D. with Prof. Randall Feenstra, an expert in tunneling spectroscopy at Carnegie Mellon University, I utilized the momentum-conserving property of vertical tunneling between 2D layers and the twist degree of freedom in van der Waals materials to explore physics that was not accessible in 3D. I developed a theory of planar tunneling between 2D materials including twist angle, wavefunction chirality, momentum relaxation, elastic- and inelastic-scattering-assisted tunneling, evanescent states in the tunneling barrier, quantum capacitance effects, and the electrostatics of dual-gated tunneling structures. While investigating these effects, I realized that twist provided access to momentum-space mapping of electronic structures in 2D, but the technology to continuously control twist angle did not yet exist.

What did you focus on in your postdoc research?

During my postdoctoral training, I broadened my focus into the areas of superconductivity, ferroelectricity, and other low-temperature phenomena. I also developed an expertise in electronic transport and compressibility measurements in 2D materials, including making

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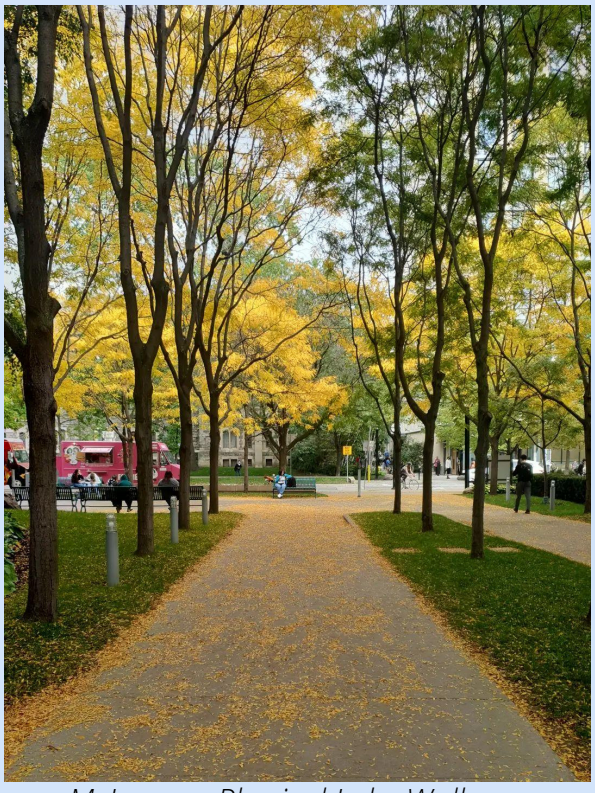
significant contributions to low-temperature cryogenic amplifier and filter designs, improving nanofabrication techniques and adapting existing methods to extremely air-sensitive materials.

How was your experience and time working at MIT?

At MIT, I worked in one of the leading moiré physics research groups in the world, with Prof. Pablo Jarillo-Herrero, experience I will now bring to Canada, where moiré systems are not yet a major experimental focus.

More on Prof. Barrera's research here: *https://barrera.physics.utoronto.ca/*

McLennan Physical Labs Walkway
(credit: Darya Zanjanpour)



McLennan Physical Labs Walkway
(credit: Dixshant Shree Shreemal)

Faculty Profile

Xiang Li

Assistant Professor, Physics and Chemistry of Quantum Materials

Dr. Xiang Li joined the Department on May 4, 2023.

Welcome to U of T Physics Dr. Li!

You completed your PhD in Chemistry from The Pennsylvania State University. How does you research in Chemistry overlap with your current research in Physics?

My PhD projects in Chemistry focused on the design and synthesis of a new class of one-dimensional carbon nanomaterials, i.e., nanothreads, from small organic molecules. The tetrahedral, diamond-like bonding in nanaothreads, which is clearly distinct from carbon nanotubes, makes it promising for superlative mechanical properties and for completing the last remaining entry in the matrix of the hybridization and dimensionality of extended carbon structures. The formation of these ultrathin 'diamond' threads takes place in high pressure cells with anvils either built with single crystal diamond or diamond powder. The research experience of working with diamond anvil cell and in-situ high pressure scattering experiments gave me the opportunity to join a condensed matter physics group at Caltech as a postdoc. Since then, my research focus moved down from the first two rows in the periodic table to the sixth, where the 5D transition metals are.

What is your current area of research and why did you choose this topic?

My current research includes exploring new phases in quantum materials, especially those under extreme conditions, and understanding their underlying physical and chemical principles. This uncharted phase space provides fertile ground to search for and realize novel states, at the cost of great experimental challenges. For example, the Raman scattering technique has been established for decades and has become a popular noninvasive characterization approach. However, taking the measurement in demanding sample environments that are far from ambient conditions (temperature, pressure, fields,

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etc.) is much less straightforward and requires nontrivial development in techniques. Each technique provides a limited window into the behavior of the material. We need to idevelop a variety of techniques to avoid the problems illustrated in the parable 'the blind men and the elephant'. The efforts that we have been making with our collaborators mainly focus on using light as the probe to study strongly correlated systems under cryogenic, high-pressure conditions. The measurement results cut across different energy and time scales by adopting different optical techniques.

What research and or discoveries are interesting to you today?

Interdisciplinary research is increasingly appreciated these days, and the theme of quantum materials is one of the natural meeting points where researchers coming from diverse backgrounds can/need to work closely. While inorganic systems currently make up the majority of work in the broad field of quantum materials, organic materials are a promising source for both scientific investigation and next-generation technology, given the merits of abundant raw materials, greater chemical tunability, and low processing cost. For instance, metal-organic materials have long been the attractive systems for chemists, including but not limited to their applications as the storage media for gases and catalysts. Recent studies showed that certain metal-organic materials possess excellent magnetic properties that are comparable to those purely inorganic magnets available on the market. In the meantime, they offer the hope of building lightweight magnets with more abundant material source. This is an outstanding example of research that encompasses perspectives from both chemistry and physics, with great potential for application. I am also interested in the development of the frontier characterization techniques that are pushing probe and detection limits.

What are you looking forward to at U of T?

I found that my academic training experience in both chemistry and physics is sort of serendipitous. This joint appointment in the Departments of Physics and Chemistry at U of T is definitely an incredible opportunity to pursue interdisciplinary research.

Post-Doctoral Fellow Profile

Spencer Farrell

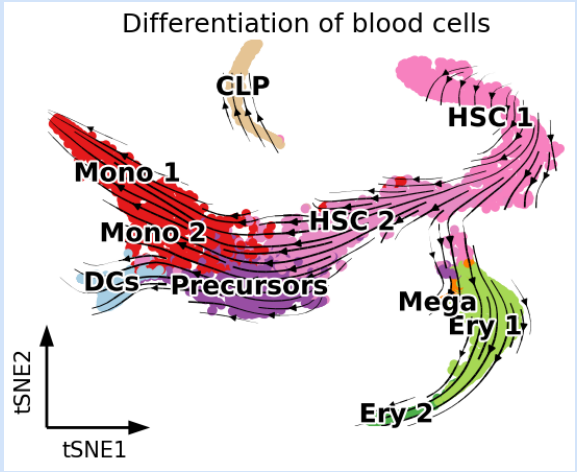
Biological Physics

Dr. Spencer Farrell joined the Department of Physics in March 2022 working with Professor Sidhartha Goyal. She has been awarded a University of Toronto Data Sciences Institute Post-Doctoral Fellowship. She is interested in developing and applying machine learning and data science methods to problems at the intersection of physics and biology.

Dr. Farrell is currently working on developing new methods to understand the process of cell differentiation, where immature cells mature into specialized cells. The development of single-cell sequencing technologies has resulted in an explosion of data, providing detailed information about single cells. Her work aims to develop new tools to analyze these data to understand the dynamics of cell differentiation in tissue development and cellular reprogramming.

Dr. Farrell initially got started in biophysics through her interest in computational physics. During her undergraduate years at Dalhousie University, she had the opportunity to work as a summer student performing simulations of enzymes diffusing through biological channels. From there her interest in biophysics grew and she has continued to work on a variety of problems in this area ever since.

During her PhD at Dalhousie University, she worked on human and animal ageing, developing computational methods to analyze ageing data. This interdisciplinary work involved collaboration with clinical medical researchers, experimental biologists, and biophysicists using a combination of machine learning and physics-based methods.



The Single-cell RNA sequencing (scRNA-seq) measures the gene expression of single cells. Spencer's research has developed an approach to infer the dynamics of cell differentiation from scRNA-seq data.

This figure shows a visualization of the gene expression of differentiating blood cells. Our approach infers the shown velocity field that indicates that stem cells (pink, HSC 1) differentiate into a variety of other blood cell types.

Graduate Student Profile

Emily Zhang (She/They)

PhD Candidate in Physics (4th year)
Quantum Condensed Matter Physics

As a daughter of Chinese immigrants, Emily was always encouraged to pursue a career in a field with a stable income, like medicine or law. Thinking these were the only two options, her affinity for math and science drew her to the former when she was choosing her undergraduate program. She discovered her love of physics when taking her prerequisite first year courses, took a leap a faith and switched programs, and hasn't looked back since.

Emily obtained her Bachelor of Science, Honours in Physics at the University of Ottawa. Having zero guidance on how to navigate the institutions of academia, and with the lack of representation of people that intersected with her many minority identities, Emily had no idea what to do with a physics degree or where she would fit into the field. That is, until her second year, when she attended her first Canadian Conference for Undergraduate Women in Physics (CCUWiP). It was at this conference where she was exposed to the plethora of career options, and diverse physicists who were not only thriving in their careers, but also had fulfilling personal lives. This conference sparked her interest in equity, diversity, and inclusion in physics, and it was where she first learned about her future school of choice. At the graduate fair, Emily learned about the University of Toronto's research in condensed matter theory – a field she didn't know existed – which closely aligned with her own research interests. This, among many other reasons, drew her to choose U of T Physics for her graduate studies.

