Interactions

Message from the Chair

We have all seen stories in the press about the financial value of a university degree, often denigrating humanities and social sciences while pushing engineering and business. As a physicist I find these stories quite irritating, firstly because I don't think that a university degree should be considered vocational training; but secondly, if it is going to be viewed that way, then physics should have better press. Regarding the first objection, most of us studied physics at university just because we liked it. We didn't expect it to lead to a great job, as I recall, my class-mates didn't think that way. But we found that, like a humanities or social science degree, the greatest value of a physics degree is that it deepens and enriches our experience of life. The story on (page 10) about the success of our physics "Weather Club" team reminds me of one of the great mysteries of existence: what do people who don't know any physics think about when they think about the weather? If you don't understand the ideal gas law, latent heat, Coriolis forces, angular momentum, fluid mechanics, probability distributions, etc – is the weather just an arbitrary sequence of mysterious events? Physics is worth doing simply for the insight it gives, and the pleasure of understanding.

On the other hand, it is irritating that these stories focus on the utility of engineering and business degrees, while physics is rarely mentioned. But as the website of the Institute of Physics in the UK shows, physicists have skills, including numeracy, problem solving, and modelling, that are valuable across a range of businesses, most famously (or infamously) in the financial industry, but also beyond. Moreover, as noted in a recent American Physical Society study, physics is increasingly prominent in entrepreneurship, partly because physicists have an understanding of nature that allows them to predict and implement possibilities that engineers may not see; but also simply because of the way that physicists think – a willingness to try new things, combined with the ability to do modeling, consider limiting cases, and be guided by the results, is a great advantage when you are trying to start a new business.

So I find it annoying when people talk about university degrees in terms of the financial payoff, but only partly because I don't believe that is the proper measure of a university degree; it's also because, even if it were the proper measure, a physics degree is a much better degree than many people realize. This is shown in the latest employment data for physicists from the American Institute of Physics.

In this issue of Interactions there are a host of articles, covering many of the faces of our Department. I am really proud that we hosted the annual Women in Physics Canada conference for the first time (pages 1-3). I attended several of the science sessions, and met many of the participants. It was a tremendous success, and thought provoking too. We have articles about our brilliant undergraduates (page 5); a description of what you missed if you didn't attend last year's Welsh lectures (page 4); stories about our incredibly successful physCAP mentorship program (page 7) and our alumni Spring Reunion event (page 8). On page 9 we describe some of our recent outreach activities. For me, our most surprising story features the athletic ability of present and former faculty members (page 11). I can just about believe that my colleague William Trischuk was an international-level cyclist; but that Boris Stoicheff, whom I was privileged to have as a prof when I was an undergraduate, had been a champion long-distance runner in his youth is difficult to reconcile with my memory of him. We also have profiles of new faculty members, our wonderful staff, and graduate and undergraduate students (pages 14 – 21). And more!

Finally, we always want to see more of our alumni. So please come to the Tuzo Wilson lecture on November 3rd (page 3). The topic is "Ice in the Solar System from Mercury to Pluto". Perhaps the speaker will broaden this to include the recent discovery of flowing water on Mars. It promises to be a great and topical event. Also, as always, please get in touch with us if you have any feedback, or if you would like to get involved in our mentorship program, at mentorship@physcs.utoronto.ca.

Sincerely,

Stephen Julian

2015 Women in Physics Canada Conference

The fourth annual Women in Physics Canada (WIPC) Conference was held on July 30 to August 01, at the University of Toronto. Professor and Associate Chair of Undergraduate Studies, Sabine Stanley, led the Local Organizing Committee which included a group of dedicated U of T graduate students. WIPC is a national conference aimed primarily at (but not restricted to) graduate students in physics, astrophysics, mathematical physics and related fields.

Continued on next page.

WIPC 2015

Women in Physics Canada Conference

July 30 - August 01, 2015
University of Toronto

Continued from page 1.

In previous years, the conference was held at the University of Waterloo, the University of British Columbia and Simon Fraser University.

WIPC is first and foremost a scientific conference, in which early career scientists have the opportunity to present their work and to hear plenary talks from leaders in the field. Its intent is also to provide support to early career women, encouraging them to continue with a career in physics. The conference provides participants with the opportunity to network with women in physics from across Canada and to facilitate the sharing of experiences, ideas and advice. WIPC aims to foster a sense of community and belonging among participants.

The conference consisted of a combination of:
(i) plenary science talks by leading women in physics in Canada,
(ii) expert panels, focused on topics of interest to Canadian female graduate students and postdocs in physics,
(iii) oral and poster sessions for scientific presentations by attendees,
(iv) participant activities to foster professional skills, and
(v) social events to facilitate networking and mentorship of participants.

This year 95 participants attended the conference.

The plenary talks were on a range of topics including: physical chemistry of charged droplets, breast cancer radiotherapy, stellar mergers and interactions, particle physics, superconductivity and the quantum world.

The panel topics were: Challenges to Women in Physics, Non-Academic Career Paths and Making Progress (a conversation with leaders which included our own Professor Kimberly Strong).

There were also 14 poster presentations that ranged in topics from custom engineered optical tweezers with a digital micro mirror device to measurements of CFC-11 (CCl_3F) and CFC-12 (CCl_2F_2) from space.

There were 12 oral presentations from participants as well. The topics ranged from building bacteria-phage interaction networks using the CRISPR locus to detecting gravitational waves with LIGO.

On the second day of the conference, the participants were taken on a dinner cruise around the Toronto harbor, where they networked as well as shared advice and experiences.

We asked Professor Stanley some questions about WIPC.

Why did you decide to be on the organizing committee for WIPC2015?
Last summer I was a keynote lecturer at the International Conference for Women in Physics (ICWIP) which was held at Wilfrid Laurier University. It was a truly inspiring conference and I thought that hosting a Women in Physics Canada conference here at U of T would benefit many of our graduate students. In addition, the Chair of the Department, Stephen Julian, and several graduate students approached me about hosting this conference here; it appears that people in Toronto thought it was a good time to host this conference.

What is the significance of the WIPC in your opinion?
In addition to learning about some great science, the conference allowed attendees to share experiences and meet other women in physics. Role models are very important factors in keeping women in physics and this conference allowed for meaningful interactions between leaders and early career women in the field. Many attendees are the only woman in their lab and aren't aware of the issues faced by women in physics or the support that is available to them. The WIPC2015 conference gave them the opportunity to learn about this and develop a community for support.

Continued on next page.

WIPC Continued from page 2.

Why do you think it is important to encourage women to continue careers in science?

We constantly hear that there aren't enough people trained in STEM (Science, Technology, Engineering and Math) fields to meet our economic and societal needs. Scientific evidence shows that girls are just as good as boys in these fields, but somewhere along the way in their education they move away from STEM fields. There are many factors involved here, including the lack of women role models in the field, conscious and unconscious bias against women and unfavourable working conditions. We need to work on fixing these issues so that the many women who are capable and passionate about science don't face unnecessary barriers to enter and stay in the field. By not doing so, we are essentially cutting the talent pool in half from the start. In addition, diversity in thought and experience is very important for moving a field forward. It is in the best interest of science to build the most diverse talent pool possible.

What do you think is the main challenge for women in physics?

I don't think there is a 'main' challenge. I think there are several that are important to different individuals. For some women, it is the intrinsic discord between the academic tenure clock and the biological clock. For others, it's the lack of encouragement to enter and stay in the field. The list continues and we need to entrench mechanisms into the system to overcome these challenges.

What did you learn from this conference?

So much, I don't know where to begin! Ultimately, I learned about the usefulness of these conferences. To be honest, as a graduate student, I wouldn't have even thought of attending such a conference. I was so focused on my science at the time and on fitting in with the crowd (mostly male), that I was somewhat naïve regarding issues surrounding women in physics. Now that I know better, I think it is important to actively encourage students (both women and men) to attend such conferences, learn about the issues and then become part of the solution.

Finally, what would you tell other women who are interested in pursuing a career in the sciences, any advice?

I would say that the most important thing is to find something you love to do. If you are passionate about science, then it is a fantastic field to work in. There are many great aspects about my job and I wouldn't trade it for any other job in the world, its who I am. Although there are issues for women in science, we can overcome them, especially if more women pursue science.

