Concordia University
Arts and Science
Department of Physics

CONCORDIA PHYSICS

CONCORDIA PHYSICS NEWSLETTER, Vol. 1, No. 2 March 2015

2015: International Year of Light

Truong Vo-Van, Chair, Department of Physics

Light, the visible part of the electromagnetic spectrum, has been the muse of poets and painters for centuries. Less known to the public is the fact that light is also an inspiration for countless scientists and physicists that include names such as Newton, Einstein, Huygens, Planck, Hertz, Maxwell and Townes.

Given the importance of light in all facets of our life, 2015 has been proclaimed by the United Nations as the International Year of Light and Light-Based Technologies (IYL). We not only take for granted the comfort provided by the lighting of our homes, our streets and our cities, but also the wonderful and uquibitous innovations since the discovery of quantum mechanics and the invention of lasers and optical fiber networks. Millions of communications via video-chat means that happen everyday would not be possible without these. Light equally allows us to bring changes and multiple benefits to a panoply of areas, be it in education, environment, development, building, electro-optics, photonics, energy, transport, health care or medical diagnostics.

The Department of Physics at Concordia is also a place where training and research are conducted with light at the center stage. Laszlo Kalman and Valter Zazubovits work to unlock the mystery of the photosynthesis process. Pablo Bianucci is confining light in tiny spaces in search of optical resonators while Truong Vo-Van uses light to trigger color changes in nanocellulose-based smart papers. Parts of the non-visible electromagnetic spectrum on the other hand form the basis of medical physics imaging work by Claudine Gauthier and Christophe Grova.

Que 2015 soit une année illuminée de culture scientifique et de paix!

> "From early attempts to understand the motion of stars and planets to the appreciation of the importance of light in photosynthesis, efforts to understand the nature and the characteristics of light have revolutionized nearly every field of science"
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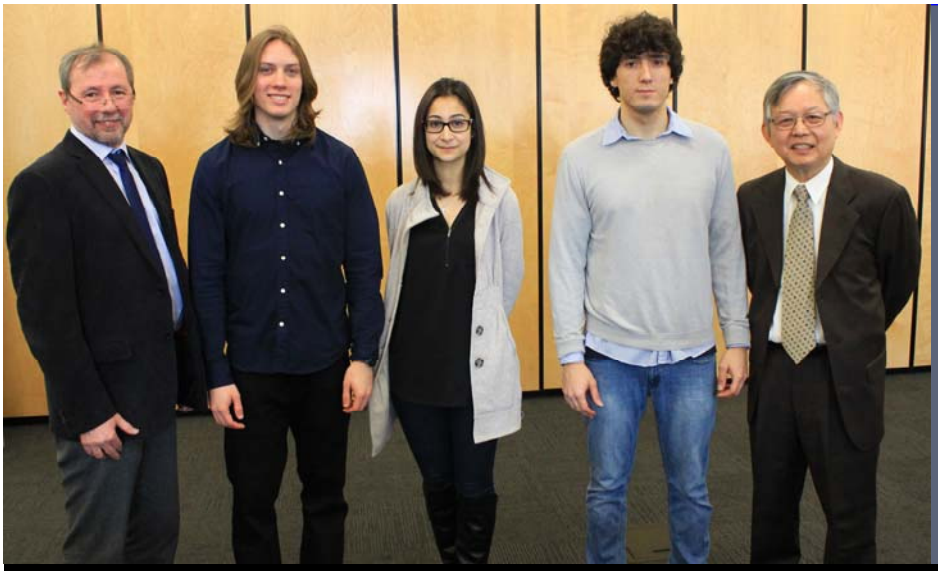
> 2015 International Light Year: http://www.light2015.org/Home.html



Physics Awards Event: FAS Dean André Roy, Daniel Andrews, Anastasia Kolokotronis, Shon Boublil and Chair Truong Vo-Van

In This Issue

String Theory and Harmonics: A Physics Student Profile

String Theory is not just a theoretical framework in physics; it is also the name of a great guitar music world competition, Six String Theory. In 2010 Shon Boublil won the Grand Prize (out of 500 contestants from around the world) at this competition which was held in Santa Monica and was awarded a four-year full scholarship to Berklee College of Music in Boston. Shon was planning to go to college to study science but opted instead to study music in Boston. After spending four years in this city, with one semester at Berklee Valencia campus in Spain, he graduated from Berklee with a Bachelor degree in musical performance with a highest distinction. Shon made his debut recording on probably one of the most interesting live guitar CDs produced, Six String Theory, along with 20 of well-known guitarists in the world that included Lee Ritenour, B. B. King, George Benson, Steve Lukather, Joe Bonamassa and Slash. Shon has also participated and won many national and international classical guitar competitions including the CMC (Canadian Music Competition) and a first place at the International Classical Guitar competition held in Concordia. He was recognized as a Yamaha Performing Artist and a D'Addario Gold Performing Artist. During these past years Shon performed solo in concert halls in the US, France, Spain, Russia and Canada. No doubt, his decision to study the art of music was an excellent choice.