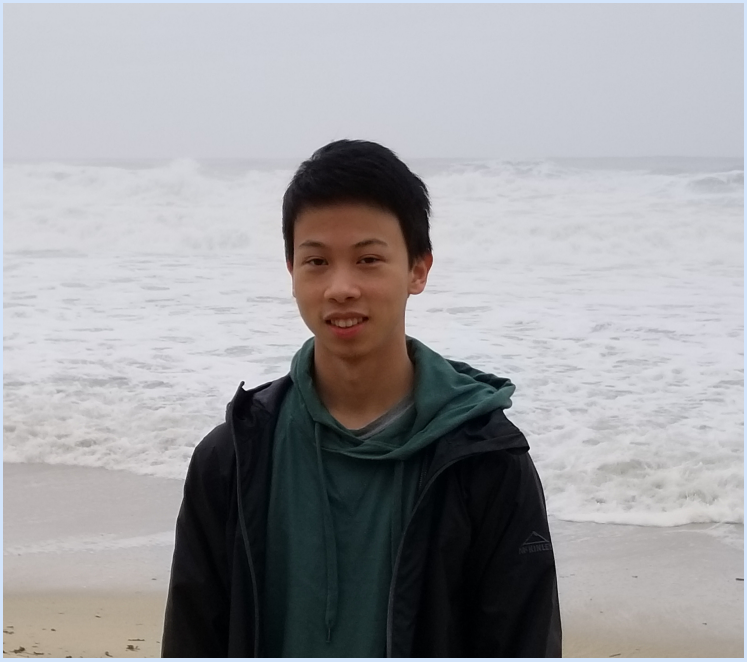
Emily works with Prof. Yong-Baek Kim as a condensed matter theorist, and her research focuses on quantum spin liquids. If Emily were applying for a grant, she would say that her research is going to facilitate the discovery of quantum spin liquid materials, giving rise to emergent laws of physics on your tabletop, with applications in topological quantum computation and quantum memory. However, Emily's actual favourite part of her research is solving complex problems without exact solutions using numerical methods. The endorphin rush of her code finally working after many hours of debugging is what fuels her graduate studies and is precisely the kind of rush she intends to chase after her PhD.

Outside of physics, Emily does jiu jitsu and rock climbing, which she describes as her jock era. She also enjoys cooking, crocheting, and networking (with computers rather than people).

Undergraduate Student Profile

Tony An

Program: Physics Specialist
Year of Study: 4



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

I was inspired by my friend Henry, who qualified for the International Physics Olympiad when we were in grade 10, and also my high school physics teacher Mr. Van Bemmel. Incidentally, his first name is also Henri. They showed me a ton of really cool stuff (including Morin's Introduction to Classical Mechanics) and I've wanted to keep learning more physics ever since.,

What do you enjoy most about the physics program?

I like how the physics program offers many easily accessible undergraduate research opportunities like the NSERC summer student program (which I did twice), SURF, and the supervised research courses. These were very valuable learning experiences for me.

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

I have fond memories of the Putnam training club, where we solved difficult math contest problems at weekly meetings. It was still held in-person when I was in first year, and this club was where I made most of my friends. I also managed to get a half-decent score on the Putnam competition that year.

What are your research interests?

My main interests tend to fluctuate around condensed matter physics, general relativity, and high energy physics.

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What is your favorite course and why?

PHY456 (Quantum Mechanics II) was fun; I thought Professor Erich Poppitz was hilarious. And now I finally know what a Clebsch-Gordan coefficient is.

I also want to mention PHY254 (Classical Mechanics). It was taught by Stephen Morris, who is not only a great lecturer, but the actual guy from the dominoes meme. I asked for his autograph, but he refused. So that's why it's only my second favourite.

What are your future plans?

I guess I'm going to graduate school for physics in the fall, and I'm not sure what happens after that. Honestly, thinking about things 10+ years in the future kind of scares me.

Where do you see yourself in 10 years?

Oh, well in that case... I hope I will be doing something that I enjoy. It will probably involve physics research.

Tell me something interesting about yourself.

My hometown is Toronto, so you could say that I'm a ToronTonyAn.

McLennan Physical Labs Picnic Table (credit: Amar Vutha)

Emeriti Profile

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

James R. Drummond

How many years you were a faculty member in the department of Physics?

1979-2006

Can you tell us about your educational background?

I studied at Oxford University, Jesus College. I read Physics from 1969-1972. My next degree was a D.Phil. from 1972-1979 under the supervision of John Houghton who was one of the pioneers of the Intergovernmental Panel on Climate Change (IPCC).

What was your PhD on and why?

My thesis was about a balloon program to measure nitrogen oxides in the stratosphere, which was of interest because of a controversy over the destruction of the ozone layer due to nitrogen oxides from the Concorde supersonic aircraft. At that time it was speculated that there would be a fleet of Concordes flying eight hours every day – remember that this was before the first 1970 oil crisis.

My thesis project was to help construct an instrument and fly it on a balloon in the South of France - in summer no less!

My thesis was nearly done in late 1975, when I was asked to pause it and work on a satellite instrument (I got paid for it!) which became the SAMS instrument in the Nimbus G satellite, and so I only got back to my thesis in 1977 to write it up and pass the viva (exam).

What kind of physics did you teach? And why?

I used to teach electricity, electronics, atmospheric radiation, and the laboratory courses. Why? – because I can't do theory! I also love tinkering with things and making things work.

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I also like to think about how we do things. I used to occasionally give talks about how we could quickly figure out how to fix a computer program, instrument, etc. that didn't work and talked about the process of devising tests and ensuring you understood the results. (The most difficult-to-diagnose dead instruments are those that blow the fuses immediately because you can't do any diagnostics on them.)

I also used to think about how to present our results with colleagues and others and share the excitement of our research. This was in the early days when these were new thoughts. When the Department asked me to a seminar about this, I said that I would only do it if the first sentences of the abstract would be: "Have you ever fallen asleep in a physics lecture? Were you giving the lecture at the time?" Unfortunately, they took me up on it.

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

The Geophysical and Atmospheric Physics daily coffee mornings were special. Connie was the person who made the coffee and tea. People actually came and talked face-to-face about science (and other things). I met Gordon West, Richard Peltier, George Garland, Nigel Edwards, and others. Even Tuzo Wilson made an appearance occasionally. Now that everything is "virtual", it is really hard to get people to become a community. The room is still there, but the room is often empty.

My major in-house project during the time I was in Toronto was the Measurements Of Pollution In The Troposphere (MOPITT) which started in 1987. The main instrument was built by COMDEV in Cambridge down the road, and we built a test chamber and clean room in the basement. The test chamber is still there because no one knows how to get it out! MOPITT was launched on the Terra satellite on December 18th, 1999 – just before Y2K. That was a great time with high pressure to make things work. Paul Chen was the main technician and many other faculty, graduate students and undergraduate students participated. Recently we counted up and found over 50 people who have been involved in the project. As of now, January 2023, MOPITT is still running.

Dr. David May and I also ran a difference frequency laser spectroscopy laboratory, and we produced a lot of papers, students, and memories.

In 2003, Dr. Kim Strong and I (and others) proposed The Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nunavut which is at 80N and 86W. We got a $6.9M grant from the Canadian Foundation for Innovation (CFI) and produced one of the few observatories so high north. Since the location is so isolated (no roads and so on), when everyone came to a campaign we were all together – faculty, technicians, and students together with one purpose. Those connections made between people then have continued even now. I have now passed the PEARL baton to Kim Strong and Kaley Walker and there are over 25 instruments still active there now.

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James Drummond with wife Rosemarie Drummond, UK Peak District, 2022

How has the Physics Department changed since you were a faculty member?

Computers, e-mail, paperwork, and diversity – not in any particular order. When I started, there were few computers in the university. One was the central computer which had a terminal on the 12th floor with a line printer and a card reader. The high-energy Physics group had their own computer as well. Another was in the atmospheric Physics group so that we could connect to the Cray 1 in the National Center in Atmospheric Research (NCAR) in Boulder Colorado. We had a 50 Mbyte disk that cost more than $10,000 and was as big and noisy as a washing machine. There was a new "word processor" on the third-floor coming in. Gradually during my time, we got more and more computers. During the 1990s, we had discussions about finding the funds so that we could have one computer for each group, then each faculty member, and then for each student. Now (almost) everyone has one in their pocket, and the idea of doing research without a computer is farcical.

What can I say about e-mail (and now "social media")? It is like fire: good in its place and terribly destructive outside. I still work through my e-mail every day and some of it is useful, and the rest is not.

I think that the paperwork deluge was spawned by the computer revolution and e-mail. When I started, all paperwork had to be typed by a typist and this limited the paperwork. The circulation of a memo was limited by the number of carbon copies in the typewriter. Now we can circulate everything to everyone, but then we have difficulty sifting.

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out the important things from the rest. Proposals were short and about the research. I remember equipment proposals with a two-page limit. Now proposals are often as much about the "rest" as about the science. All proposals are long and have to cope with ramifications far away from the science issues even sometimes to the exclusion of the science.