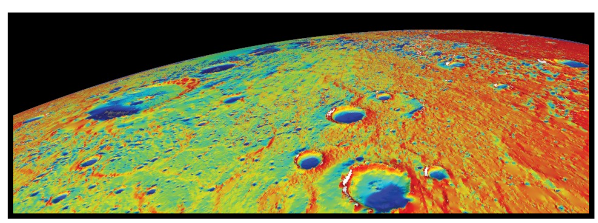
For more information the on Women in Physics Canada Conference, visit: womeninphysicscanada.ca

Outreach in Action - you are invited to the 2015 Tuzo Wilson Lecture

Date: Tuesday, November 3, 2015
Time: 8:00pm
Location: Isabel Bader Theatre (93 Charles St W, Toronto, ON M5S 2C7)

Speaker: David Paige, UCLA

"Ice in the Solar System from Mercury to Pluto"



David Paige is Professor of Planetary Sciences at UCLA. He is a Principal Investigator on NASA's Lunar Reconnaissance Orbiter mission, and also on NASA's MESSENGER spacecraft, which discovered ice on the Moon and on Mercury. For more information on David Page, visit: www.planetary.org/explore/projects/mcs/david-paige.html

Alumni Profiles for the Department of Physics Website

We want to hear about what our alumni are doing with their physics degrees, so we can share this with our undergraduate students in the form of pamphlets and profiles on our website. Want to share your story?
Email: mentorship@physics.utoronto.ca

2015 Welsh Lectures

The Welsh Lectures have been held annually since 1975 in honour of former faculty member Harry L. Welsh. This year they were held on May 7 & 8, 2015. These lectures are intended to be broadly accessible to an audience drawn from across U of T, other academic institutions and the interested public.

The technical lectures took place on May 7 and the public lectures took place on May 8, both lectures were at capacity and attended by current faculty and staff, emeritus faculty, students, alumni and members of the public. This year, the distinguished speakers were Professor William Bialek (Princeton University) and Professor Serge Haroche (Collège de France, Paris).

Professor Bialek is the John Archibald Wheller/Battelle Professor at Princeton University, a member of the multidisciplinary Lewis-Sigler Institute and visiting Presidential Professor of Physics at the Graduate Center, City University of New York. His research interests have ranged over a wide variety of theoretical problems at the interface of physics and biology and his talks reflected this. Professor Bialek's technical lecture was titled "Are biological networks poised at criticality?" and he talked about how new, large scale experiments have made it possible to construct statistical mechanical models of biological systems directly from real data. In examples such as families of proteins, networks of neurons and flocks of birds; models emerge from the data that are poised at a special point in their

Speakers William Bialek and Serge Haroche with Chair Stephen Julian

parameter space – a critical point., suggesting there may be some deeper theoretical principle behind the behavior of these systems. His public lecture was titled "More perfect than we imagined: A physicist's view of life" and he talked about the phenomena of how evolution has selected mechanisms that operate near what is allowed by the laws of physics, for example we can hear sounds that cause our eardrums to vibrate by less than a diameter of an atom.

Professor Serge Haroche is Professor and Chair in quantum physics at the Collège de France and in 2012 was the co-recipient of the Nobel Prize in Physics. The United Nations has declared 2015 to be the International Year of Light and Light-based Technologies and fittingly, Professor Haroche's lectures were about quantum theory and his experiments involving light.

Professor Haroche's technical lecture was titled "Controlling photons in a box and raising Schrödinger cats of light" and he talked about his group's Cavity Quantum Electrodynamics (CQED) work. These studies trap microwave photons in a superconducting cavity and let them interact with large electric dipole-carrying Rydberg atoms crossing the cavity one at a time, enabling photons to be counted without destroying them and to stabilize photon number states in the cavity using quantum feedback. He also talked about his experiment involving the preparation and reconstruction of photonic superposition states suspended between different classical realities, generating the cat that Schrödinger imagined to be dead and alive at the same time. These experiments illustrate quantum concepts and investigate the process of decoherence, which explains the transition between the quantum and classical worlds. Professor Haroche's public lecture was titled "Power and strangeness of the quantum" and he talked about how recent technological advances have allowed for the control and observation of isolated quantum systems such as molecules, photons or superconducting microchips.

Once again, the Welsh Lectures were a big success and we thank all involved. Especially the Welsh Committee: Dylan Jones (Chair), Richard Bond, Vatche Deyirmenjian, Sidhartha Goyal, Arun Paramekanti, Pekka Sinervo, Aephraim Steinberg and Helen Iyer.

For more information on the Welsh Lectures, visit: www.physics.utoronto.ca/~welsh/

Robin Armstrong (former Chair and Dean), John Martin, Chair Stephen Julian and Welsh Committee Member Pekka Sinvero at the Welsh Lectures Lunch

Chair of the Welsh Committee Dylan Jones and John Martin

Canadian Association of Physicists (CAP) University Prize Exam

In the Spring 2015 issue of Interactions we told you that U of T Physics took 4 of the top 10 Spots in Canada in the Canadian Association of Physicists (CAP) University Prize Exam that took place in February 2015. The CAP University Prize Exam is an annual national competition for Canadian undergraduate physics students. This year, the first place prize was the $500 Lloyd G. Elliott Prize, plus an all-expense paid trip to the CAP's Annual Congress. Second place prize was $250.

In this issue, we would like to tell you more about the exam itself and the students who placed in the top ten. You will also hear from exam coach Professor Robin Marjoribanks.

Professor Marjoribanks began coaching for the exam approximately ten years ago. He had been a marker at the International Physics Olympiad for high school students, and later a national team leader, so the whole idea of prize exams is a familiar one to him.

According to Professor Marjoribanks, the purpose of the CAP University Prize Exam is to increase the profile of physics among undergraduates as well as providing a sense of community, because across the country, many undergraduates are writing the same exam and looking at the same difficult questions. For many students, it is a chance to prove themselves and go up against the brightest students. For these students, who love physics so much, it's a "mini-festival" of intriguing questions, followed by pizza and pop. Professor Marjoribanks also says that placing well in the exam is a nice "feather in the cap" to add to graduate school applications. But the broadest benefit according Professor Marjoribanks is when students make the pleasant discovery that they can do more than they thought they could.

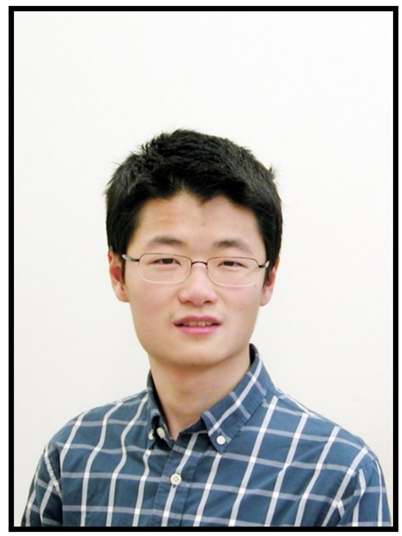
The February 2015 results were:

Chao Wang – 1st place

Ramanjit Sohal – 7th place

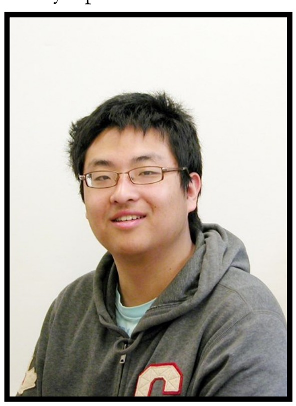
Oguzhan Can – 8th place

Jeremy Li – 9th place



Chao Wang

Oguzhan Can



Jeremy Li

Ramanjit Sohal

Here's our Q&A with coach Marjoribanks:

Why should physics students be encouraged to write the CAP University Prize Exam?

It's intimidating to throw your hat into the ring. Not everyone is used to the idea of collaboration and competition going together and not everyone is comfortable to speak up for themselves, to risk getting attention, really of any kind. The CAP prize exam has a beautiful feature: beyond the top ten places, and best at each school, results are reported only generally (top quarter, second quarter, etc.) and only to the students themselves. The door is open to announcing success, and quite private otherwise. That's a good way to throw your hat into the ring.

What do you like the most about coaching some of our students for this exam?

I like the sense of possibility that students come to, after encouraging them with ideas and images. Many arrive at the session saying they're not sure they really will go to write the exam, but most leave excited at the prospect.

Four of our students took 4 of the top 10 spots this year, how does that make you feel?

To be honest, I knew they would have at least three top-ten placings, so the real pleasure comes in being able to say, for the ones who were coached and regardless of where they placed, "See? I knew you could!"

Continued on next page.

Canadian Association of Physicists (CAP) University Prize Exam

continued from page 3

Let's hear from our top-10 placers:

Why did you decide to participate in this exam?

Chao
I decided to participate because I thought it would be a good learning experience and a good way of identifying the weak spots in my physics knowledge.

Jeremy
I participated in the exam mostly for fun, partly for the pizza, but also because I enjoy a challenge and I enjoy solving tricky problems.

Ramanjit
It seemed like a good way to gauge how much I have learned from my physics courses. Also, spending an afternoon working on physics problems sounded like fun.

What does placing in the top 10 mean to you?

Chao
I feel very honoured to place in the top 10, as it is a form of recognition of my basic undergraduate physics knowledge. This is thanks to the solid undergraduate education I have been fortunate to receive at U of T.

Jeremy
Being placed in the top 10 shows me that the physics education I'm receiving here at U of T is strongly competitive at the national level. Being placed in the top 10 despite the limited knowledge I had in second year is a testament to the power of the general problem solving skills we learn here at U of T.

Ramanjit
I am glad to have had the opportunity to represent our school. Placing in the top 10 also gives me some motivation to compete again next year.