On another note, Shon started fencing at a very early age and was a three times Quebec Fencing Champion, Montreal Fencing Champion and winner of the "Jeux du Québec". Fencing was very much a part of his winter sports activities. He spent his summers sailing pursuing White Sail certificates and his Powers Squadron sailing license mostly as a longtime member of the CFSA (Canadian Forces Yacht Club, Dorval).

Shon is now pursuing his initial passion of studying science in the Department of Physics at Concordia specializing in Biophysics and being a member of the Co-op program. This year is all about catching up, taking basic science courses and working hard, as well as adjusting to a very different learning environment. For Shon, the harmonics of physics are as inviting as music and with a profile like his, there is no doubt that his search for excellence will continue.

Shon Boublil, first-year physics student at Concordia University

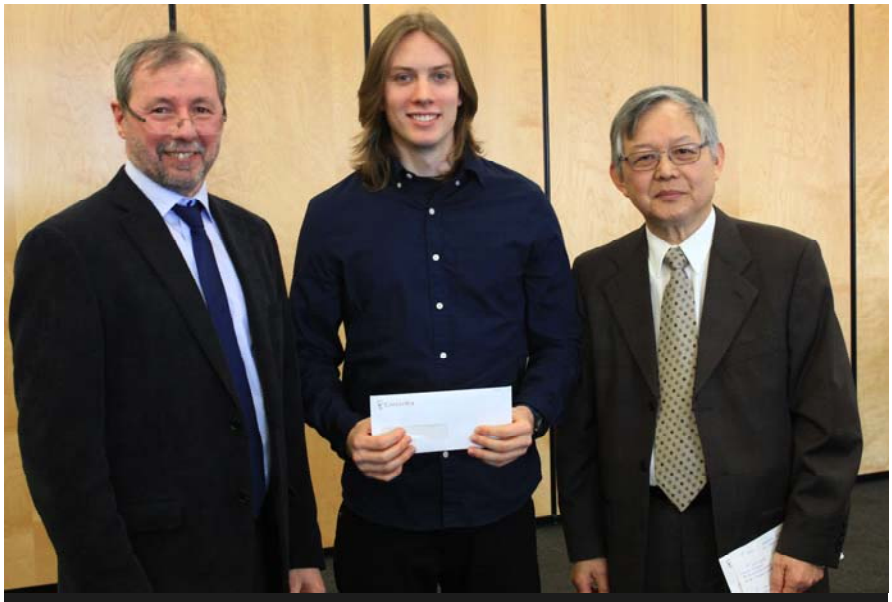
To listen to some of Shon's recordings, please visit: http://shonboublil.com/

Anastasia Kolokotronis receiving the First-Year Student Award 2014-2015

Physics Student Awards 2014-15

This year's Physics Awards Event was organized on February 16, 2015. The event was well attended by faculty, staff and students. We were particularly pleased to have the presence of parents of two of the award recipients. The Dean, Dr. André Roy, was on hand to congratulate the students and remit the scholarship cheques. The Physics First-Year Award ($1,500) was given to Anastasia Kolokotronis and the Physics Second-Year Award ($1,500) to Peter Collins (not present at the event). For his exceptional academic results in all physics program courses since his transfer from another program, the Physics Scholarship Committee has decided to attribute a special $500 award to Daniel Andrews, also a first-year student. Congratulations to all for their achievement!

These undergraduate physics awards were made possible thanks to the generous contributions from staff and faculty members of the Department of Physics.



Daniel Andrews receiving the Special Physics Student Award 2014-2015

The celebration spirit of the event was enhanced greatly by a multi-talented first-year student, Shon Boublil (featured in this Newsletter). Shon played with virtuosity two pieces of guitar music from his repertoire: La catedral, by Agustin Barrios Mangore, and Variations on a theme by Sor, by Miguel Llobet.