I also note that the mix of the Department has changed significantly. I arrived after the explosion of the faculty in the 1960s and around when I began there was a lull in hiring. Then everyone realized that we needed young people (by that time I wasn't a young person) and they were hired through various means. Then it was realized that women were not properly represented, and efforts were made to recruit women and now there is a diversity effort to make the cohort more representative.

What have you been doing during your retirement?

Retirement – what's that? I technically retired from the Department in 2006, but I immediately took up a Canada Research Chair in the Physics and Atmospheric Science Department at Dalhousie University in Halifax. Then I retired again in 2016 but have still been active in both the MOPITT project which is still running, and the PEARL project and have several virtual meetings every week.

Throughout my life, I have been involved in a church and am currently a member of West End Baptist Church. This is important to my life and well-being and connects with my concern about the climate.

I love doing things with my hands and my brain. At the end of my career, I did a lot of management and that got me away from doing more "interesting" things. I have finished a renovation at our house – although houses are never completed finished. I have been playing with some of these wonderful technical gizmos that have come along – raspberry pis and picos (those are really tiny computers and cost as little as $4) – 3D-printers - I have one in my basement - and I am also building a model railway in my basement. What would my first projects have been like if I'd had access to these toys, I wonder?

Anything else you would like us to know or share?

In 1987, I went to a seminar with Richard Hamming – Hamming codes, Hamming windows and others – with the title "How to be a Famous Scientist". You had to go to a seminar with that title! The funny thing is that he made three points and even 35 years later I can remember them:

1) Work on the big problems: You won't be successful if you only look at the small problems - think big thoughts and solve them.

2) Don't have lunch with your colleagues: His point was the biggest advances are achieved by taking the knowledge that is well-known in some fields and moving it into another field. So have lunch with another group who don't have your knowledge and share.

3) Take Friday afternoons to think deep thoughts. Take some time to reflect on important things rather than deal with the minutiae of life.

Alumni Profile

Jonathan Gotfryd

HBSc 2004 - Physics and Philosophy Specialist
MArch 2011 - Architecture

Jonathan Gotfryd is currently working as an established Set Designer with the Directors Guild of Canada. He graduated with a degree specializing in both Physics and Philosophy in 2004, and later pursued a Masters in Architecture and has been working within the field of Design since.

Why did you choose physics?

Upon graduating high school in 1999 from the Etobicoke School of the Arts, I chose to pursue an undergraduate degree in Physics because I sought to understand the human capacity to perceive and represent light and matter. Throughout the previous five years, I had been studying Visual Arts, which included drawing, painting, sculpture, and photography. Whatever mechanisms had been responsible for my abilities to do so, I wanted to research and understand. This included mechanical, quantum, and nonlinear physics, as well as a trove of electives in astronomy, quantum field theory, and lasers. As my undergraduate degree continued, however, I grew to recognize Philosophy too, as another, related discipline for understanding our perception of light and matter. So, I delved into the philosophy of physics, studying various conceptions of spacetime, contemporary philosophies of human and artificial intelligence, as well as language use and meaningful appropriation, especially as they relate to the mathematics, I had been exposed to within the Physics Department. In the end, I could not choose between Physics or Philosophy, and so I completed my degree after an extra year to specialize in both.

What are you doing now?

After graduating from the Physics Department, I completed a Master of Architecture at the University of Toronto, and since then, I have been working steadily within the field of design. Filling positions like Research Technician, Systems Designer, and Set Designer; I have been drafting and helping bring to fruition the vision of renowned architects, artists, art directors, production designers and film makers. Currently, I am between projects, working as an established Set Designer with the Directors Guild of Canada.

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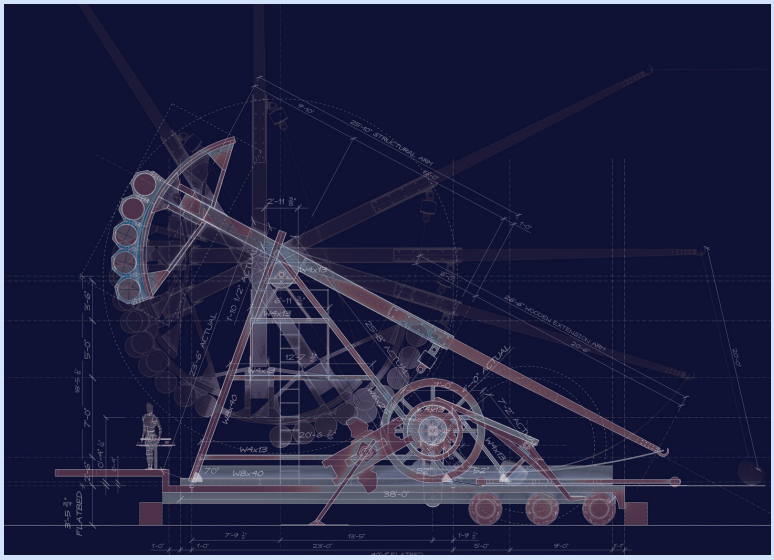
How has physics helped you in this career?

Contemporary design has come to include a great deal of computation. As numerically controlled devices become more prevalent in fabrication and even proposal phases of any design work, a deep understanding of geometry, and the physics behind form generation can facilitate mastery of this. My Physics degree has not only fostered an understanding of geometry but provided me with the foundational knowledge required to practice computational design.

What are your fondest memories of being a U of T Physics student?

Some of my fondest memories of being a U of T Physics student stem from the social aspects of research within the field. Students with varying backgrounds, genders, and interests come to U of T for its renowned programs, and within Physics, there is a shared longing for integrative knowledge that encouraged me and my colleagues to look beyond our differences. I chose physics to understand the human capacity to perceive and represent light and matter. I enjoyed it at U of T because I could collaborate with so many different people.



The first image is a drawing that Jonathan Gotfryd made for See: Season 3, and the second photo shows a Build on Location.

CREDITS:

See: Season 3 – Apple TV+
Production Designer: Dean A. O'Dell
Supervising Art Director: Brent McGillivray
Construction Coordinator: Vince Donato
Key Scenic Artist – Jennifer Wardle
Special Effects Supervisor: Tony Kenny
Art Director: Guy Roland
Set Designer: Jonathan Gotfryd
Special Effects: Dynamic Effects Collective
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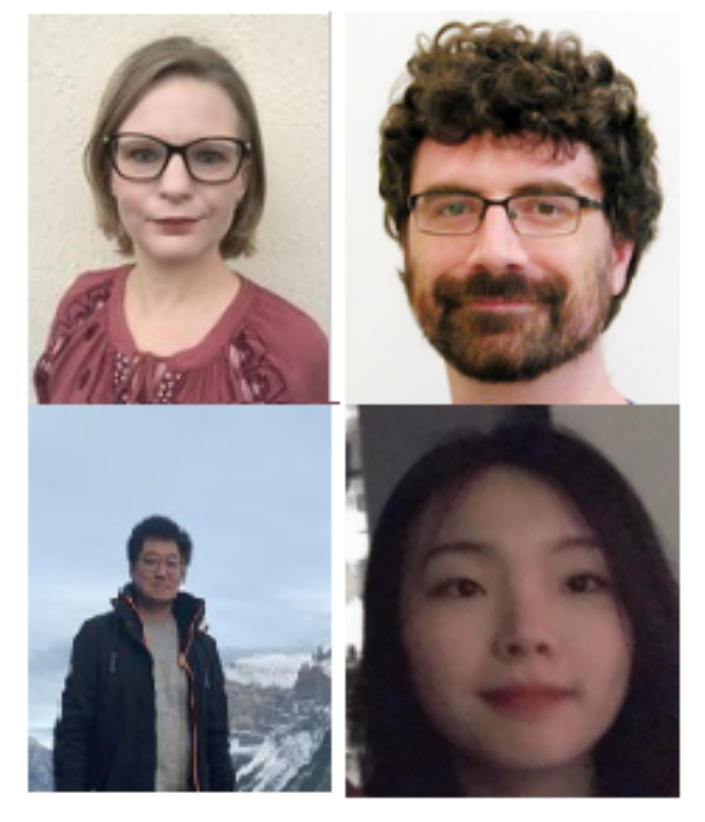
Research Spotlight

Barbara Zemskova - Earth, Atmospheric and Planetary Physics

"A deep-learning estimate of the decadal trends in the Southern Ocean carbon storage" published in July 2022 in *Nature Communications*



Authors: Barbara Zemskova, Nicolas Grisouard, Tai-Long He, and Zirui Wan *(top left to bottom right)*

We spoke to post-doctoral fellow Barabara Zemskova about this work.

Can you tell us a little bit about the research you have been doing and its importance?

One of the major sinks for anthropogenic carbon dioxide is thought to be the ocean, in particular at the higher latitudes because the solubility of gases increases with decreasing temperature. It is estimated that the Southern Ocean, where persistent zonal (i.e., east-west) winds are strong and temperatures are relatively cold, is responsible for approximately 40% of the oceanic carbon sink of anthropogenic emissions.

Understanding the changes in ocean carbon content is crucial not only for understanding the climate, but also marine chemistry. For example, an increased amount of dissolved carbon in the ocean has led to ocean acidification, which affects marine organisms. However, there are large uncertainties regarding the carbon storage potential of the ocean: studies have shown that after a period of decline during the 1990s, ocean carbon uptake may have increased in the 2000s. Because the shipboard measurements of carbon content in the ocean interior are sparse both spatially and temporally, estimating ocean carbon trends is difficult. Recent deployment of Argo floats (robotic instruments that drift around in the ocean interior) equipped with biogeochemical sensors has greatly enhanced the volume of available data; however, the timeseries of this data span a relatively short time period since 2014.