Congratulations to our students and thank you to coach Marjoribanks!

For more information on the CAP University Prize, visit:
www.cap.ca/en/activities/medals-and-awards/prizes-students/university-prize-exam

2015 - 2016 Luste Prize Recipients

These prizes were set up by the late Professor George Luste to recognize and support undergraduate physics students of merit. George always believed in financially supporting higher education.

Professor George Luste

George Luste Prize in 1st Year Physics: Yujie Wang and Kin Yu Zheng

George Luste Canadian Association of Physicists Prize University Exam Award: Chao Wang, Ramanjit Sohal, Oguzhan Can and Jeremy Li (please see page 3 for more on this award)

George Luste Prize in Biological Physics: Stephania Assimopoulos

Brian Wayne Statt - George Luste Prize in Experimental Physics: Anthony Ardizzi and Sepehr Ebadi

You can donate to the Luste Prizes online: donate.utoronto.ca/physics

physCAP Recap

Sponsored by:

Manulife

In the Spring 2015 issue of Interactions, we introduced you to the Physics Career Accelerator Program or "physCAP". physCAP consists of programs to help students transition to the world of work, graduate studies, and a professional career. Here are some selected highlights from the 2014-2015 academic year.

physCAP LinkedIn Session

On Friday, February 13, 2015 students attended a special LinkedIn workshop for physics students with Jonathan Turner from the University of Toronto Career Centre. Students learned how to manage and improve their online profiles and they learned how to make professional connections.

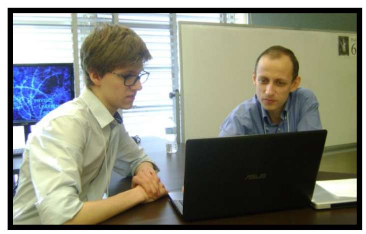
Undergraduate students Mary Miedema and Chengyun Li working on their LinkedIn profiles

Physics Career Fair

On March 13, 2015, 30 undergraduate physics students had the opportunity to hear presentations from 6 speakers who all have degrees in physics: Mark Shuster and Chris Derken (Environment Canada), Dmitry Vyushin (Bank of Montreal), Stuart Heggie (Dupont – retired), Emanuel Istrate (Impact Centre, U of T) and Stephen Leonard (Hill and Schumacher). Students learned about how each speaker got to where they are, what employers look for and job search strategies. After the presentations, the students had the opportunity to have one on one sessions with speakers where they could network and ask questions.

After the Career Fair students said they learned to apply physics to other fields, got job seeking advice and interview tips, made new professional connections and gained different perspectives on jobs available after graduation. Thanks to Professor Krieger for organizing and leading a very valuable afternoon.

We are always looking for alumni who would be interested in networking with or hiring a physics graduate or summer student. If you are interested, please contact mentorship@physics.utoronto.ca



Above: Alum Mark Shuster and student Bang Chi Duong
Left: Student Zacharie Leger and alum Emanuel Istrate at the Career Fair

Canadian Association of Physicists (CAP) Professional Physicist (P.Phys.) Certification Exam Preparation Program

On November 29, 2014 and January 19, 2015 students participated in the Canadian Association of Physicists (CAP) Professional Physicist (P.Phys.) Certification Exam Preparation Program, a preparation for the professional practice exam. The November session was an information session and the speakers were M.K. O'Neill from the CAP Foundation and Professor Emeritus Henry van Driel and hosted by Professor Peter Krieger. The students were given information on P.Phys. Certification, its benefits and information on the exam. In the January session, students had the opportunity to work on practice questions and this was facilitated by Professor Peter Krieger.

Have you written the P.Phys. Exam? Want to come to talk our students about your experiences? contact: mentorship@physics.utoronto.ca

Left: M.K. O'Neill from the CAP foundation at the information session

Left: Students at the November information session

Explore It/Job Shadow Program

Want to have a bright undergraduate student visit your workplace for a half or full day? Sign up for Explore It, our job shadowing program for 2nd year students. Our 2014-2015 hosts said that they liked having the chance to meet new and interesting students. Contact c.gilderdale@utoronto.ca for more information.

Spring Reunion 2015

Photo from the wine the cheese portion of Spring Reunion 2015

On Saturday May 30, 2015, Spring Reunion took place across the University of Toronto. Thousands of alumni got together to reconnect with old friends and make new ones.

The Department of Physics participated by hosting Tours, Talks, Wine and Cheese, which was attended by 50 alumni from across the University of Toronto.

The talks began in the graduate lounge with opening remarks by Chair Stephen Julian. Professor Paul Kushner gave the first talk called "Climate Models, Climate Physics, and Climate Change" and graduate Student Deepak Chandan gave the second talk called "Back to the Future: Determining the mid-Pliocene sea level to assist with making climate projections for the end of this century".

Set up in the lounge were demos like the double pendulum, Newton's cradle, gas spectra, upward rolling cone, synchronized penguins and the bell crank. All alum enjoyed tinkering with these.

Shortly after the talks, alum were taken on tours of the Department. Professor David Bailey led tours of the Undergraduate Teaching Facilities and Dave Rogerson, Manager of Physics Learning and Research Services led the tours of Technical Services. Grad students Chris Granstrom and Graham Edge led the lab tours of Scanning Tunneling Microscopy and Ultra Cold Atoms respectively.

After the tours, alumni had the opportunity to mingle with faculty and other alumni at the wine and cheese. For more information on Spring Reunion, visit: springreunion.utoronto.ca

Emeritus Reunion Lunch

The second Emeritus Reunion Lunch was held at the Faculty Club on Wednesday, May 20, 2015. Our Emeritus Faculty had the opportunity to have some lunch and reconnect with old colleagues. The lunch was also attended by Chair Stephen Julian, Graduate Chair William Trischuk, Undergraduate Chair Paul Kushner and Professors Sabine Stanley and Michael Luke.

Back Row: David Rowe, Bob Logan, Henry van Driel, Jennifer Code, Fraser Code, Sabine Stanley, John Perz, Paul Kushner, Malcolm Graham, John Pitre, Richard Bailey, William Trischuk and Michael Luke

Front Row: Ozden Ozdemir, David Dunlop, Gordon West, Stephen Julian, Nigel Edwards, Albert Litherland and Robin Armstrong

Outreach in Action - Particle Fever

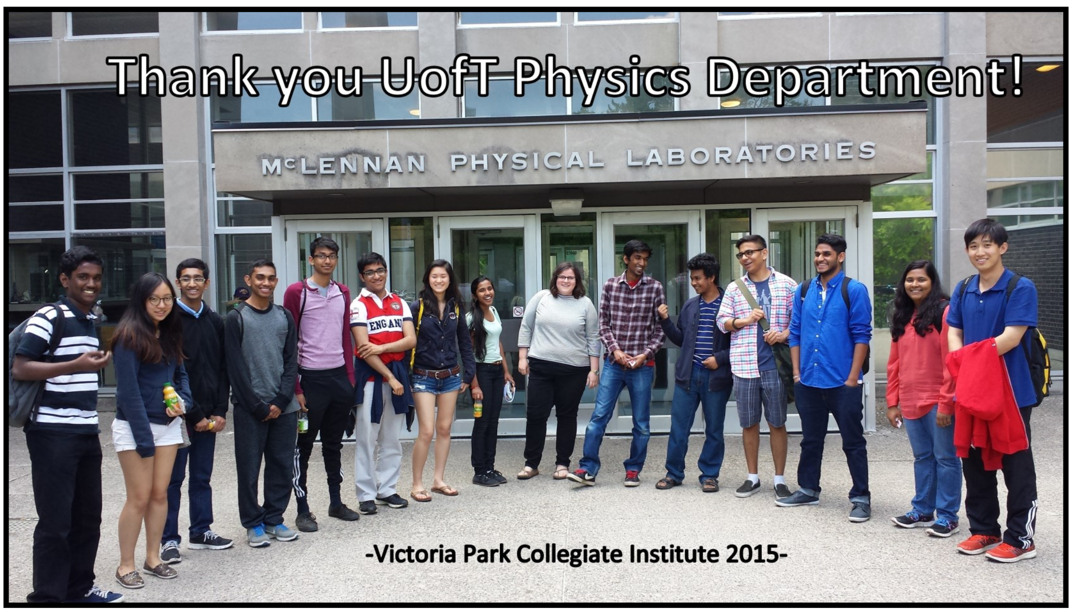
With one switch, everything changes...

On Wednesday, April 1, 2015 the Physics Department along with Inigo Films hosted a free screening of the film Particle Fever. This film follows six scientists during the launch of the of Large Haldron Collider. The screening was moderated by Alison Rose from Inigo Films and following the screening there was a question and answer session with physicist turned film director Mark Levinson and star Monica Dunford.

