Concordia University
Arts and Science
Department of Physics

CONCORDIA PHYSICS

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A Journey, not a Destination

Truong Vo-Van, Chair, Department of Physics

What can I do with a Degree in Physics? This question is often asked by students, and even by their parents, when physics is considered as an option for study. As a physics educator, I naturally have an answer. In this Newsletter, Josh Laroche, an alumnus, proposes his own version by recounting his journey through physics and how he succeeded in defining his fulfilling occupations. Another alumnus, James Kass, an invited speaker at his alma mater, has lived through marvelous adventures in his exploration of human spaceflight, sometimes working with astronauts of the Salyut and MIR space stations, sometimes involving himself in space isolation studies in various countries…Mariana Frank, a professor at Concordia and equally an alumnus, has chosen to follow the odyssey of particles into the heart of the matter. A mini-interview will reveal her work and passion beyond the Standard Theory.

During the past few years, the department was able to improve considerably its situation by working relentlessly on the renewal of its faculty complement and reinforcing the main research orientations in nanophysics and bio/medical physics. One of the talented new hires is presented in this issue: Christophe Grova is busy establishing his lab to explore brain imaging using magnetic resonance.

After six years as Chair of the Department of Physics, I believe that it is about time to pass the torch to someone else, someone with fresher ideas and a renewed approach to teamwork. For me, it was indeed an enjoyable period working with our team, and I am grateful for the collaboration and friendship offered. Thanks are also due to the Faculty of Arts and Science and the University. *Bonne continuation!*

In This Issue

A Group of Graduate Students, Research Associates, Faculty and Staff at a Recent Department Lunch (photo credit L. Kalman)

A Mini-Interview with Prof. Mariana Frank: Beyond the Standard Theory for Not-So-Standard Problems in Particle Physics

Where did you study and when did you start as a faculty member at Concordia University? How and why were you interested in your research subject?

I got my undergraduate degree from Concordia! (Honours Theoretical Physics), my PhD from University of Toronto, and did my postdoctoral work at Oxford University. I started in 1986. (Wow, almost 30 years ago…time flies when you are having fun.) I have always been fascinated by Physics for its ability to answer questions about the fundamental structure of matter. This is what Particle Physics (or High Energy Physics) does, and I can't imagine doing anything else.

Please describe briefly your current research projects and the involvement of your students and associates.

There is a very successful framework for Particle Physics called the Standard Model. It is successful, because it explains almost all the observed phenomena. Almost, but not all; and then the model leaves some questions unanswered. Why do neutrinos have mass? Why do we have more matter than antimatter in the universe? And what is dark matter and dark energy? All of this is Physics Beyond the Standard Model, which is what our group works on. Some of it involves Supersymmetry, a transformation which stabilizes the Standard Model by linking different spin states, and which provides a candidate for the dark matter in the universe; some involves the existence of extra dimensions, which can explain why gravity is so weak at atomic scales; and some of my research is linking the properties of the newly discovered Higgs boson and those of the elusive dark matter. The graduate students are involved at the beginning in projects with me alone, and when they become more advanced they may also collaborate with Manuel, our Research Associate, and with other international scientists. And the students are expected to participate in international conferences and all have been accepted to prestigious summer schools (Nima to TASSI in Colorado, Sahar to CERN, Ash to the Perimeter Institute, and Jack to DESY in Hamburg). The international exposure is important because I am the only particle physicist here. As for specific projects, Nima and Manuel work on warped extra dimensional models, Sahar on Dark Matter, Jack in Supersymmetry at Colliders, and Ash on the stability and precision tests of Beyond the Standard Model scenarios.

How do you feel about the research environment in the Department of Physics?

The department has grown tremendously since I arrived and we have an exciting research culture. Being not too big, the unit fosters a family-like structure for graduate students. We celebrate each other's success and also the students'.

What would be the challenges ahead?

We are waiting anxiously for results from the Large Hadron Collider, which, when operating at 7 TeV center-of-mass, gave us the Higgs boson. It was turned back on recently, with the goal of operating at 13 TeV. Will we now see new Physics (beyond the Standard Model), and if so, are we ready to interpret the signals? In the meantime, direct and indirect detection experiments for dark matter, believed to comprise 25% of all matter in the universe, provide complimentary information on the structure of matter and a link between Particle Physics and Cosmology. The next decade will be very exciting and provide some of the answers we have been waiting for.