Our research attempts to resolve this issue of scarcity of carbon concentration data below the ocean surface through machine learning.

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We developed a deep-learning neural net model that takes as input ocean surface measurements, which are readily available from satellite observations at regular and high-resolution spatial and temporal intervals. Our model then outputs estimates of dissolved inorganic carbon concentrations from the ocean surface to 4 km depth. We applied this method to calculate trends in ocean carbon concentrations over the past three decades and found that while ocean carbon content has decreased in the 1990s and 2000s, it has been decreasing at a faster rate since the 2010s. This means that the ocean's potential to take up more atmospheric carbon has declined. Importantly, once trained, our model is fast and computationally inexpensive, which gives it an advantage over traditional ocean models. This makes our model a useful tool for monitoring future ocean carbon content from new satellite measurements as they become available.

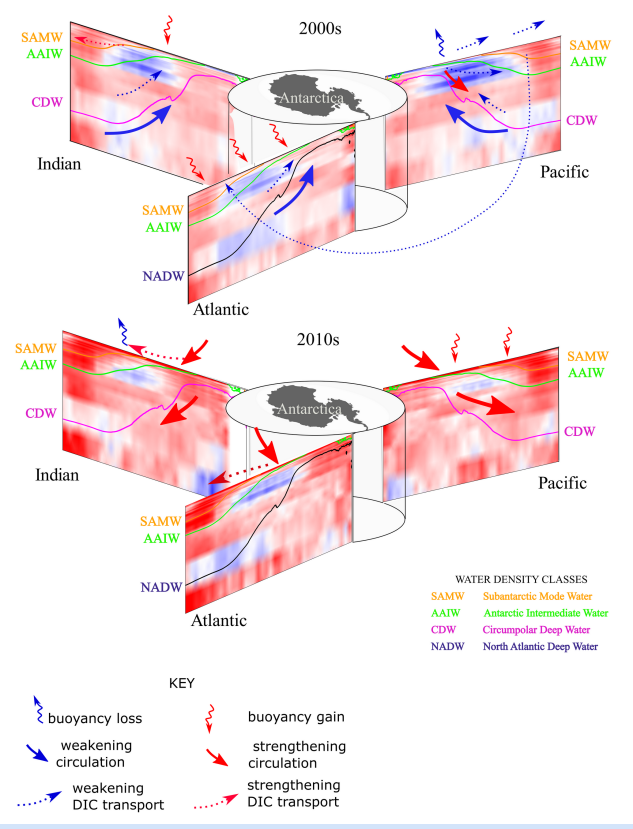

Figure: Schematic of the mechanisms affecting dissolved inorganic carbon (DIC) trends in the 2000s and 2010s broken down by ocean sectors (Atlantic, Pacific, Indian). Solid colored lines trace out representative density surfaces of each water-mass: Subantarctic Mode Water (SAMW), Antarctic Intermediate Water (AAIW), Circumpolar Deep Water (CDW), North Atlantic Deep Water (NADW). Blue (red) color shading indicates decreasing (increasing) DIC trends. Curly arrows mark buoyancy forcing at the surface: blue (red) indicating buoyancy loss, i.e., input of denser water (buoyancy gain, i.e., input of lighter water). Solid thick arrows mark changes in ocean circulation: blue (red) indicating weakening (strengthening) flow in the indicated direction. Small dotted arrows mark relative strength of DIC transport: blue (red) indicating weakening (strengthening) transport or transport of lower (higher) DIC concentrations.

What is your area of research and why did you choose to specialize in this field? How does it relate to the research article in the spotlight?

I am a physical oceanographer, and my area of specialization is understanding the physical mechanisms that drive mixing in the ocean interior, in particular what processes control the transport and distribution of heat and dissolved gases below the ocean surface. As my

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graduate education was interdisciplinary across different fields of marine sciences, one of my research goals is to connect the physical mechanisms that I study to biogeochemical processes, which fits well with the research article highlighted here. Most of my research has been driven by numerical modelling that is grounded by observational measurements. With the large volume of ocean data available from satellites, there is a big potential for the application of data science models to study the ocean, which is what we explore in the highlighted article.

What is the long term impact of this research?

Assessing the impact of atmospheric carbon uptake by the ocean requires both the estimates of past trends and continued monitoring efforts. Our model reconstructs the ocean carbon content for the past three decades, and computing new estimates requires only a small amount of computational resources and time. As such, it is a great tool to study the changes in the ocean carbon concentrations, which is important not only from a climatological point of view, but also for the management of marine ecosystems, which are sensitive to acidification.

What challenges do you face in this field of research and how do you overcome some of these challenges?

One of the major challenges in ocean modelling is that one must consider a wide range of temporal (seconds to decades) and spatial (millimeters to hundreds of kilometers) scales. Resolving across all of these scales takes a tremendous amount of computational power, time, and storage for model results, which is not yet possible with existing technologies and available resources. My research tackles this challenge by studying ocean processes in smaller-scale idealized set-ups in order to understand what mechanisms may not be fully captured in large-scale ocean circulation and climate models. Another challenge in oceanography is the sparseness of available direct measurements. Data science techniques, such as the deep-learning model used in the research article highlighted here, offer a promising solution to address this challenge in order to understand the spatial variability and temporal changes in the distribution and transport of tracers (e.g., heat, dissolved gases) in the ocean.

What else are you working on?

My current research has two primary directions. The first one involves further application of data science techniques (regressions and neural net models) to estimating carbon

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concentrations in the Labrador Sea. We seek to understand what physical and biogeochemical processes drive the spatial patterns and temporal changes in the carbon content. The second is focused on the generation mechanisms and propagation of internal waves, which are oscillatory movements below the ocean surface that exist because the ocean has variable density that changes, in particular, with depth. I focus on how these waves of different origin (either generated at the ocean surface due to wind blowing across it or by the flow encountering topographic obstacles along the ocean bottom) affect transport and mixing in the ocean interior.

Are there any other milestones that you hope to achieve and where are you in this process?

I am hoping to secure research funding in order to extend the model to other biogeochemical variables in the ocean. These estimates would enable us to separate the proportion of the increase in the ocean carbon concentrations that is due to the anthropogenic emissions compared with the portion due to the natural variability in the ocean circulation. Such a study would be able to assess the anthropogenic impact on ocean chemistry and evaluate the future carbon uptake potential of the ocean.

Read the full article here: *https://www.nature.com/articles/s41467-022-31560-5*

McLennan Physical Building on a snowy day
(Credit: Amar Vutha)

November 2022 PhD Graduates

Congratulations to our November 2022 graduates!

Bonsma-Fisher, M. J. - Population Dynamics of CRISPR Adaptive Immunity in Communities of Bacteria and Phages. (Supervisor S. Goyal)

Carter, J. W. S. - Luminosity studies and a search for heavy resonances decaying into a pair of Z bosons with the ATLAS detector. (Supervisor P. Kreiger)

Gryba, S. K. - From Dark Matter to Leptoquarks: Phenomenology of Physics beyond the Standard Model. (Supervisor D. Curtin)

He, T. - Mitigating model errors in chemical data assimilation: Application of new data assimilation and machine learning approaches. (Supervisor D. B. A. Jones)

Hirasawa, H. - Atmosphere and Ocean Components of the Sahel Climate Response to Aerosol Forcing. (Supervisor P. J. Kushner)

Huo, Y. - High Resolution Climatological Simulations for South and Southeast Asia and the Tibetan Plateau. (Supervisor W. R. Peltier)

Mirsanaye, K. - Digital Histopathology with Second-Harmonic Generation Microscopy. (Supervisor V. Barzda)

Nunn. C. J. - Mitochondrial genome dynamics in yeast: How mutation and selection inform the fate of a dispensable genome. (Supervisor S. Goyal)

Sarracini, A. - Time-Resolved Electron and Serial X-Ray Crystallography of PbS Quantum Dots and Biomolecules. (Supervisor R. J. D. Miller)

Smart, M. R. - Collective Dynamics of Interacting Cell Types. (Supervisor A. Zilman)

Towstego, T. - Study of Neutrino Oscillations with Enhanced Selection of Electron Neutrino Interactions. (Supervisor H. A. Tanaka)

Tretyakov, I. - Signal Processing and Instrument Characterization on a Large-N Radio Interferometer. (Supervisor K. Vanderlinde)

Venu, V. - Strongly Interacting Fermions in a Multi-Orbital Optical Lattice. (Supervisor J. H. Thywissen)

Zhang, C. - Interacting Electronic Orders in Cuprate Heterostructures and Praseodymium-doped Cuprate Thin Films. (Supervisor J. Y. T. Wei)

Xanadu Award

PhD candidates Noah Lupu-Gladstein and Batuhan Yilmaz receive the 2023 Xanadu Award for an Outstanding Publication in Quantum research.

With support from Xanadu, the Faculty of Arts & Science and the Department of Physics have established this $5,000 scholarship, which is 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 with U of T Physics faculty through the MITACS Program.

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.

Batuhan Yilmaz and Noah Lupu-Gladstein shared the award this year for their publication "Negative Quasiprobabilities Enhance Phase Estimation in Quantum-Optics Experiment", published in *Physical Review Letters*.

The research students shared their thoughts on their award-winning research:

What inspired you to pursue research in this field?