For more information on this film, visit:
particlefever.com

Mark Levinson, Alison Rose and Monica Dunford

Outreach in Action - School Visit from Victoria Park Collegiate



On Thursday, May 28, the Department hosted another school visit, this time for grade 12 students from Victoria Park Collegiate. The students had presentations on earthquakes, particle physics and careers in physics. The teacher of this class, Sarah Torrie has a connection to the Department too, she graduated in 2002 with an Astronomy and Physics Specialist and fondly remembers being taught Macrophysics by Stephen Morris.

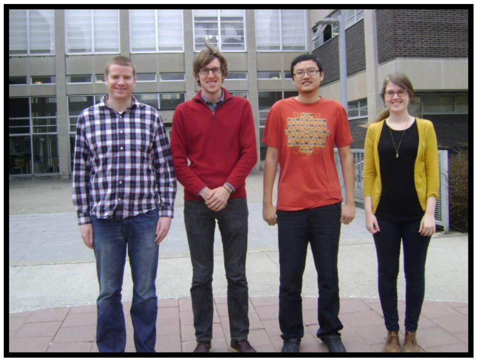
There was also a similar school visit on May 21 from Newtonbrook Secondary School.

If you are a high school teacher and want to bring your class to the Department for a visit, please contact:
outreach@physics.utoronto.ca

U of T Physics Rises to the WxChallenge

Congratulations to members of our Department for their achievements during this year's WxChallenge weather forecast competition. The U of T Physics team consisted of graduate students Melanie Cooke (team manager), Russell Blackport, Oliver Watt-Meyer, Stephanie Hay, Xuesong Zhang, and Robert Fajber, and postdoctoral fellow Neil Tandon. Our team competed with weather forecasters from colleges and universities across Canada and the U.S. in this annual competition with around 2000 participants. Russell Blackport won the Overall Individual Champion and our team took 2nd place – a stunning achievement!

Participants in the WxChallenge spend 20 weeks predicting high and low temperatures, maximum sustained wind speed, and total precipitation from select locations across the United States.



Russell Blackport, Oliver Watt-Meyer, Xuesong Zhang and Melanie Cooke

Scoring of forecasts is done by assessing forecast accuracy compared to verified meteorological measurements.

Our team members will also get individual trophies for the following cities this year:

Russell Blackport:
Wilmington, NC - Category 2 - Winner
Abilene, TX - Category 2 - Runner-Up
Long Beach, CA – Category 2 - Runner-Up

Stephanie Hay:
Springfield, IL – Category 2 Runner-Up

Xuesong Zhang:
Laramie, WY – Category 2 Runner-Up

We asked team leader, Melanie Cooke about the contest.

Why are you involved in this contest?
I was required to participate in the contest for a forecasting course that I took during my Master's and I've been participating ever since then. The variety of weather and climate offered by the contest cities in addition to the competitive aspect makes it a fun and interesting way to practice my weather forecasting skills.

How many years have you been doing it?
Last year was my 6th year! 3 with the McGill team, 3 with the UToronto team.

What kinds of skills have you built on?
When making a forecast, I like to first understand how the continent-scale atmospheric flow will be evolving over the week, then focus in on the weather system of interest, then look at how it will affect the city or town of interest. This builds on knowledge of geophysical fluid dynamics and meteorology and develops your understanding of climatology. But for this contest specifically, when you are trying to forecast precise numbers rather than a human-relatable description (like you'd see on Environment Canada or Weather Network), it often comes down to statistics and understanding the bias that weather models can have for certain locations, what types of weather they represent well and what types they represent poorly. Sometimes doing well in the contest is also about risk management - when is it worth it to predict that a thunderstorm will dump a lot of rain on your weather station's rain gauge?

What is your favorite part of being involved in a contest like this?
I really love talking about weather, so having a forecasting team to talk to about it with is great. The contest helps me keep tabs on all the weather happening in North America - there is almost always something fascinating happening with the weather on this continent!

Finally, can you tell our readers if the winter of 2016 will be as brutal as the winter of 2015?
I cannot! Seasonal forecasting is entirely different than weather forecasting. It's a field of atmospheric science that's still in development, with lots of interesting research being done right now. Be careful using seasonal forecasts - they are statistical products, don't have a high reliability at long lead times, and the results can easily differ between forecasting offices using different models. You can see Environment Canada's seasonal forecast here: weather.gc.ca/saisons/prob_e.html

Pan Am Games and Professor William Trischuk

In the Spring 2015 issue of Interactions, our faculty profile featured Professor and Chair of Graduate studies, William Trischuk and we learned about all his work in high energy physics and CERN. This summer, we also learned that Professor Trischuk has a history in competitive cycling, that inspired him to become involved in the Pan Am games that took place in Toronto in the summer of 2015.

Cyclists left to right Kristi Lay, Jasmin Glaesser, Laura Brown and Alison Beveridge. Behind the cyclists left to right Hélène Barrette, Steve Head, Chantal Thompson, Gordon Singleton and William Trischuk.

The photo on the right shows Canada's women's team pursuit cycling team at the start of one of their Pan Am races at the new velodrome in Milton. Cycling was a success at the velodrome and Canada took home gold in the team pursuit.

Professor Trischuk can be seen on the far right in the photo. He is one of two people holding the start-gate, an electronically controlled clamp that makes sure teams competing start at exactly the same time. In this event another team starts from the opposite side of the track, and they chase each other for the best time - or if they are lucky, they can catch up to and eliminate their opponents.

Next to Professor Trischuk is Gordon Singleton - one of Canada's most famous track-cycling sprinters, he was the first Canadian cyclist to win a World Championship (in the Keirin race, in 1982).

We asked Professor Trischuk some questions about his history with cycling and the Pan Am games.

Tell me a little about your involvement in cycling.
I was a member of the Canadian national cycling team from 1982 to 1985. I rode for Canada in the junior world championships (U19) in Florence in 1983 where I competed in this same event (we finished in the top 8 but not the medals), the 1000m time trial, the match sprint and the road race. I won a handful of Ontario Provincial championships and a handful of Canadian national championship medals (but was never a national champion). My last "adventure" in international track cycling was finishing second in the 1000m time trial Olympic qualifications in 1984. Curt Harnett beat me, qualified and won the silver medal in that event at the Los Angeles Olympics. He never looked back and went on to be a world-famous cyclist, several time world-champion and now the chef de mission for the Canadian team at these games. I realized it was time to go to graduate school and concentrate on physics. I've never looked back either…until now.

What are you doing at the Pan Am games and why?
With the construction of the cycling velodrome, that meets international competition standards, in Milton for the Pan Am games, I've been drawn back into riding my track bike and even racing it (from time to time). I volunteered to help out with the competition almost a year ago. There has been extensive "training" involved, including performing all the same functions for the national championships and an international test event that were held in Milton over 9 days in January. I was lucky (or persistent) enough to be asked to look after the start-gates (the white structure holding the lowest rider on the track in the photo). This device is linked to the starter and ensures that riders on opposite sides of the track don't have an unfair advantage as they leave the start and 'pursue' each other around the track. In this event there are actually teams of four that pursue each other around the track, but the one in the start gate must take the lead for the first lap. By high energy physics standards the start-gate is a pretty benign piece of equipment, but the whole timing and photo-finish system, that I also helped maintain for the games, is pretty sophisticated. We even had one photo-finish tie that couldn't be decided (with 1/10000th of a second resolution) which is almost high energy physics-like precision.

What does participating in these games mean to you?
Participating in these games was a unique opportunity to re-connect with my origins in cycling. Much of what I use every day in my research (goal setting, the ability to persevere, organization, attention to detail) I learned from being a nationally ranked athlete. It is inspiring to see, first-hand, what the current generation of cyclists have been able to accomplish. I hope to help build enthusiasm for track cycling in the GTA now that we have a world-class facility on our door-step and that this enthusiasm will translate into other areas of life even for athletes that don't win Pan Am or Olympic medals.

Thank you to Professor Robin Marjoribanks and Professor William Trischuk for their contribution to this article.

Physics Flashback

It's not an unusual thing it would seem, that systematic years of hard work and ambition in sports prepares scientists well. Boris Stoicheff, was in his youth, one of the top track and field sprinters in Canada! Boris was ranked 5th in the province of Ontario as a teenager in cross country racing and in University he ran the mile in under 5 minutes!

Joint TCCON-NDACC IRWG Meeting

In June 2015, the Physics Department was host to a gathering of approximately 70 scientists from around the world. This was one of a long-running series of annual meetings that bring together scientists from the Total Carbon Column Observing Network (TCCON) and the Network for the Detection of Atmospheric Composition (NDACC) Infrared Working Group (IRWG). This year, the meeting was hosted by Professor Kimberly Strong and held at Hart House. Network members, who use Fourier transform infrared (FTIR) spectrometers to measure atmospheric composition, gathered to discuss improvements to techniques, hear about new sites, talk about the latest science, and show how their data is being used to validate new satellite missions. More than 65 talks and 20 posters were given over five days, accompanied by topical discussion sessions, and including site reports from stations spanning the globe.