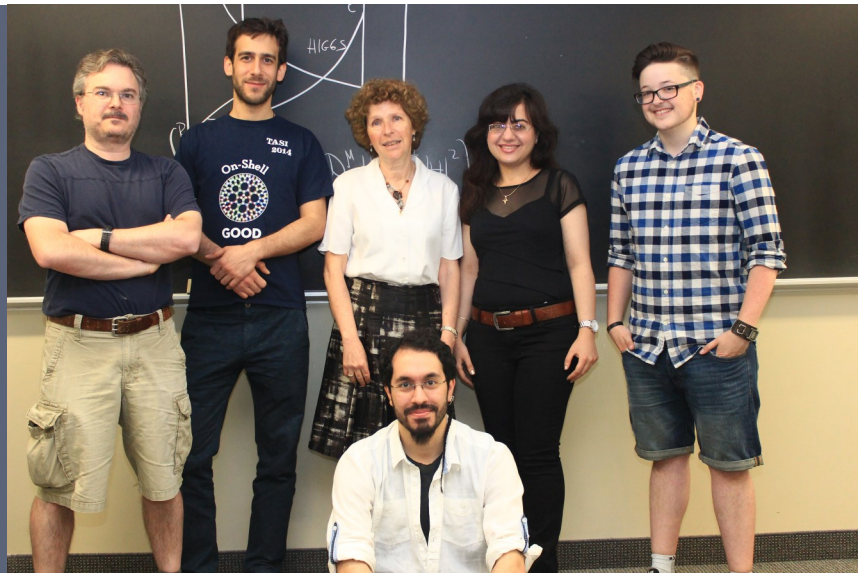
The Particle Physics Group

Front: Jack Araz

Standing (from left to right):

Manuel Toharia, Nima Pourtolami, Mariana Frank, Sahar Bahrami, Ashley Arsenault

Photo credit: Laszlo Kalman



What Can I Do with a BSc in Physics?

Josh Laroche, BSc, Physics (Concordia University)

These are words I admittedly searched on Google during my First years in the Concordia Undergraduate Physics Program. For me, getting a Degree in Physics was nothing like the experience my friends had in Engineering, Comp-Sci or the Accounting programs, where you end up working in a pre-defined sector. There is no clear path set out in front of you, no special "job" awaiting you on the other side of that diploma and hand-shake, and if you ask around it seems nobody has a really firm answer for what Physics students should look forward to upon graduation. I'll never forget this one response in particular *"A bachelors in Physics is fantastic… as long as you pair it with something else…"* – Wait, what!? Let me explain…

"We have an edge on the competition and it goes beyond just having the required skill set"

Now, that's not to say you need a second degree or to immediately go for a Masters or PhD in order to be employable, like I assumed it would as I began my third year course load - well beyond the point of no return. I can now say, as I look back on the past three years of my career after graduating, that I finally understand what it really means. You see, Physics Degrees have a uniquely intrinsic value not common among others, and how that value comes to fruition is all in how you "spin" it. So many school programs are focused on "*teaching kids what they need to know to get jobs*" while I feel the Physics program taught me about solving the world's most complex and abstract problems and finding creative solutions, managing high work-loads and learning to work in a team to solve really difficult problems - Those are real skills which I have been able to directly benefit from. Physics is a naturally inquisitive subject, where we are constantly asking questions about our surroundings, and just like the path to scientific discovery, we are always trying to leverage what is currently known to gain something further.

During my time at Concordia I had many side projects, and for me, Music and Physics have always been a passion; I played guitar in a band for many years, we played in all the local clubs and toured across the country to the West Coast in 2009, I was also running a small concert promotions company booking a few shows a month to make some cash, along with working night-shift at a security job on the weekends and grading papers and assisting in research at the Concordia Physics Lab during the week (*they have a great Co-op program and some very kind professors doing some very interesting research*).

When I graduated, I incorporated my concert promo business and made the transition from a local concert promoter to a booking agency, signed a couple of international DJ's and Artists and started setting up shows and tours all across the country, operating under the name of SkyRocket Entertainment Agency (www.flyskyrocket.com) which today, 4 years later, is now merging with the Internationally renowned Convoy Artist Agency (www.convoyagency.com). I've always been very passionate about working with my hands too – which is why I thought the Physics Labs were such a valuable experience; while in school I imported a right-hand drive 1992 Nissan Skyline GTR from Japan and over the course of a few years became a self-taught mechanic, totally rebuilding the car from the ground up, replacing vital engine components, upgrading the turbo-chargers and tuning the ECU for the car on a dyno to over 400 horse power. In doing so I documented every step along the way and posted this information on a purpose built website community that I started, (www.skylife4ever.com). Today this website sees more than 20,000 visitors a month and features contributions from some of the world's most specialized engine builders and world record holders.