We love science that wrestles with fundamental questions but also has clear applications to something concrete. A few years ago, some theorists brought this topic to our attention. At the time, they had just discovered the connection between quasiprobabilities and metrology, but their work wasn't constructive. In other words, they knew that this link had

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to exist somewhere, but they didn't know where to find it. Together, we came up with an experiment that would probe the connection directly. It was really rewarding collaborating with the theorists and the other members of our lab to bring the experiment to fruition.

How does your research impact the society we live in today?

One of the most exciting parts of metrology research is that it underpins so much we take for granted in modern life. How are you reading this text? Your device measured small changes in the frequency of light (invisible to humans) propagating all around us. How does your phone know your GPS coordinates? Several satellites triangulated your position using clocks that are so precise, they are sensitive to corrections from general relativity. Metrology isn't just about studying one of these incredible feats, but rather studying measurement itself. As a result, new results in metrology can find their way into a wide range of applications.

What impacts do you hope to make through your achievement?

In particular, our experiment demonstrates a new way of dealing with detectors that saturate. We are looking into the way our results could be used to make cameras that take sharp images, even in bright lights.

Read the award-winning paper here:
https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.128.220504

More on Xanadu:
https://www.xanadu.ai/

Student Awards

PhySU receives the ASSU's Sanjeev Dewett Course Union of the Year Award

From left to right, Kat Benevides (PhySU President), Samuel Lakerdas-Gayle (PhySU VP Communications), Aditya Khandelwal (PhySU VP Social Events), Amelie Zhang (PhySU VP Academic Affairs)

The undergraduate Physics Student Union (PhySU) received the 2022-23 Sanjeev Dewett Course Union Award, which is presented annually to the most active course union in the Arts and Science Students' Union (ASSU).

PhySU was recognized for providing students with valuable academic and social experiences throughout the year, fostering a sense of community through social events. PhySU also engaged in monthly Arts and Science Student Union Council meetings to work in collaboration with other unions and student groups on campus.

For more on this award and an interview with PhySU President Kat Benevides:
https://www.physics.utoronto.ca/news-and-events/news/physics-news/physu-receives-the-assus-sanjeev-dewett-course-union-of-the-year-award/

Awards and Announcements

Professor Anton Zilman

Associate Professor Anton Zilman has been promoted to the rank Professor, Tenure Stream effective July 1, 2023.

Dr. Tahir Shaaran

Dr. Tahir Shaaran started a one-year appointment in January 2023 as a Visiting Scholar and member of the Quantum Optics group.

Professor David Curtin receives a distinguished Connaught Fund McLean Award

The McLean Award is funded by the University of Toronto's Connaught Fund and is given in support of basic research in physics, chemistry, computer science, mathematics, engineering sciences or statistical sciences. It is awarded to an outstanding researcher early in their career to assist in attracting and supporting graduate students and post-doctoral fellows as part of their research team.

David received the McLean Award in recognition of his exceptional record of achievement in theoretical particle physics, including studies of dark matter, the weakness of gravity, and long-lived particle signatures.

"It's a great honour to win the award," says Curtin. "It's wonderful validation of the research I'm doing and I'm very grateful for it. But I also see it as recognition of the amazing people already in my group," he says, "and the incredible wellspring of motivated, talented undergraduates and graduate students that U of T attracts."

More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/connaught-fund-mclean-award-winner-david-curtins-research-spans-the-subatomic-to-the-cosmic/*

2022 CAP-INO Medal for Outstanding Achievement in Applied Photonics awarded to Professor Hoi-Kwong Lo

This medal recognizes Professor Hoi-Kwong Lo's outstanding impact on the field of Quantum communication in terms of practical implementations, laying the groundwork for commercial products for the Quantum internet.

Hoi-Kwong Lo laid the foundation of security of quantum key distribution by proving its unconditional security, thus solving a long-standing problem. Thanks to his work, we now know for sure that QKD in principle offers information-theoretic security based on the laws of quantum physics. Information-theoretic security is the Holy Grail of secure communication. Given the growing importance of cyber-security, this is an important achievement.

More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/that-professor-hoi-kwong-lo-of-our-quantum-optics-group-has-been-awarded-the-2022-cap-ino-medal-for-outstanding-achievement-in-applied-photonics/*

Professor Kaley Walker receives a 2022 Dean's Research Excellence Award

In 2022, the Faculty of Arts & Science created the Dean's Research Excellence Award to recognize mid-career faculty members whose research achievements have been cited as especially noteworthy.

Professor Kaley Walker of the Earth, Atmospheric, and Planetary Physics Group received one of the five inaugural awards. She is studying the composition of the atmosphere through the development and use of ground-based, high-altitude balloon and satellite instrumentation, especially in relation to atmospheric ozone recovery and climate change. She leads research at the Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nunavut; is Deputy Mission Scientist for the Canadian Space Agency's Atmospheric Chemistry Experiment (ACE) satellite mission, launched in 2003; and is playing a leading role in the development of the next generation of Earth observation satellites for Canada.

More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/prof-kaley-walker-is-among-the-recipients-of-the-new-deans-research-excellence-award/*

Professor Kimberly Strong receives the 2022 APECS International Mentorship Award

(Photo credit: Troy Curtis)

More: *https://arcticnet.ulaval.ca/annual-scientific-meeting-2022/*

The Association of Polar Early Career Scientists (APECS) International Mentorship Award recognizes mentors who have contributed significantly over a period of several years to the mentoring and fostering of early career researchers involved in research in the polar regions or the wider cryosphere. The 2022 award was presented to Prof. Kimberly Strong "for her devotion to the success of her students" by APECS and the ArcticNet Student Association at the ArcticNet Annual Scientific Meeting held in Toronto in December.

Staff Awards

Peter Hurley receives the 2023 Chancellor's Leadership Award

The Chancellor's Leadership Award is part of the University of Toronto's Pinnacle Awards Program, which recognizes exceptional contributions by administrative staff and librarians. Recipients of the Chancellor's Leadership Award demonstrate outstanding leadership and significantly advance the University's mission to foster an academic community in which the learning and scholarship of every member may flourish.

Peter received this award in recognition of his outstanding leadership and exceptional level of commitment to the Department of Physics over the past 31 years. Peter is deeply engaged in all aspects of managing this large and complex Department to support its teaching and research mission. As a consummate professional with an unparalleled understanding of technical, managerial, financial, and policy issues, Peter is incredibly effective in his role. He is proactive in identifying issues, creative in solving problems, known for his kindness and responsiveness, and universally admired throughout the Department of Physics.

More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/awards/*

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Employee Anniversaries

Julian Comanean, Information Systems Specialist, Physics Computing Services

Celebrating 20 years at the Department of Physics

Steven Butterworth, who leads the PCS team, shared his thoughts about this milestone for Julian.

Very soon after my own arrival in December 2002, a hiring committee was struck to increase the PCS complement to four members with a new web specialist position. Amongst the 54 candidates who made it past HR vetting, Iulian quickly stood out for having both the technical and social skills to effectively fill the position. Once hired, he immediately began work revamping the Physics website, cleaning up many years of accumulated 1990s cruft, implementing a new look, and starting us on the path to the era of web application development that we are now in.

Over the last twenty years, Iulian has improved PCS and departmental processes by developing web-accessible, database-backed tools for:

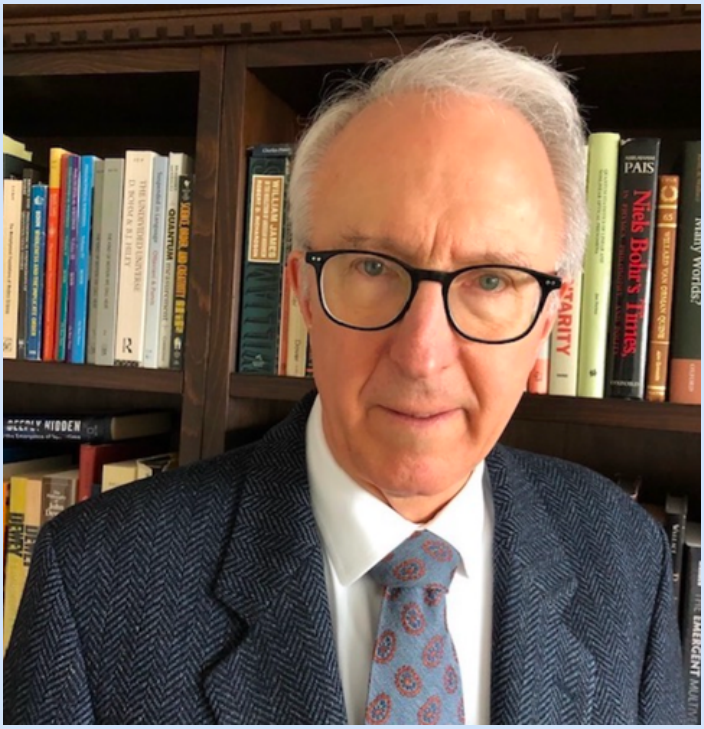
- updating personnel data,
- assignment and recovery of building keys and access FOBs,
- PCS billing
- building management,
- account lifecycle management, and
- tracking of numerous computer and network resources.

While Iulian's technical skills are impressive, I suspect that the biggest impression that he has left within the Department is with the dedication he brings to working with people to help them solve their problems, be they simple or complex. The feedback that I have received from staff and faculty has been almost uniformly positive, and occasionally, especially in the early days, bordering on ecstatic.

It has been a pleasure to work with Iulian for these two brief decades, and I look forward to many more years of rewarding and fruitful collaboration.