TCCON is a network of ground-based FTIR spectrometers recording very accurate and precise measurements of the greenhouse gases CO2 and CH4, while NDACC uses remote-sensing research stations for observing the physical and chemical state of the atmosphere to improve our understanding of stratospheric ozone depletion, air quality, and global climate. The Physics Department is home to one of two NDACC FTIR spectrometers in Canada, in the University of Toronto Atmospheric Observatory (TAO) on the roof of the Burton Tower, where students have been measuring atmospheric composition since 2002. Professor Strong's group also runs a FTIR at the Polar Environment Atmospheric Research Laboratory (PEARL) located at Eureka, Nunavut, which does double duty as both an NDACC and TCCON instrument.

Sixteen faculty and students from the Physics Department attended the Joint TCCON-NDACC IRWG meeting, helped out with the organization, gave talks and participated in a poster session. Attendees were given the opportunity to visit the Physics Department, including a visit to TAO, the atmospheric spectroscopy labs, and the Space Instrument Characterization Facility. They also had a virtual tour of PEARL, created by PhD student Dan Weaver. After experiencing near torrential June rainfall while making their way to Lake Ontario, our guests also took in a spectacular sunset cruise and dinner banquet around the Toronto harbour.

PASU Conference Day

On March 20, 2015, the Physics and Astronomy Student Union (PASU), hosted a Physics and Astronomy Conference Day for the first time. As part of a pilot project to integrate undergraduate students into research activities, PASU hosted two upper year students, Sukhwan Chung and Ilan Tzitrin, to deliver seminars about their research.

Sukhwan Chung shared his research in condensed matter, abstracted below:

Low Temperature Conductivity of $BaSnO_3$

"I talked about my research experience in a condensed matter physics lab in Korea. I was in a lab at the Seoul National University 2 years ago. I worked on finding a suitable low temperature sensor using Au and Ge mixture, and measuring thermal conductivity and electro resistivity of new material, $BaSnO_3$, at low temperature. Specifically I talked about some common methods practiced in a condensed matter lab such as 4 point contact method for measuring resistivity, how to deposit circuits using an evaporator, and a 3 omega method for measuring resistivity."

Sukhwan Chung

Ilan Tzitrin

Ilan Tzitrin shared his work, abstracted below:

Cavity enhanced spontaneous parametric down-conversion

"Generating single photons is crucial for proving fundamental theorems of quantum mechanics, and for more applied fields like quantum computation and quantum information. This talk gives an overview of how single photons are created in general, and in particular, from a narrowband source based on cavity - enhanced parametric down conversion."

A great thanks to both speakers! In the coming year, PASU hopes to continue this tradition of promoting student involvement in colloquia and scientific conferences. A possible expansion, including a poster fair, is planned. Be on the lookout for abstract submissions starting in February!

By David Han - Undergraduate student and PASU exec

Congratulations to our June 2015 PhD Graduates!

Left to Right: Kiran Rao, Scott Smale, Niall Ryan, Ian Chan, Steven Schramm, Dylan Mahler, Cathal Smyth, Simon Freedman

Physics PhD Degree Awarded in March 2015 at the University of Toronto

A. FEIZPOUR, "Nonlinear Optics at the Single-Photon Level", (A. M. Steinberg).

Physics PhD Degrees Awarded in June 2015 at the University of Toronto

S. J. BENTON, "Mapping Submillimetre Polarization with BLASTPol", (C. B. Netterfield).

J. N. BRADEN, "Nonlinear Intermittent Field Dynamics in the Early Universe", (J. R. Bond).

V. V. BURENKOV, "Security Issues of Quantum Cryptographic Systems with Imperfect Detectors", (H.-K. Lo).

I. CHAN, "Balance Models for Equatorial Planetary-scale Dynamics", (T. G. Shepherd).

S. FREEDMAN, "Applications of Effective Field Theory Techniques to Jet Physics", (M. E. Luke).

N. ILIC, "The Discovery of the Higgs Boson on the WW→ 1v1v Decay Mode", (R. J. Teuscher).

D. H. MAHLER, "Quantum Measurement on a Budget", (A. M. Steinberg).

K. M. RAO, "Photocurrent Control in a Magnetic Field through Quantum Interference", (J. E. Sipe).

N. RYAN, "The Application of Millimeter Wave Spectroscopy to Ground-Based Remote Sensing of the Atmosphere", (K. A. Walker).

S. SCHRAMM, "Search for Dark Matter with the ATLAS Detector in Events with an Energetic Jet and Large Missing Transverse Momentum", (P. E. Savard).

C. SMYTH, "Measuring Quantum Effects in Photosynthetic Light-Harvesting Complexes with Multipartite Entanglement", (G. D. Scholes).

D. SUN, "The Effect of Hydrostatic Pressure on the Nematic Phases of Sr3Ru2O7", (S. R. Julian).

Faculty Profile

Dr. Amar Vutha

Assistant Professor

Experimental Quantum Optics/Atomic, Molecular and Optical Physics

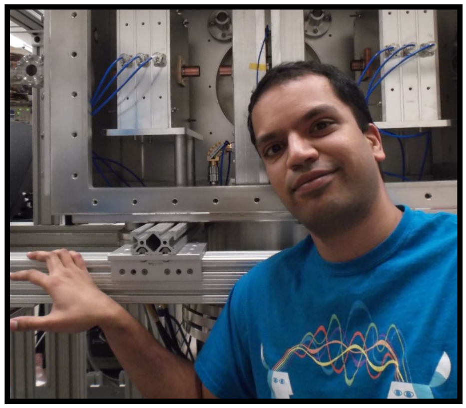
Dr. Vutha is an experimentalist working in the area of precision measurement. He received his PhD from Yale University, where he played a key role in measurements of the dipole moment of the electron. During his post-doctoral work at York University, Dr. Vutha constructed a precision measurement of the radius of the proton.

Why did you decide to pursue atomic physics? What was your inspiration?

In my final undergraduate year, after dabbling with high energy theory and laser experiments, I decided that the experimental life was the one for me. In that same year, I remember reading about Drever-Hughes experiments in a particle physics course – these experiments make precise measurements of atomic resonance frequencies, and check if the resonance frequencies change as the earth rotates, or revolves around the sun. Although these are small (garage-scale) experiments, they can set important constraints on some of the fundamental assumptions of special relativity and quantum field theory. That was the notion that hooked me in: the notion that, twiddling knobs and making measurements in modest basement labs, you can figure out useful things about the workings of the grander universe. In graduate school, I was fortunate to find an advisor who put me to work on just such an experiment, and I loved it.

What do you love the most of about this field?

First, I like the fact that as an experimenter, at the end of the day there is always something tangible that I get to create (even if it looks like a rude tangle of wires and bolts!). Our profession has some of the feel of a medieval guild of tinkering trades, which is very satisfying.



Dr. Amar Vutha

Second, in building experiments to measure small effects to high precision, one is often forced to confront the limits of commercially available technology, materials and design – it is great fun to build up experiments that thread around the various annoying constraints imposed by the mundane world, and to develop new technologies just so we can do physics with them.

Most importantly, I get to work with creative people who are all doing something that they innately enjoy. It's a treat.

You did an experiment at York University that re-measures the proton radius using the Lamb shift in hydrogen, can you tell our readers the purpose of it?

A few years ago, a measurement on muonic hydrogen atoms created a puzzling discrepancy: the radius of the proton measured using muons appears to be about 5% smaller than the same radius measured using electrons. To shed some light on this puzzle, we set about trying to make an independent and improved measurement of the proton's radius using (good old) hydrogen atoms. The measurement is a bit of a challenge, because the atomic resonance in hydrogen is heavily damped – it is like trying to accurately measure the resonance frequency of a bag of sand (that just goes "thunk" when you hit it) instead of a bell (which rings beautifully when you strike it). So, in addition to building up an apparatus that is capable of making this measurement, we had to invent a new measurement scheme – it all seems to work quite well, and we are doing all the careful tests to make sure that we have measured the proton's radius without systematic errors. I hope to know soon if our measurement will clear up this puzzle (or muddle it some more!).

What are your research plans at the University of Toronto, Department of Physics?

I hope to use the precision available with modern atomic physics, to address interesting fundamental questions. One of my projects is to use cold, confined atoms to build a compact atomic clock. Together with two students this summer, we have started to put together the building blocks of a prototype based on calcium atoms. There might be interesting technological applications of such a compact and stable clock, but my hope is to eventually use satellite-borne clocks as sensitive antennas to pick up gravitational waves from astrophysical sources.

Another research direction is to develop new techniques of precision spectroscopy. When you can confine and hold on to atoms and molecules for a long time, you can make very precise measurements on them. Further, it is possible to use interactions between atoms and molecules to improve the precision of measurements. We are building up an experiment to trap and cool light molecular ions, for microwave and terahertz spectroscopy. With improved precision comes the ability to test smaller and smaller effects due to new and unknown physics, and to test the physics we (claim to) understand with greater and greater rigour.

These are the projects that I have going on now, but I am sure that interactions with other groups in the department will lead to new research questions.