It was my education in Physics and Science, combined with my real world experience as a mechanic, which landed me my first "real" job in the work force as a Technical Documentation Writer at a Pharmaceutical Automation Packaging company. I was writing user manuals for safe operation of robotic equipment, while this wasn't the dream job I had in mind, it helped me get some experience that I could leverage to find my next job.

What Can I Do with a BSc in Physics? (continued)

It didn't take more than 6 months after I started the Technical Writer job before I was interviewed for some analyst positions in finance and web-related companies. I got my foot in the door at an IT firm that employs just over 1,000 people and was offering a competitive starting salary with room to grow as a Web Analyst. They found it valuable that I had experience running my own websites, and since I was coming from a Physics background I was more than familiar with Excel and analyzing data sets. While working as a Web Analyst I took some evening classes in accounting and have since been promoted to Business Analyst, I now work daily with Business Intelligence data cubes to examine financial trends in sales data and provide predictions, growth models, ROI analysis, and monthly presentations to explain the results to the VPs and Directors.

The lesson in all of this, is that employers aren't out there looking for all the physicists to offer jobs to; on the contrary most job postings mention other Degrees, years of experience and soft-skills. That's why it's our responsibility (as Physicists) to find something that interests us and enlighten the world as to why someone with a Physics Degree is not only going to be able to do that same job, but better. We have an edge on the competition and it goes beyond just having the required skill set.

Physics is a field where you are essentially learning how to learn, the thought processes and problem-solving skills developed while studying are a gift that will benefit you for the rest of your career and life in ways you can't even imagine right now. No matter which job or task you take on, the strengths of your education in Physics will shine through; from programming and finance, banking and insurance, business, pharma, labs, construction, music and the arts, everything is accessible from a Physics students' perspective and completing that Degree is like planting a seed, and you continue to plant seeds as you expand your knowledge and try to learn as many new things as possible, as time goes on those seeds grow and blossom into opportunities.

So to answer my question of "what can I do with a Degree in Physics"?

Well, if you spin it right, you can do anything you want to do.

Josh Laroche served as a Fire Fighter and Medical First Responder for 5 years while studying

Medical Physics Imaging: Using Multimodal Functional Data to Characterize Brain Activity

Christophe Grova, new faculty, Department of Physics/ PERFORM Centre

Following his PhD in Biomedical Engineering from Université de Rennes (France), Dr. Christophe Grova came to Montreal in 2003 for a postdoctoral fellowship at the Montreal Neurological Institute with Dr. J. Gotman before being recruited as a research assistant professor at McGill University in 2008. Since July 2014, Dr. Grova started at Concordia University as a new faculty member in the department of Physics and a researcher at the PERFORM Centre.

He is the director of the Multimodal Functional Imaging Lab, a multidisciplinary team composed of neurologists and methodologists aiming at better characterizing brain processes by combining and integrating several image modalities. Validation in well-defined clinical contexts is an important aspect of the research promoted, making sure the end-users could have access to new methods to study brain activity with the required level of accuracy. The team of Dr. Grova has developed expertise in several domains that include: a) **EEG/MEG source localization**, proposing new methods to localize along the cortical surface, the electrical and magnetic components of neuronal signals measured from scalp recordings, making these new techniques available to the community as a Toolbox in Brainstorm software: http://neuroimage.usc.edu/brainstorm/Tutorials/TutBEst; b) **Volumetric Near Infra-Red Spectroscopy (NIRS)** allowing 3D spatio-temporal reconstruction of local oxy-hemoglobin and deoxy-hemoglobin responses to brain activity, using diffusion of infra-red light in living tissues using optic fibers placed on the scalp of the subject; c) **Multimodal characterization of Neurovascular Coupling (NVC) during normal and pathological conditions** using: (i) EEG/MEG sources to model neuronal bioelectrical input, (ii) functional MRI and NIRS data to monitor brain hemodynamic response; d) **Multimodal functional connectivity (FC) characterizing resting state data in normal and pathological conditions**: while resting state fMRI data have exhibited regions showing distant correlations at low frequency (<0.05Hz) organized as connected networks, the consistent Resting State Networks (RSN), the objective is to combine multimodal data to identify EEG/MEG signatures that would explain such network organization and to characterize pathological networks at the individual level, as potential new disease biomarkers (e.g., epilepsy, Alzheimer, ...).