Congratulations, Iulian, on twenty successful years!

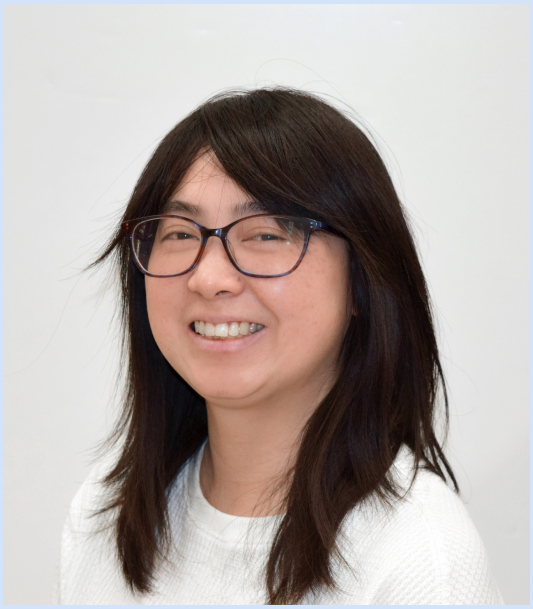
'Siposium' Celebration for John Sipe



On February 21, 2023, we celebrated 50 years of Prof. John Sipe's presence in U of T's Department of Physics; John came as a graduate student in the 1971-2 academic year, and after completing his PhD in 1975, remained in the Department as a postdoc and research associate until 1980-81, during which year he tried to continue his career outside of Toronto but then thought better of it, rejoining U of T as a professor in 1981. He has been and remains one of the stars of the Department ever since, known globally for his innumerable significant contributions to research, ranging from the philosophical to the applied. John is a Fellow of Optica, the Royal Society of Canada, and the American Physical Society, and is among other things a technical advisor at Xanadu, a company whose leadership includes a number of his former students. Locally, he is routinely held up by the Quantum Optics group as the exemplar of what it means to be a helpful colleague, and valuable collaborator, as well as a dedicated teacher, supervisor, and mentor. His students and postdocs have gone on to be leaders and pioneers around the world. For this celebration, organized by Marco Liscidini (Pavia) and Marc Dignam (Queen's), with some help from Aephraim Steinberg, 21 of John's mentees and past & present collaborators came to fête him with short scientific talks and warm reminiscences. The program at https://siposium2023.physics.utoronto.ca/program/ offers a glimpse into the remarkable breadth of John's interests and the talents he has fostered and encouraged.

By Professor Aephraim Steinberg

Arrivals



Eva Cheung
Graphic Designer and Print Operator

Eva Cheung joined the Department on October 31, 2022. She is a graphic designer with a decade of print industry knowledge, and promotional and informational design for print and digital media. Eva brings a wealth of graphics experience ranging from designing print and digital artwork, to developing assets for blogs, e-banners, e-signatures, brochures, newsletters, website, and social media. She provides her graphic arts and print production expertise to the Department. This includes the use of computer-aided tools to produce quality slides, posters, brochures, branding, illustrations and exhibit displays.

Supreet Randhawa
Outreach, Facilities and Special Projects Coordinator

Supreet joined the Department on January 30, 2023. She joins us from the Department of Mathematics with five years of experience in administrative and outreach positions. Supreet is passionate about youth education and her role in connecting pre-university students to the Department of Physics.

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Jean Xu
Physics Finance, Purchasing and MasterCard Program Administrator

Jean joined the Department on February 1, 2023, as the Finance, Purchasing and MasterCard Program Administrator. Jean previously worked in the Department of Molecular Genetics in the Faculty of Medicine as the Financial and Administrative Assistant, with a broad range of administrative responsibilities including procurement. She is very happy to join the Department and to be working with the staff, faculty, and students to promote education and research.

Diane Nguyen
Research Grants and Finance Assistant

Diane joined the Department on February 1, 2023. She came from the Department of Electrical and Computer Engineering (ECE), where she worked for a number of years as Administrative Coordinator. She was working closely with professors on a wide range of administrative and financial aspects of research operations. Prior to ECE, she worked in the government and non-profit sector in the capacity of grant-finance manager, looking after proposals, screening and budget planning and administrative operation. Her extensive experience, skills and knowledge in finance and administration has prepared Diane well for her position at the Department of Physics.

Departures

Aloma Namasivayam

With both joy and sadness, we announce the retirement of our esteemed colleague and long-standing Finance and Purchasing Administrator, Aloma Namasivayam. After 31 years of dedicated service to the Department of Physics at the University of Toronto, Aloma has decided to embark on a new chapter in her life and retire.

Aloma has been a valuable asset to our Department, consistently demonstrating her unwavering commitment to excellence in her work. Her knowledge and expertise in financial and procurement administration have been invaluable to the Department, making her an essential member of our team. Her attention to detail and passion for her work has earned her the trust and respect of all those who have worked with her.

Over the years, Aloma has become an integral part of the University community, building strong relationships with her colleagues, faculty, students, and vendors. Her friendly and supportive demeanour has earned her the appreciation and admiration of all those who have had the pleasure of working with her.

As Aloma embarks on this exciting new journey, we extend our heartfelt congratulations and best wishes to her. We will miss her energy, dedication, and enthusiasm, but we are confident that her retirement will be filled with new adventures, happiness, and fulfilment. Please join us in wishing Aloma a happy and fulfilling retirement.

By Michael Manley, Manager, Finance and HR Administration

Prof. Kim Strong, Aloma Namasivayam, and Prof. William Trischuk at the Farewell Luncheon 2023

Lisa Jefferson

Lisa Jefferson was a central figure in the financial administration of the Department for almost 20 years. She started working at U of T much earlier, in 1989 at OISE, then moved on to spend six years at the University of Toronto Schools before joining the Department of Physics in 2004 to take on the role of Research Grants and Finance Assistant.

For the next 20 years, she was indispensable in our financial office, always keeping a few steps ahead of PI's in grant administration, flagging problematic issues, making sure people met their deadlines and generally smoothing the way through the rules and regulations that would otherwise overwhelm us, all with her characteristic calm, efficiency and good humour.

A number of years ago when I was Chair, Lisa was the recipient of an administrative staff award recognizing her work. Maybe it was a particularly brutal year for grant requirements, but there was a flood of nominations for Lisa. Virtually all of the faculty nominations described how, with her characteristic calmness, thoroughness and forward-thinking, Lisa had saved the nominator from near-certain financial catastrophe. She was described as "tremendous … helpful … diligent … indispensable … resourceful … unfailingly helpful and creative … patient … accommodating" and with "tireless energy" and "good humour". Lisa's nominators not only praised her ability to solve problems, but more importantly, her ability to recognize an issue four months in advance and deal with it before it became a problem. As one of her nominators said, the Physics Department is exceptionally lucky to have her.

We were indeed very lucky to have Lisa, and we wish her the very best for her retirement.

By Professor Michael Luke

Prof. Kim Strong, Lisa Jefferson, and Prof. Michael Luke at the Farewell Luncheon 2023

Sheela Manek

When Sheela arrived in the Physics Department in Spring 2014, few knew the many roles she would play, some official, but many she created herself. With her ideas, skills, and enthusiasm, the Physics Department became a leader in Arts & Science outreach, and she also took care of many other Physics special events and quickly responded to the many maintenance issues associated with our geriatric building. It is impossible to list everything she did, especially since so much of her work was done so invisibly that we were not even aware of it. Many of us have been saved from a tricky situation by Sheela's forethought and great organization.

Sheela was the Physics Department's primary contact for everything outreach: high school visits, Science Rendezvous, Alumni Reunion, Doors Open, Science Unlimited Summer Camp, undergraduate mentorship, public lectures, …. Sheela kept track of and managed all the organizational details: publicity, volunteers, scheduling, food, photos, Instagram, Zoom, …. She did this all with invariable enthusiasm, optimism, and good cheer, so working with her was always a joy.

Sheela was also the person to call whenever anything went wrong or needed fixing: if your office is freezing or boiling – contact Sheela; if water is pouring through your lab ceiling – contact Sheela; if a window or door or sink is broken – contact Sheela. She even saved the University network services from crashing by banging on their door to let them know their computer room was flooding and leaking down into the Physics undergraduate labs.

Another great thing about working with Sheela was that she never cringed if someone proposed something new. Professors are creative and regularly come up with ideas which are often weird, occasionally good, but almost always make work for someone else. Sheela never complained but instead always happily tried to figure out how to make it happen. Even more importantly, Sheela didn't just manage and administrate, she innovated. She was constantly thinking about how our Outreach could be improved, making suggestions, and coming up with new ideas. None of us would have thought of being part of Toronto Doors Open, Canada's largest public architectural festival, but Sheela made the connection. This has now become our largest annual outreach event, with over 1800 visitors to the McLennan Physics Building in a single weekend. Sheela was a driving force.

This also illustrates Sheela's great skill in creating relationships. She regularly reached out to other science and math departments to partner in outreach activities.

While working on her Higher Education Leadership M.Ed. at OISE, she made the crucial contact that eventually led to the creation of the Pursue STEM program for Black high school students. One of Sheela's priorities was outreach to groups that are traditionally underrepresented in Physics, in particular Black and Indigenous youth. She knew that Physics could not do this on our own – we needed a strong community partner so Sheela took the initiative to reach out to a wide variety of groups. Making connections and building trust takes time, and finally in 2020, Physics partnered with the Lifelong Leadership Institute, whose Leadership By Design program turned out to be a perfect match for our goals. In short order, Physics developed the Pursue STEM initiative that currently provides activities for over almost 70 high-achieving Black high school students. Aside from organizing and administering the program, Sheela was key in securing funding from the Provost's Office.