Faculty Profile

Hirohisa Tanaka

Associate Professor & Institute of Particle Physics Principal Research Scientist, Experimental High Energy Physics

Dr. Hirohisa Tanaka obtained his PhD from Stanford in 2002. He was a Research Scholar at Princeton University from 2002 to 2007. Since 2007, Dr. Tanaka has been an IPP Scientist at the University of British Columbia. Starting in September of this year, he has joined faculty of the Department of Physics at U of T. He is a leading figure in the T2K long baseline neutrino oscillation measurement, where his current interests include CP-violation and tests of the Standard Model. He is also involved in dark matter searches at SNOLab near Sudbury, and developing future neutrino oscillation experiments.

Why did you pursue particle physics?

My interest in particle physics started in college when I learned about some of the big questions facing the field. The professor of one of my first year classes decided one day to talk about how he was perplexed by why the proton doesn't decay. In proposing the "unification" of the electromagnetic, weak, and strong interactions into a single theory, he found this required new processes which would make the proton unstable, leading to its decay. Experiments had just found that this wasn't happening, at least at a rate required by his theory, and so he lamented the apparent immortality of the proton. I also learned about "CP violation", which are imbalances in the behavior of matter and antimatter that were first observed in the 1960s, whose fundamental origins were still unknown and hotly debated. Finally, there were many mysterious results arising from the study of neutrinos. I thought it would be amazing if I could play even a tiny role in answering or elucidating any of these questions. I was fortunate then and since have had incredible mentors and colleagues to encourage and support me in my endeavors.

Can you tell our readers about the T2K neutrino Project?

T2K, the "Tokai-to-Kamioka" experiment, sends a beam of neutrinos from one side of Japan (Tokai) to the other (Kamioka) 295 km away, where we observe them with the gigantic Super-Kamiokande detector. Along their way, quantum mechanical processes allow neutrinos to transmute between three species or flavors, a process called neutrino oscillations. A few years ago, we observed the transition between muon neutrinos and electron neutrinos, the first time a neutrino produced in one flavour has been explicitly observed transforming into another. This has opened up the possibility that we may be able to observe CP violation, which would manifest itself as an asymmetry in this neutrino oscillation process relative to the corresponding process in antineutrinos. This is the next milestone for the field, though it may take some time to realize. At T2K, we recently started our first steps towards this goal by producing an antineutrino beam to perform our first studies of antineutrino oscillations.

I understand that your group from the University of British Columbia had a leading role in the time projection chambers (TPC) and fine-grained scintillator tracking detectors (FGD) for the T2K near detector system. What was your role?

The FGD was a collaboration with our Japanese colleagues, while the TPC was a multinational project with France, Germany, Italy, Spain and Switzerland. I joined T2K at the beginning of the construction effort for these detectors, when components built by our partners were delivered to TRIUMF and assembled to make fully functional detectors. We used the accelerator facility at TRIUMF to shoot particles through the detector and see that they worked as expected. After each detector was constructed and tested, they were shipped to the J-PARC laboratory in Tokai, Japan. Eventually, I shipped myself to Japan for about a half a year, when a parade of detectors descended down the detector hall by crane into the enormous UA1 magnet provided by CERN.

J-PARC at the time was a brand new laboratory, and the civil construction of the facilities for our new detectors had just completed as we shipped the detectors. We found ourselves making nearly daily trips to Joyful Honda, an enormous home supply store that was sort of like a Home Depot on steroids. Here, one can find anything from "all in one" kits to start your own soba restaurant to heavy construction equipment, and we found just about any random component we needed, from cable ties and clamps to hoses and hoists. It's hard to imagine how we would have finished our installation without Joyful Honda. After the installation and commissioning of the detectors, I served as the analysis coordinator for the near detector systems.

What was the outcome of this project and what was the significance of the outcome?

The detectors are working spectacularly. The FGDs and TPCs form the core of the near detector, which studies the properties of the neutrino beam and interactions before the onset of neutrino oscillation effects. This provides a baseline from which we can compare the corresponding interactions 295 km away at Kamioka, making the experiment much more sensitive to the neutrino oscillation effects. Our goals at T2K are much more ambitious than previous experiments and depend heavily on our ability to effectively use the near detector systems to control the many uncertainties in the experiment. While we have much more work to do, our success so far makes me confident that if nature gives another opportunity to discover something groundbreaking like CP violation in neutrino oscillations, we will be ready.

Continued on next page.

Continued from page 15.

Can you tell our readers about your dark matter searches at SNOLab?

I am working on a dark matter experiment called "SuperCDMS-SNOLab". This experiment uses a remarkable method to detect possible dark matter particles by sensing the thermal and electromagnetic perturbations caused by an atomic nucleus recoiling from an encounter with a dark matter particle. Exquisite "transition edge sensors" tuned right at the threshold of superconductivity can register the minute disturbance arising from a single dark matter interaction in a silicon or germanium crystal. This technique has been at the forefront of the field for some time, and SuperCDMS represents its latest incarnation, where a large array of such detectors will be deployed deep underground in SNOLab. While there are many dark matter searches going on around the world, SuperCDMS-SNOLab will have unique sensitivity to potential low mass dark matter particles. The experiment was recently approved in the US, while we have also secured support in Canada for our role.

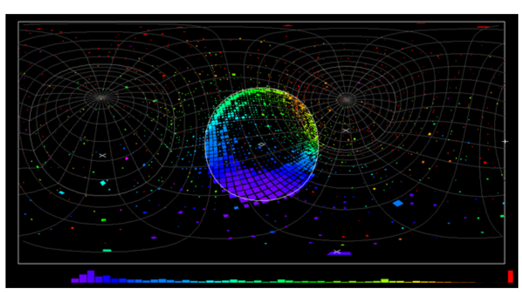
You also work on water Cherenkov detectors, can you tell our readers about those?

These detectors use a process called Cherenkov radiation, in which charged particles that exceed the velocity of light in a medium emit light in a manner analogous to the sonic boom created by supersonic aircraft. The electromagnetic disturbance effected by the particle results in a pile up of radiation (i.e. light) that propagates in a cone away from the path of the particle. The process is illustrated on Cherenkov's tomb in the Novodevichny Cemetery in Moscow as an epitaph to his seminal contributions for discovering and elucidating this effect. In water Cherenkov detectors, this light passes through the water and is detected by photosensors arrayed on the periphery of the water tank. The amount of light and its geometric pattern can tell us the location, direction, energy, and type of particle.

The Super-Kamiokande detector we use in T2K is the quintessential water Cherenkov detector, both because of its size (50 kilotons of water contained in a cylindrical tank 40 meters tall and wide) and the granularity of the photosensor instrumentation (over 11,000 20" photosensors in the inner detector), leading to beautiful images of neutrino interactions from the Cherenkov radiation they produce.

While the water Cherenkov technique has been denigrated as a "miserable old technology" by some, due to its inherent scalability, it remains the best means for searching for proton decay, where one effectively wants to view as many protons as possible to see if any of them decay. While other detector technologies can tell us more of what happens in a neutrino interaction, the water Cherenkov technique has managed to tell us "just enough" information regarding neutrino interactions to get the job done. I expect that it will play an essential role in uncovering the CP violation and hope to see it in neutrino oscillations. Also, as common and prosaic as water may seem, a successful water Cherenkov detector relies on many surprising and fascinating properties of ultra pure water. It offers enumerable opportunities for clever ideas and optimizations, and so the method is being continuously improved.

For my part, I have worked on pattern recognition algorithms that can be employed to reconstruct the particles emitted from the neutrino interaction based on the observed pattern of Cherenkov radiation. Based on this work, we have been able to make a general algorithm to reconstruct an arbitrary number of Cherenkov rings and their type, with a significant improvement of performance over previous algorithms (see image below).



We are also exploring new photosensor concepts to improve the performance of these detectors in their next generation incarnations, for example, the one megaton Hyper-Kamiokande detector which we hope will be built as a successor to the Super-Kamiokande detector. Such a detector will open a new frontier for the study of proton decay and provide our best opportunity to observe CP violation in neutrino oscillations.

What are your research plans at the University of Toronto?

Particle physics is at a sort of crossroads, with the field as a whole reaching what may appear to be a dénouement with the discovery of the Higgs particle, the last missing piece of the puzzle we call the standard model of particle physics. However, we are struggling to understand dark matter, something that simply cannot be explained by the standard model, and where long held "common wisdom" about its nature may be wrong. In neutrinos, we are confronting a pattern of properties which is very intriguing and begging for explanation, along with questions on whether they played an intrinsic role in bringing our universe to a matter-dominated state. Both of these questions highlight the importance of the connections of particle physics to cosmology; the standard model simply comes up short when it comes to explaining the universe as we see it, so we know that there are missing pieces we must find. Finally, proton decay remains a big question; there would be tremendous consequences if we were to observe it, and so we are planning the next generation of detectors to seek it out with significantly enhanced sensitivity.