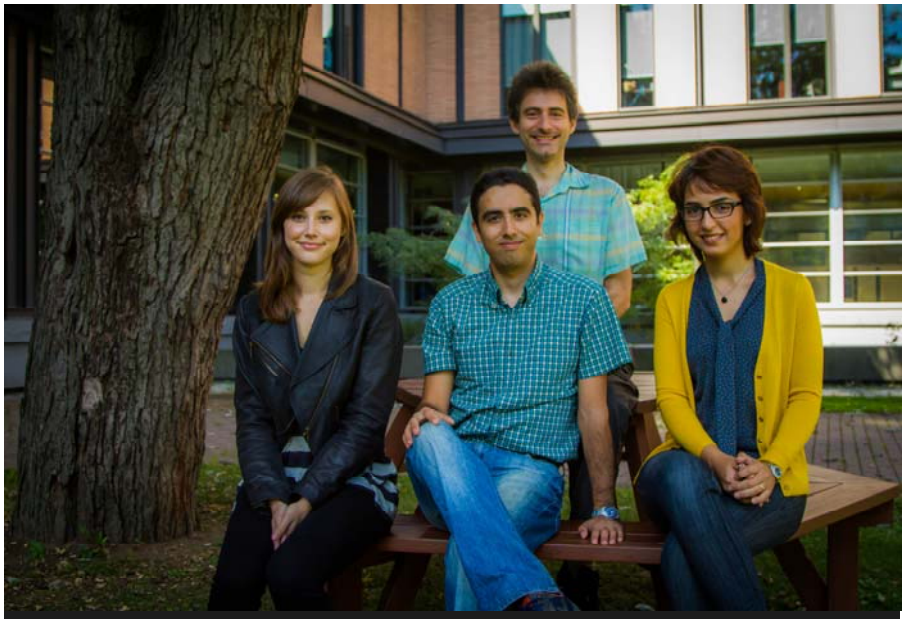
Shon Boublil performing at the event
Photo credit : Laszlo Kalman

A Profile in Nanophysics & Nanophotonics

Dr. Pablo Bianucci was recruited as an Assistant Professor in the fall of 2012.

He brought to the department knowledge and experience complementary to existing expertise in the strategic field of nanophysics. His research focuses on studying light trapped in microscopic structures and its interaction with the environment.

The application potential of his nanophotonics research is very high, and increased collaboration and partnership with industry is expected.



Pablo (back row) with graduate students Kathleen, Amir & Tabassom (left to right)

Pablo Bianucci: Researching Light in Tiny Spaces

Talking with Pablo we discovered that he wanted to be a physicist since the tender age of 14! He started his formal study of physics as an undergraduate at the Universidad de Buenos Aires in Argentina where he grew up. There, besides learning about a great deal of background in physics he got introduced to quantum mechanics and quantum information, prompting him to further explore these areas.

When Pablo started graduate school in Austin, Texas, he still had quantum information in mind when he joined an experimental research group doing optical manipulations of the quantum state of single semiconductor quantum dots. How cool was that? He did not know much about this field at the time but was resolute in engaging himself more in this field. It was during this time that he became an expert in laser spectroscopy and intimately familiar with the quantum mechanical interaction between light and matter, shaping progressively his future research program. He was also introduced to optical micro-resonators, microscopic structures capable of confining light for reasonably long times, a subject that immediately fascinated him. With time and experience Pablo refined his interests in research, always staying at the intersection of these two areas, studying diverse aspects of the interaction of light and matter in the confining environment of optical micro-resonators, and thinking on how to apply those ideas to make better optical devices.

As a professor at the Department of Physics at Concordia his research program follows these same lines, studying light trapped in microscopic structures and how it interacts with matter. All of the research projects in his group ask questions about light and matter. One of the projects, led by Amir Hassanpour, involves growing photon-confining structures out of zinc oxide nanorods. Once these structures are in hand, they can be used to explore the interaction between ultraviolet light and the nanorods, particularly in regimes where the interaction is very strong. In another project, led by Tabassom Hamidfar, optical micro-resonators were fabricated with losses so low that a photon could travel more than twenty thousand round trips before being lost. With the ultra-low loss of these resonators, it is possible to study how light can drive mechanical oscillations. Chip-compatible optical structures were also designed, using a new photonics technology known as “Silicon-on-Insulator” (which companies such as Intel are researching as a better alternative to electronic circuits). In this line of work, led by Kathleen McGarvey-Lechable, a very interesting structure was designed: it not only traps light, it also slows light down while trapping it. With the support of the Canadian Microsystems Corporation, Pablo’s group is converting this design into a real device that will be characterized fully in order to learn how well the theoretical design expectations are matched by real-life devices with imperfections.

With so many ideas still in the drawing board and the good recent results obtained so far, a bright and productive year can be expected ahead!

A Profile in Biomedical Physics & MRI Research

Dr. Claudine Gauthier joined the Department of Physics and PERFORM Centre this fall as a new Assistant Professor with a remarkable interdisciplinary background in training and research.

Dr. Gauthier's main research interest lies in the strategic area of preventative health for the aging population using magnetic resonance imaging (MRI) techniques. Together with Dr. Christophe Grova of the Department of Physics, she is part of a dynamic group of interdisciplinary researchers and clinicians at the PERFORM Centre of Concordia University.