It can't be overemphasized how critical it was for Outreach to have Sheela's ability to track and manage so much. For example, just Pursue STEM involved eight university departments, volunteers from all those departments, university recruitment, our community partner, three graduate student facilitators and a coordinator, and the Canadian Black Scientist Network. Sheela was the person who "kept all the balls in the air."

Sheela was also the key person in involving Physics graduate and undergraduate students in both our own activities and other outreach programs we support, enriching the lives of both our students and the school students in these programs. Few of our programs could happen without student volunteers, and Sheela worked with our Physics Graduate Student Association, our undergraduate Physics Student Union, and many individual students.

During the pandemic, Sheela still kept everything running remotely from a few hours outside Toronto. Unfortunately for the Physics Department, she also realized she enjoyed living outside Toronto, both up north and down south in Jamaica.

We will all miss her awesome competence, sunny disposition, and - not least of all - her home-made cookies. We wish her excellent scuba diving, wonderful travels, and a great future.

By Professor David Bailey, with inspiration from Professor John Sipe, Professor Stephen Morris, Professor Jason Harlow, Professor David Curtin, and Greg Wu.

Farewell Luncheon: 24 February 2023

NuRee Lee, Daisy Yuan, Prof. Kim Strong

Prof. Kim Strong, Raul Cunha, Peter Hurley

Prof. Kim Strong, Ana Sousa, Prof. Dick Peltier

Prof. Kim Strong, Dylanne Dearborn, Prof. Stephen Julian

PhysCAP Recap

Updates from the Physics Career Accelerator Program.

Physics Mentorship Program

The 2022-23 Physics Mentorship program closing event took place on Tuesday, April 4, 2023. The event was held in-person and was attended by Mentors and Mentees.

The program had 54 pairs of Mentors and Mentees participate, with meetings throughout the academic year (both in-person and online).

Selected mentee comments:

"I gained specific knowledge pertaining to grad school choices, the difference between business/industry and academia, and advice for navigating interactions with administrators. I also learned about the intricacies of grant writing and what a career in academia looks like."

"I gained insight into what working in the field of physics sort of looks like and how the hiring process works. I learned about how to make my resume better and what employers look for in a person they're hiring."

"It is such a valuable opportunity for me to get in touch with an expert for learning and planning my future career path. I feel like I have accumulated lots of crucial points for getting in touch with the professors and doing research."

Selected mentor comments when asked what they liked best about the program:

"Getting to know a great, smart, engaging student and perhaps being able to help them a little bit."

More information on the Physics Mentorship Program can be found here:

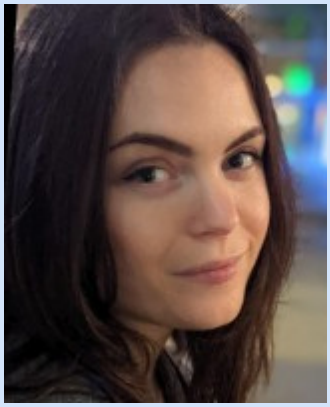
https://www.physics.utoronto.ca/undergraduate/physics-career/mentorship/

PhysCAP Recap

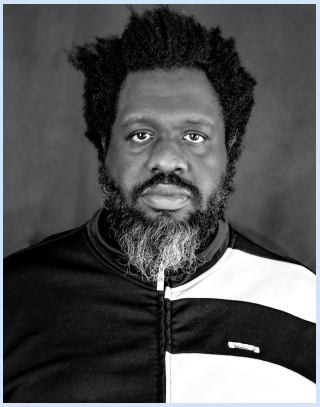
physCAP Careers Outside Academia

The 2022-23 PhysCAP Careers Outside Academia event was held on Thursday, March 2, 2023. Upper-year students attended a panel discussion by physics alumni who have pursued careers outside academia. Students learned about career opportunities relevant to their degrees in physics and about the skills that employers value. The event featured a diverse group of speakers who shared their personal stories and described the paths they had taken over the years and how their trajectories had shifted from their original plans.

Event panelists:

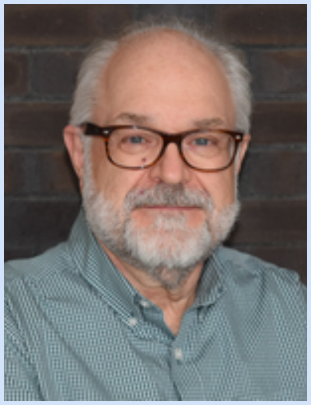


Jaclyn Marcil
Specialty Tax Analyst - Research and Development
HBSc (2016) - Mathematics and Physics



Julius Lindsay
Director, Sustainable Communities, David Suzuki Foundation
HBSc (2006) – Mathematics and Physics

Lucas Durand
VP, Data Science Engineering
HBSc (2013) – Physics & Philosophy (Specialist), University of Toronto
MSc (2016) – Theoretical Physics, York University



Peter Hurley
CAO, Department of Physics
BSc (1979) – Physics, University of Toronto
MSc (1983) – Geophysics, University of Toronto

Outreach in Action

Pursue STEM

If you happen to be in the Physics Department on some Saturday afternoons this spring, you may notice many excited students participating in the Pursue STEM science and math enrichment program for Black high school students that is now in its third year. The program was initiated and led by the Physics Department in partnership with the Lifelong Leadership Institute (LLI) as part of its Leadership By Design (LBD) program and provides science activities by leading faculty and students from the Departments of Astronomy & Astrophysics, Cell & Systems Biology, Chemistry, Computer Science, Earth Sciences, Mathematics, Statistics, and the School of the Environment. The program is supported by the participating departments, the Office of the Provost, the Faculty of Arts & Sciences, the Canadian Institute for Theoretical Astrophysics, and the Dunlap Institute for Astronomy & Astrophysics. The program has also benefited from help and advice from the Canadian Black Scientists Network.

This year we are very excited to be offering most of the activities in-person for the first time. The kit-based at-home sessions that ran over Zoom in previous years were very successful, but hands-on interactive science and math are always better with in-person engagement, and having access to university labs and facilities greatly increases what we can offer students. Because students come from all over the Greater Toronto Area, we also provide space and LBD provides refreshments and discussion for waiting parents.

Grade 10 group photo, 2023

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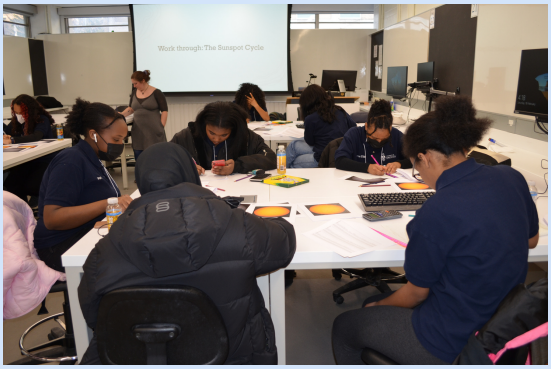


Pictures from the 2023 workshops .

So far this year, students have investigated the mathematics of museums, used Arduino microprocessors, studied worm regeneration, panned for precious minerals, and much more. We are looking forward to the rest of the program and are already planning for next year.

Thank you to the Departments of Astronomy and Astrophysics, Cell and Systems Biology, Chemistry, Computer Science, Math, Earth Sciences, Physics, Statistics, and the School of the Environment for another successful year.

Pursue STEM provides high-achieving Black high school students with the opportunity to participate in STEM workshops. The program is a joint effort between U of T Physics, U of T Office of Student Recruitment, and Leadership by Design.

Grade 11 group photo, 2023

More on Pursue STEM:
https://www.physics.utoronto.ca/physics-at-uoft/outreach/pursue-stem/

Outreach in Action

U of T Physics School Visit Program

On November 9, 2022, grade 4 and 5 students from Dr. Eric Jackman Institute of Child Study participated in a school visit to the Department. Professor Ania Harlick demonstrated cool physics experiments in the lab.

On November 10, 2022, grade 12 students from Greenwood College School came to the Department for a workshop on light-matter interactions by Joscelyn van der Veen (a graduate student in the Department of Physics). This was followed by a campus tour.

Continued on next page.

On November 23, 2022, grade 11 and 12 students from the Ontario Science Centre School attended a workshop on "Laser Diffraction" by Prof. Brian Wilson. Students also participated in a self-guided tour of the campus in the morning.

On February 22, 2023, grade 4 and 5 students from the Dr. Eric Jackman Institute of Child Study participated in a school visit. Prof. Daniel Gregory from the Department of Earth Sciences ran a workshop on “Starburst Rock Cycle”.

Are you a high school teacher who wants to bring your class to the Department of Physics or participate in a virtual visit?
For more information visit:
https://www.physics.utoronto.ca/physics-at-uoft/outreach/school-visits-students/

Outreach in Action

Canadian Association of Physicists High School Exam Workshop

Saturday, March 18, 2023

Grade 9, 10, 11 and 12 students attended a virtual workshop for the Canadian Association of Physicists (CAP) High School Exam on Saturday, March 18, 2023. Twenty students attended from the Toronto area, and other regions of Canada.

This workshop introduces high school students to the CAP exam, gives them the opportunity to work through previous exam questions, and provides tips on test-taking.