I still consider myself a relative newcomer to Canada, but one thing (or complaint) I've heard often is that Torontonians view their city as the center of the Universe. In that case, it seems Toronto is a particularly appropriate place to ponder these questions regarding the fundamental building blocks of the Universe and the implications for how they shape the Universe as we see it today.
I'm glad to have finally arrived.

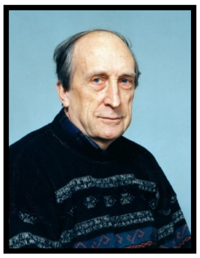
Announcements

Hirohisa A. Tanaka
Dr. Tanaka has been appointed Associate Professor & Institute of Particle Physics Research Scientist, Experimental High Energy Physics. Please see page 15 for a profile on Dr. Tanaka.

Amar Vutha
Dr. Vutha has been appointed to a tenure-track assistant professorship in the Experimental Quantum Optics/ Atomic, Molecular and Optical Physics group. Please see page 14 for a profile on Dr. Vutha.

Sabine Stanley
Dr. Stanley Has been appointed Associate Chair of Undergraduate Studies, taking over for Paul Kushner.
Dr. Stanley also received an Outstanding Achievement Award for Teaching from the Faculty of Arts and Science in May 2015.

In Memory



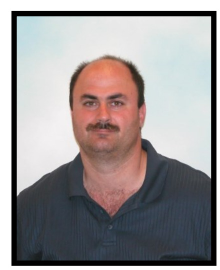
The Department mourns the loss of Professor Emeritus Derek Manchester who passed away on May 1, 2015.
Professor Manchester was an experimental condensed matter physicist. He obtained his PhD from the University of British Columbia in 1952, after which he worked at the National Research Council in Ottawa, before coming to U of T in 1964. He was well known for his early work on the Kondo effect (the surprisingly rich and intractable problem of an isolated magnetic moment in a metal), and for his later work on hydrogen in metals. Please see obituary in the Times Colonist.

The Department mourns the loss of Professor George Stegeman. Professor Stegeman was a graduate student of Boris Stoicheff in the 1970's. He was a faculty member at the University of Toronto Mississauga campus from 1970-1979. He then moved to the University of Arizona. He was a Fellow of the Optical Society of America and received the Hertzberg Medal for Achievement in Physics from the Canadian Association of Physicists and the R. Woods Prize of the Optical Society of America. His research interests were the study of nonlinear optics in waveguide structures, especially the properties of spatial solitons in various regions of the electromagnetic spectrum. Please see obituary on OSA website.

Celebrating 15 years

The Physics Learning and Research Services (PLRS) group supports teaching and research in Physics and the U of T community. We have many long serving members and in this newsletter we recognize two of our staff who are celebrating their 15th year with us.

Larry Avramidis



Larry Avramidis is a friendly and welcome face to students in the teaching labs, providing valuable assistance with their experiments. He also enjoys working with the Faculty and TA's and using his creative skills in designing, building and maintaining experimental apparatus used in teaching.

Larry's creativity and time management skills are particularly valued and constantly put to the test with increasing enrollment, new classes, renovations and keeping the experiments up-to-date with the limited amount of time and resources available.

One of the biggest changes Larry has seen in his fifteen years here is the movement from stand alone, dedicated measuring equipment to computerized data acquisition devices. Larry quickly became an expert in National Instrument's LabVIEW and NI's data acquisition products.

When Larry is not in the labs, he likes spending time with his family, playing the Bouzouki (a Greek stringed instrument), traveling and enjoying the outdoors.

Shuqing Li

A member of the Physics Electronics Resource Center (PERC), Shuqing Li enjoys working with students, faculty and staff to design state-of-the-art electronics apparatus to support research in Physics and across the UofT. When a student has an electronics related questions, Shuqing is always willing to help.

PERC is not a production environment; each project is completely different from the one before. The only thing in common is that in these days of limited research dollars, the budget is limited. The challenge for Shuqing is to make it right the first time, on-time and on-budget as there is little opportunity to start again. Electronics is a constantly changing field and so another challenge is keeping his knowledge and skills up to date.

When not at work Shuqing is keeping busy with home improvements. He likes to spend time with friends and family, going fishing and watching movies.

Graduate Student Profile - Graham Edge

Graham Edge
PhD Student
Ultra Cold Atoms

Graham Edge is currently finishing his 5th year in the direct entry PhD program, where he works with Professor Joseph Thywissen in the Ultracold Atoms group. Graham has always had a passion for the problem solving aspects of Physics and Mathematics, which has stayed with him through high school, a Bachelor's degree, and now nearly to the end of his Doctorate. He hopes to continue finding more of these problems and challenges once there are no more degrees for which to study.

Before he arrived at the University of Toronto, Graham studied Physics and Mathematics at Queen's University in Kingston. While at Queen's, he spent time working in the field of Nanophysics, studying the self-assembly of nanostructures on semiconductor surfaces through the use of a scanning tunneling microscope. Scanning tunneling microscopes allow one to explore the structure of a material down to the level of individual atoms and electronic bonds, allowing the study of the microscopic behaviour of atoms, molecules, and materials. This way of building up an understanding by starting with a microscopic picture was very appealing to Graham and stayed with him as he graduated and moved to Toronto to start graduate studies.

Graham Edge

Impressed by the direct real-world applicability that comes with research in the physics of materials, but at the same time hoping to continue learning about quantum physics, Graham was unsure what research to take up for his PhD. In the end, a perfect compromise was formed by starting a project in the field of ultracold atoms, which combines ideas from quantum physics as well as the physics of materials. In an ultracold atoms experiment, a collection of atoms are cooled to one millionth of a degree above absolute zero, a temperature at which the motion and interaction of the atoms is fully quantum mechanical. This quantum mechanical gas can then be studied to unravel the ways that quantum physics apply to a system with many interacting particles.

In order to learn about the physics of materials, ultracold atoms can be trapped inside a crystal lattice made of laser light, mimicking the way that electrons are confined inside a real material. This creates a kind of highly-tunable artificial material which can provide information regarding the ways quantum mechanics can dictate material properties. Graham's specific project has involved first preparing this kind of artificial material out of ultracold atoms, and then developing new techniques to image the resulting structure atom by atom and site by site in the crystal structure. This method of imaging ultracold atoms is referred to as a quantum gas microscope, and gives access to the same kinds of microscopic information for the quantum gas that a scanning tunneling microscope provides for real materials. Graham's experimental apparatus now produces on a daily basis such images of the single atoms that make up a quantum gas.

Graham has received financial support from NSERC (CGS-M and PGS-D awards), the Ontario Graduate Scholarship program, and the E.F. Burton Fellowship Fund

When taking a break from work, Graham likes to take his rascally dog out for walks to the various parks and green spaces around downtown Toronto. He also likes to play soccer, cook, and take in concerts of all sorts.

Graduate Student Profile - Ray Goerke

Ray Goerke
PhD Student
High Energy Physics

Ray Goerke

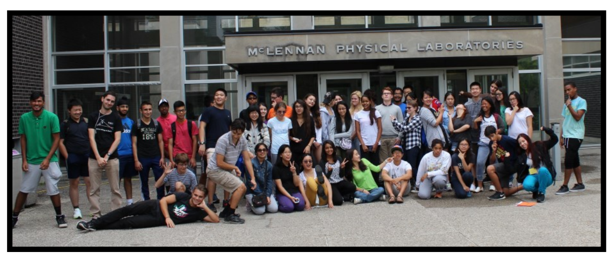
Ray Goerke is a 4th year PhD student and a member of Michael Luke's group. His research is focused on precision calculations in high energy Quantum Chromodynamics (QCD) using effective field theory. Ray has been fascinated by fundamental physics since high school when he read numerous popular science books covering topics from quantum physics to cosmology. While doing his undergraduate degree in Physics and Mathematics at the University of British Columbia, Ray had the opportunity to work in an applied physics research lab run by Thomas Mattison as well as in the theory group at TRIUMF, Canada's national particle and nuclear physics laboratory, under Sonia Bacca.

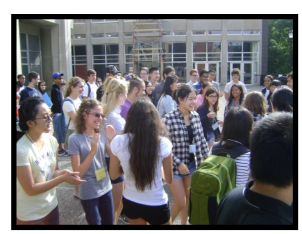
Ray has always been interested in the mathematical side of theoretical physics, and so he chose to focus on high energy particle physics for his PhD primarily due to his interest and fascination with Quantum Field Theory.

The projects Ray is currently working on revolve around the study of jets at high energy particle accelerators. Due to the phenomena of confinement in QCD, quarks and gluons that are produced in high energy collisions do not propagate as free particles into the detector. Instead, they form strongly interacting composite particles called hadrons which themselves cluster into collimated sprays called jets. At machines like the Large Hadron Collider (LHC), experimentalists are often most interested in collision events that produce specific numbers and types of jets. That allows them to identify what type of interaction occurred deep in the collider. The interpretation of experimental results therefore relies on accurate theoretical predictions of how high energy collisions of quarks and gluons produce jets. Ray works on using effective field theory techniques to improve these theoretical predictions.