As the chair of PERFORM Applied Bio-Imaging Committee (ABC), Dr. Grova is now highly committed in developing methodological research and education programs in medical imaging. The mandate of the ABC committee is to promote the emergence of a new community of medical imaging users and developers at Concordia University. At PERFORM, the team of Dr. Grova will notably develop the use of high density EEG (256 electrodes cap) acquired simultaneously with fMRI data, as a brand new technique to characterize brain activity at the time of specific EEG discharges and during resting state functional connectivity. There are currently several opportunities in the lab for undergraduate or graduate students to initiate some new research projects in medical imaging. Interested students are welcome to contact Dr. Grova (christophe.grova@concordia.ca)!

Concordia Student Participation in the International Rocket Engineering Competition in Utah

Team Members (from left to right):

Anita Haurie, Computer Engineering

Nicholas Moore, Specialization Physics

Matias Rittatore, Specialization Physics

Thomas Vaudry-Read, Computer Engineering

Teaming up in a Space Concordia Project

Nicholas Moore, Undergraduate Student in Physics

Our Payload consists of 2 Geiger Müller tubes that are wired to circuits we are assembling ourselves. The counts from the Geiger Muller tubes will be recorded by data loggers. We will monitor the increase in the count rate with altitude. The whole setup will be fit into a rocket that will ascend in June to more than 10,000 feet as part of the **International Rocket Engineering Competition in Utah.** At this competition, the rocket (and its payload) will be judged against those of other schools such as MIT, Queen's, and UCLA, to name but a few.

We are a team of four students who are experiencing what it is to do your own research and it has been an awesome, if humbling, process. We first started by brainstorming ideas and found that it wasn't easy to think of an experiment that would meet such space constraints, totally isolated, inside the carbon fiber walls of a rocket. We settled on the idea of our own Geiger Müller counter after reading papers on the energy of certain cosmic rays that reach the surface of the earth. Since then, the project has been all about checking our sources, double checking our sources, acquiring equipment, and finally, the assembly and fitting of the payload inside the rocket.

The rocket and its payload have already passed their preliminary and complete design reviews. Now that we are nearer the competition, we are all very busy but also very excited. Anita, Thomas, Matias, and myself all have plans to continue working at SpaceConcordia in the years to come, because this society gives us a chance to learn about physics and engineering in ways never seen in any classroom. The organization has two satellite teams, one robotics team, one ground station team, and of course the rocketry division of which we are part. SpaceConcordia is growing quickly, with new accomplishments every year: in 2012 we won the Canadian Satellite Design Challenge, in 2014 we placed second in this same competition, this year we will be launching our first rocket, and next year, we have plans to launch a satellite and send our first robotics team to Utah, along with our second rocket.

If you'd like to support this innovative, hardworking, and ambitious student body, please visit our Concordia FundOne page:

http://www.concordia.ca/alumni-friends/giving-to-concordia/fundone/space-concordia-rocketry-division.html

Our success depends on the generosity of people like you!

What Can You Do with a Degree in Physics: the Case of Alumnus Dr. James Kass

A public lecture by an alumnus (BSc, Physics, 1968, Sir George Williams), Dr. James Kass, is scheduled for June 3, 2015, 2 pm – 3:30 pm (Rm MB-1.210, John Molson School of Business). In this lecture entitled "Human Spaceflight" of the Concordia Summer Institute, Dr. Kass will recount episodes of his adventurous career in the domain of human spaceflight. He will share what inspired him, how the university helped him take the first steps in those pioneering days when Jules Verne's fiction became a reality, and how he fulfilled his dream to work in this exciting domain. One can read from his professional biography (http://www.kass-space.com/index.php/about-the-ceo/professional-biography) :

"Throughout most of the 35 years of his multi-disciplinary professional career Dr. Kass has worked in the domain of human spaceflight (since 1980), uniquely spanning the very different infrastructures of academic research, industry, and the European Space Agency. But, he has also run his own companies and has been on the board of directors of several companies and international institutions in several countries. Thus Dr. Kass' career has been multidisciplinary and multinational. He has had long experience working with international and national agencies, industrial and research institutions, medical centres and hospitals, in most countries of Europe, including many of the new accession states, as well as Russia, USA, China, Canada and Japan".