The workshop was facilitated by Professors Ania Harlick and Ziqing Hong, with the assistance of U of T Physics undergraduate and graduate students. The high school students commented on how they found interacting with U of T students very useful.

Professors Harlick and Hong wowed students with physics demos, including the popular liquid nitrogen train to demonstrate superconductivity. Professor Hong also treated the students to a tour of his Dark Matter Lab in the McLennan Lab basement.

More: *https://www.physics.utoronto.ca/physics-at-uoft/outreach/u-t-physics-high-school-cap-exam-preparation-workshop/*

Physics News

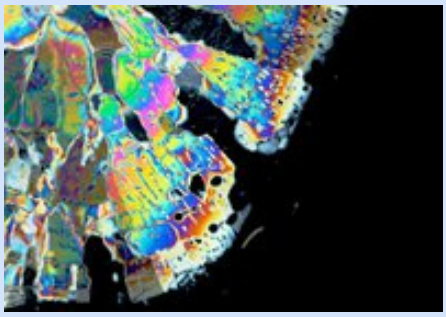
National climate science satellite mission co-led by U of T secures more than $200 million

Scientists will be able to better predict and mitigate extreme weather events in the face of climate change thanks to a new satellite mission, co-led by Prof. Kaley Walker, awarded $200 million in federal funding.
More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/national-climate-science-satellite-mission-co-led-by-u-of-t-secures-more-than-200-million/*

Tracking carbon dioxide emissions from space could help support climate agreements

Adjunct Professor and ECCC Research Scientist Ray Nassar has written an article for "The Conversation" in which he provides insights about how tracking carbon dioxide emissions from space can support climate agreements.
More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/tracking-carbon-dioxide-emissions-from-space-could-help-support-climate-agreements/*

A more profound appreciation for the complexity of natural ice formations': Researchers unlock cause of ripples on icicles

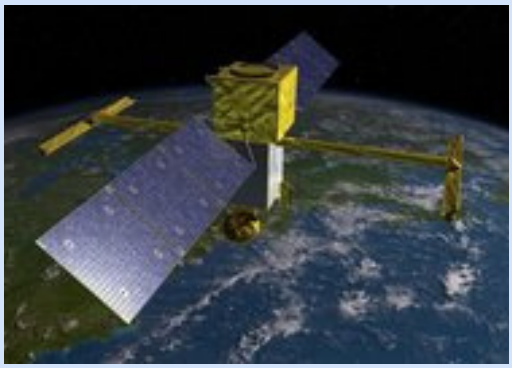


Experimental physicists growing icicles at the University of Toronto are closer to understanding why some form with ripples up and down their outsides, while others form with smooth, slick, even surfaces.
More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/a-more-profound-appreciation-for-the-complexity-of-natural-ice-formations-researchers-unlock-cause-of-ripples-on-icicles/*

Solving the Mystery of Dark Matter

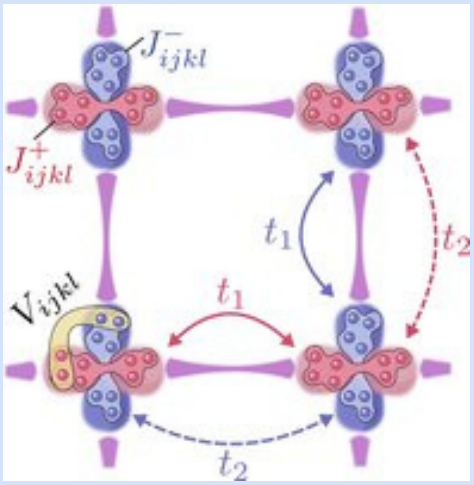
Professors Miriam Diamond and Ziqing Hong's Dark Matter Group is featured in Compute Ontario's Annual Report.
More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/solving-the-mystery-of-dark-matter/*

NASA launches mission to measure Earth's surface water – with help from Canada



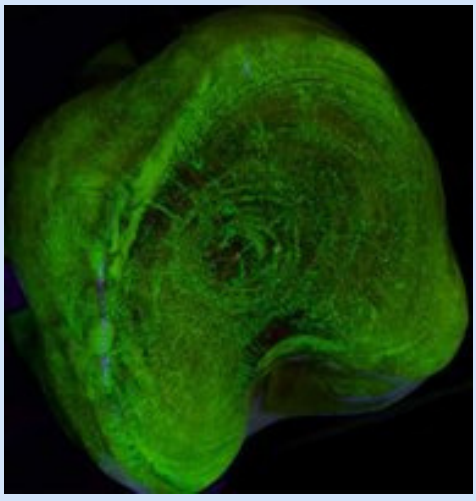
Professor Kaley Walker describes the SWOT mission, launched in December 2022. Professor Nicolas Grisouard is a member of the SWOT science team.
More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/nasa-launches-mission-to-measure-earths-surface-water-with-help-from-canada/*

Strange Quantum Fluids Feel the Strain



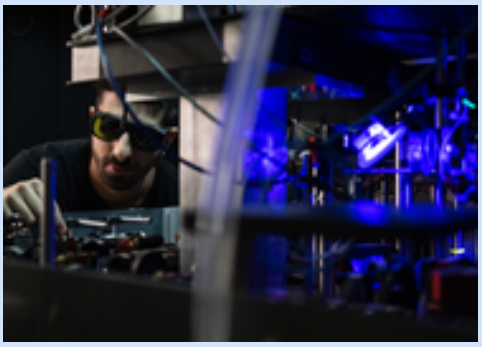
A study by PhD student Andrew Hardy, Arijit Haldar and Prof. Arun Paramekanti provides insight into this exotic non-Fermi liquid physics using the paradigmatic "SYK model". Strong interactions can cause electronic fluids to shed their electron-like character and exhibit anomalous behavior. Understanding such strange quantum fluids, their transport properties, and the impact of strain, are important for new quantum materials and technologies.
More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/strange-quantum-fluids-feel-the-strain/*

Tiny bubbles that make icicles hazy are filled with water, not air



Like tree rings, layers of water pockets also preserve a record of an icicle's growth. While examining 3-millimeter-thick cross sections of icicles grown in the lab, University of Toronto physicists Stephen Morris and John Ladan uncovered pockets of impure, liquid water surrounded by relatively pure ice.
More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/tiny-bubbles-that-make-icicles-hazy-are-filled-with-water-not-air/*

"A perfect little system": University of Toronto physicists isolate a pair of atoms to observe p-wave interaction strength for the first time



A team of students and researchers led by Professor Joseph Thywissen, in collaboration with a theory team from JILA at the University of Colorado Boulder, has measured unitary p-wave interactions for first time in ultra-cold atoms in work published in the 12 January 2023 issue of Nature.
More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/a-perfect-little-system-university-of-toronto-physicists-isolate-a-pair-of-atoms-to-observe-p-wave-interaction-strength-for-the-first-time/*

Experts gather at U of T to discuss Canada's new National Quantum Strategy

Leading scientists with expertise in Quantum research at the University of Toronto produce impactful knowledge in the domain through a collaborative approach at the Centre for Quantum Information and Quantum Control (CQIQC).
More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/experts-gather-at-u-of-t-to-discuss-canadas-new-national-quantum-strategy/*

Prof. Hoi-Kwong Lo's start-up company QBT receives $1M in federal funding

Toronto-based start-up company Quantum Bridge Technologies (QBT) has been awarded a $1 million contract from the Department of Innovation, Science and Economic Development, to test its quantum-resistant key distribution solution.
More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/prof-hoi-kwong-los-start-up-company-qbt-receives-1m-in-federal-funding/*

U of T-supported startup Xanadu aims to lead quantum computing sector

Quantum computing is one of the fastest-growing tech sectors in the world – and Toronto startup Xanadu Quantum Technologies is among the companies leading the way.

More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/u-of-t-supported-startup-xanadu-aims-to-lead-quantum-computing-sector/*

Condensed matter physicists develop new insight into the enigmatic realm of 'strange metals'

Andrew Hardy, Arijit Haldar and Professor Arun Paramekanti from the Department of Physics and Centre for Quantum Information & Quantum Control (CQIQC) have developed a theoretical model that describes the interactions between subatomic particles in quantum matter.

More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/condensed-matter-physicists-develop-new-insight-into-the-enigmatic-realm-of-strange-metals/*

First space images captured by balloon-borne telescope

Astronomers have successfully launched a balloon-borne telescope that has begun capturing images of the universe on its first flight above the Earth's atmosphere. The Super Pressure Balloon-Borne Imaging Telescope (SuperBIT) was flown to the edge of space by a helium-filled NASA scientific balloon the size of a football stadium.

SuperBIT is a collaboration between Professor Barth Netterfield's group, Princeton University, Durham University and NASA.

More: *https://www.physics.utoronto.ca/news-and-events/news/physics-news/first-space-images-captured-by-balloon-borne-telescope/*

UNIVERSITY OF TORONTO
FACULTY OF ARTS & SCIENCE
Centre for Quantum Information and Quantum Control

CQIQC TORONTO

Call For Nominations:
John Stewart Bell Prize 2024

U of T's Centre for Quantum Information and Quantum Control (CQIQC) invites nominations for the 2024 John Stewart Bell Prize for Research on Fundamental Issues in Quantum Mechanics and their Applications.

The nomination should include:
The nominee's name & affiliation, a statement of the research contribution's importance, and principal literature citations.
Deadline: August 30, 2023

For more information, please refer to:
https://cqiqc.physics.utoronto.ca/bell-prize/about/

Robarts Library in Reflection
(credit: Deepayan Banik)

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