When not working on his PhD, Ray spends much of his time practicing Judo, which he has been doing for 13 years. Ray has a first degree black belt and occasionally competes in local and provincial tournaments. His other interests include hiking and backcountry camping, board games, and tabletop roleplaying games.

Outreach in Action - Science Unlimited Summer Camp @utoronto





Science Unlimited Summer Camp took place August 10-14, 2015. 50 high school students had the once-in-a-lifetime opportunity to participate in a week of workshops from the Departments of Physics, Computer Science, Earth Sciences, Math, Astronomy and Astrophysics and the School of the Environment.

Here at the Department, students learned about Scientific Computing with Prof. Sabine Stanley and Atmospheric Physics with Prof. Kaley Walker's group. Grad Student Deepak Chandan demonstrated Magnetic Propulsion and Grad Student Miriam Diamond demonstrated the cloud chamber. Students were also shown how to make ice cream with liquid nitrogen!

Professors Amar Vutha and Stephen Morris treated the students to tours of their labs, Dave Rogerson showed them the Physics Learning and Research Services and Larry Avramidis showed them our undergraduate teaching facilities.

Students said they were "mind blown", loved the opportunity to learn new things, meet faculty and grad students and make new friendships.

To be notified when registration opens for 2016 camp email: outreach@physics.utoronto.ca

For more information visit: scienceunlimited.utoronto.ca

Undergraduate Student Profile

Chao Wang

Mathematics and Physics Specialist

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

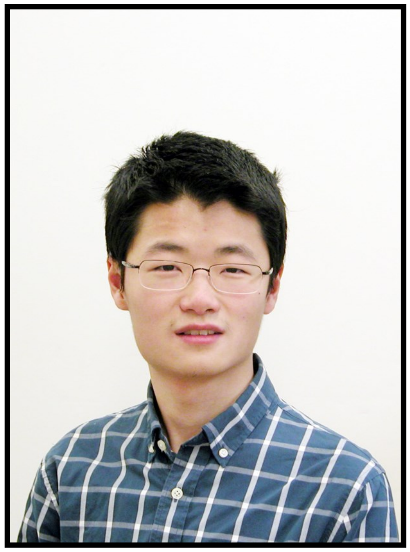
I decided to study physics in university when I was preparing for local physics competitions in high school in China. I studied college-level mathematics and physics curriculum during the preparation, and became very interested. One of our high school alumnus was a graduate student studying theoretical high-energy physics at UC Berkeley, and he gave us a series of lectures during the summers, on a variety of subjects such as electromagnetism, special relativity and thermal physics, which opened up my eyes. Looking back, my interest back then was extremely naïve, because I am able to get a much better sense of what modern physics research constitutes during my four years at University of Toronto; however the passion developed in high school has lived through to this day.

What do you enjoy most about the physics program?

The best part of the physics program at the University of Toronto is the abundant research opportunities in a diverse range of fields. I also thoroughly enjoyed the intensive and rigorous curriculum that the department of mathematics offers for physics students.

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

During first year I participated in the Hart House debating club and model United Nations, as an attempt to improve my oral communication skills. However, I soon discovered that I was not very skilled at socializing with other people, and as my course load became heavier I stopped participating. In the last two years I have been going swimming on a semi-regular basis, which is a necessary complement for intense focus on courses.



Chao Wang

What are your research interests?

My current research interests lie in two distinct subfields of physics, namely cosmology and condensed matter physics. It is a bit unusual that I still have not made up my mind on exactly what field I wish to pursue at this point, but I want to keep my mind open on a variety of fascinating physics topics. In recent years a lot is going on where different subfields meet, such as the interface between AMO/quantum optics and condensed matter physics. I wish to find out more about them.

What is your favorite course and why?

My favourite courses/paid physics activities are definitely undergraduate research or supervised study. The three research groups I have worked in, under the supervision of Prof. Daniel James, Prof. Aephraim Steinberg and Prof. Richard Bond, have all provided hands-on opportunities to work on interesting experimental/theoretical problems, and more importantly they have given me the opportunity to be exposed to cutting-edge physics through intense interactions with mature physicists.

What are your future plans?

I will be pursuing a physics PhD at Stanford University starting from Fall 2015. Stanford offers the unique opportunity for first year students to try out research in three different groups, and I want to take advantage of this to seriously explore my options and decide my focus before second year.

Where do you see yourself in 10 years?

My plan is to be a research physicist. More concretely, I will want to find post-doc and ultimately faculty positions after PhD graduation. However, ten years is a long time and a lot can change.

Tell me something interesting about yourself.

Uh... I really liked Jeong Yeon's answer to this question in the Spring 2015 newsletter. "for some reason, this question is harder than my last problem set, I can finish a carton of ice cream at one go."

Undergraduate Student Profile

Mary Miedema

Physics (Specialist) & Classical Civilization (Minor)

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

Resorting to a terrible cliché and quoting Feynman, "Which end is nearer to God; if I may use a religious metaphor. Beauty and hope, or the fundamental laws? . . . To stand at either end, and to walk off the end of that pier only, hoping that out in that direction is the complete understanding, is a mistake. And to stand with evil and beauty and hope, or to stand with the fundamental laws, hoping that way to get a deep understanding of the world, with that aspect alone, is a mistake."

I didn't read The Character of Physical Law until first year, but Feynman's words eloquently summarize what I find most appealing about the study of physics: getting a deep understanding of the world. To me, learning about physics and the fundamental laws of nature is an essential part of appreciating and participating in the world around us. In this sense, physics is incredibly fulfilling. Of course, as Feynman says, physics isn't in itself a complete understanding, so I'm also minoring in classical civilization (about as far from physics as you can get).

What do you enjoy most about the physics program?

I really enjoyed participating in the physics mentorship program this past year. I've also found the department's colloquia to be an exciting way to learn about new and emerging research.

Mary Miedema

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

I am a volunteer tutor with U of T's Centre for Community Partnerships. I have also been taking a number of sculpting classes at the Art Gallery of Ontario.

What are your research interests?

I'm particularly interested in condensed matter and quantum optics, with a focus on experimental methods and data analysis.

What is your favorite course and why?

My favorite course was PHY189 (Physics at the Cutting Edge), which helped me figure out where my research interests lay. More recently, hands-on experimental courses like PHY424 (Advanced Physics Laboratory) and PHY479 (Undergraduate Research Project) have helped me appreciate what actual research entails (while also being a lot of fun).

What are your future plans?

This fall I'll be applying to graduate programs in physics and trying to figure out exactly what my future plans are.

Where do you see yourself in 10 years?

I am not really sure. Hopefully still doing something physics-related.

Tell me something interesting about yourself.

I have a very high tolerance for cold, so I am habitually under-dressed for the weather. For this reason, I tend to encounter a number of concerned passers-by in the winter. The willingness of perfect strangers to offer me coats, scarves, hats, etc. has certainly strengthened my belief in the friendliness of Torontonians!

Mary and Chair Stephen at the end of term party where Mary received the Abdus Salam Award.

Nitrogen Tank Switch

The Physics Department uses a lot of liquid nitrogen (LN_2), and serves as a distributor to many others on the Saint George campus and at our affiliated hospitals. We buy the LN_2 in bulk, and store it in a large tank at the north end of the McLennan Physics Laboratories. Every five years we go through an open procurement process to ensure that we are paying a fair price. This year, for the first time in two decades, a new supplier was chosen. Mainly because of liability concerns, liquid nitrogen tanks are provided by the supplier, so a new supplier meant that the old tank had to be removed (on the coldest day of the year!) and a new one installed. The old tank was approximately 3.1 metres in diameter, 7.3 metres long, capacity of 34,000 litres, and weighed 18.7 kilograms empty. The new tank is a bit smaller, with a diameter of 2.4 metres, length of 7.9 metres, capacity of 23,000 litres, and empty weight of 13,600 kilograms. Filling the new tank took many hours. First, it had to be purged several times with very cold nitrogen gas. This served to remove other gasses, especially oxygen, and to precool the tank, avoiding the sudden build-up of pressure that would have been caused by the sudden vaporization of liquid introduced to a warm tank.

Please see the pictures of the huge task of moving the tank on the right.

The old tank being taken away

The arrival of the new tank

The filling of the new tank

Support the Department of Physics

Canada's leading Department of Physics is proud to offer an unrivalled breadth of cutting-edge research opportunities and educational programming designed to expand our knowledge of nature. These range from traditional core areas of condensed matter physics, quantum optics, subatomic physics and astrophysics, through globally influential work in climate change to the exciting emerging areas of quantum information, string theory and biological physics. Internationally renowned faculty are training future generations of scientists—all in an effort to respond strategically to some of the most pressing questions of our time. Your support will play a vital role in advancing the Department's reputation for excellence and innovation.
You can make a donation online here: donate.utoronto.ca/physics

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Physics Funny

Where does bad light end up?

A prism!