This is indeed another example of an exciting career of a physics graduate!

There are those who are going to be disappointed when no life is found on other planets. Not I — I want to be reminded and delighted and surprised once again, through interplanetary exploration, with the infinite variety and novelty of phenomena that can be generated from such simple principles.

Richard Feynman

New Department Chair Appointed

Dr. Alexandre Champagne has been appointed Chair of the Department of Physics for a three-year term (2015-2018). Dr. Champagne was hired as an Assistant Professor in the Department of Physics at Concordia University in 2008, and promoted to the rank of Associate Professor in 2013. He received a BSc in Physics from McGill University in 1999, and PhD in Physics from Cornell University in 2005. He completed postdoctoral studies at the California Institute of Technology in 2008. Dr. Champagne's research field is experimental nanoelectronics and quantum materials, and his work currently focuses on the interplay between quantum electronics and mechanics in graphene, carbon nanotubes, and silicon nanowires. These materials offer the possibility to discover new intricate phases of matter and develop nano-electro-mechanical devices (NEMS). He has published several high-impact publications, and received grants from NSERC, FQRNT, and CFI. He was awarded the Petro-Canada Young Innovator Award in 2010, the University Research Award (Emerging) in 2011, and a Tier II Concordia University Research Chair in 2012.

Dr. Champagne is optimistic about the future of the Department of Physics, and is committed to contribute actively to its development in the coming years.

New Grants Received

Recent research grants awarded: Claudine Gauthier, in collaboration with PERFORM (L. Bherer, J. Steffener), Douglas Hospital and Copenhagen University: **Quebec Bio-Imaging Network**, Pilot Project Grant, $15,000 (2015-2016); Christophe Grova, Claudine Gauthier and collaborators (P. Bellec: UdeM, J.M. Lina: ETS, E. Kobayashi: McGill): **FRQNT Research Team Grant**, $182,880 (2015-2018) + $11,811 in equipment (2015-2016). On the other hand, all applicants (new and renewals) in the **NSERC-Discovery Grant Program** have been successful this year: Mariana Frank: $200,000 for 2015-2020; Claudine Gauthier: $110,000 for 2015-2020, with a $5,000 supplement in 2015-2016; Valter Zazubovits: $100,000 for 2015-2020. Congratulations to all!

Graduating MSc & PhD Students (2014-2015)

The department is pleased to present the graduating class for 2014-2015:

MSc, Physics

Matei-Alexandru Ivanescu, *Manganese as Secondary Electron Donor in Native Bacterial Reaction Centers.* Supervisor: Dr. Laszlo Kalman.

Wahidun Nahar Khanam, *Helping Students to Get a Better Understanding of Physics Concepts Using the Learning Tool 'Course Dossier Method'*. Supervisor: Dr. Calvin Kalman.

Tabassom Hamidfar, *Fabrication and Characterization of Surface Nanoscale Axial Photonics Microresonators.* Supervisor: Dr. Pablo Bianucci.

Kathleen McGarvey-Lechable, *Design of Slow Light Modes in Photonic Crystal Ring Resonators.* Supervisor: Dr. Pablo Bianucci.

PhD, Physics

Nima Pourtolami, *Higgs Phenomenology in Warped Extra Dimensions*. Supervisor: Dr. Mariana Frank.

Serap Yigen, *Electronic Thermal Conductivity Measurements in Graphene*. Supervisor: Dr. Alexandre Champagne.

Congratulations to all and best wishes for continued success!

Inaugurating Showleh Physics TA Awards

The Showleh Memorial Award Fund in Physics has been created by members of the Department of Physics in memory of a beloved Laboratory Supervisor, Mr. Mostafa Showleh, who worked for the department from the early 90s until February 2007. This award recognizes the excellent work done as tutors by graduate students in physics laboratory. The inaugurating Showleh awards accompanied by a $500 cheque are attributed this year to the following teaching assistants (TA):

Charles Protheroe, Showleh Teaching Assistant Award, Undergraduate Physics Lab 2014-2015

Golia Shafiei, Showleh Teaching Assistant Award, General Physics Lab 2014-2015

Congratulations to our two winners!

Contact Us

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