Dr. Claudine Gauthier

Claudine Gauthier: MRI Physics in Preventative Health Research

Claudine Gauthier began her academic training in biochemistry at McGill before conducting her PhD in neuroscience at Université de Montréal. During her PhD, Claudine worked to develop novel magnetic resonance (MR) techniques for measuring oxidative brain metabolism and vascular health. This new method of measuring oxidative metabolism (termed QUO2) allows researchers to measure resting oxidative metabolism on any MR scanner, making possible a wide range of clinical applications in diseases such as stroke and dementia. Her PhD work also explored the relationship between central vascular health, vascular health in the brain, cardiorespiratory fitness and cognition in healthy aging. Results from this work indicate that exercise can help prevent some of the consequences of poor vascular health on cognition. During her postdoctoral work at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany, Claudine extended the use of these vascular and metabolic techniques to ultrahigh magnetic fields and applied them in the context of acute stroke, to better identify the brain tissue that can be rescued following the attack.

As a member of the growing group of interdisciplinary researchers and clinicians at the PERFORM Centre of Concordia University, Claudine is applying her expertise in MR physics, physiology, and aging to understand the consequences of common vascular diseases on brain physiology and cognitive function, and the plasticity processes that can lead to the restoration of cerebral vascular health once it has become impaired. As people age, cardiovascular health becomes a growing concern and has an increasing impact on quality of life at all levels: from daily activities to changes in cognition. In the context of a population that is living longer than ever before, it is therefore crucial to preserve individual autonomy and quality of life. To help understand these physiological changes, we can now image blood vessels and metabolism in the living human brain with advanced Magnetic Resonance Imaging (MRI) techniques. In her work, Claudine develops physiological imaging techniques such as these and applies them in younger and older populations. By measuring the impact of components of lifestyle, for example exercise, on these measures of vascular and metabolic health, she is building our understanding of the mechanisms whereby lifestyle influences cognition in aging.

A better understanding of the vascular and metabolic mechanisms that lead to loss and preservation of cognitive function during aging is necessary to improve lifestyle guidelines and measure the success of medical interventions in elderly populations. By developing new techniques to measure vascular and metabolic health, and applying them to questions of aging, lifestyle and cognition, Claudine will contribute to devising better prevention strategies to preserve health and cognition during aging.

A Rich and Stimulating Physics Seminar Series (2014-2015)

The Department of Physics in the last few years has had an exciting Physics Seminar Series aimed at providing undergraduate and graduate students as well as faculty members with seminars by noted researchers from different backgrounds, universities and research institutions.

For 2014 and up to this month, the seminar program with invited speakers included:

10/Jan/2014: **Dr. Carlos Silva**
Département de Physique, Université de Montréal
Direct Observation of Ultrafast Long-Range Charge Separation at Polymer: Fullerene Heterojunctions

15/Jan/2014: **Dr. Xuefeng Wang**
Department of Physics, Soochow University, Suzhou, China
Electron Transport via Edge States in Graphene Nanoribbons

17/Jan/2014: **Dr. Roberto Morandotti**
INRS - Énergie Matériaux Télécommunications
Novel Integrated Devices Based on Nonlinear Frequency Generation

24/Jan/2014: **Dr. Valerio Faraoni**
Physics Department, Bishop's University
Modifying Gravity to Explain the Cosmic Acceleration

31/Jan/2014: **Dr. Jérôme Pollak**
Tekna Plasma Systems
Nanopowder Synthesis, Powder Treatment and Deposition by Inductively-Coupled Plasma

7/Feb/2014: **Dr. Thomas Szkopek**
Department of Electrical and Computer Engineering, McGill University
The Hall Effect in Graphene: Science and Applications

14/Feb/2014: **Dr. Richard Leonelli**
Département de Physique, Université de Montréal
Recombination Dynamics in InGaN/GaN Nanowire Heterostructures

28/Feb/2014: **Dr. Jack Sankey**
Department of Physics, McGill University
Laser-Enhanced Micromechanical Sensors

14/Mar/2014: CAP Lecture Tour 2014—**Dr. Paul Kushner**
Department of Physics, University of Toronto
Climate Physics, Climate Models, and Climate Change

21/Mar/2014: **Dr. Sylvain G. Cloutier**
Département de Génie Électrique, École de Technologie Supérieure
Hybrid Polymer-Nanocrystal Architectures for Low-Cost Opto-Electronics

28/Mar/2014: **Dr. Richard Mackenzie**
Département de Physique, Université de Montréal
The "Theoretical Discovery" of the Higgs Mechanism

11/Apr/2014: **Dr. Tsuneyuki Ozaki**
INRS—Énergie Matériaux Télécommunications
Intense Terahertz Radiation and Nonlinear Terahertz Spectroscopy at the Advanced Laser Light Source

5/May/2014: **Dr. Andal Narayanan**
Light and Matter Physics Group, Raman Research Institute, Bangalore, India
Cavity Opto-Mechanical systems: A New Paradigm for Realizing Quantum Effects with Light and Mechanical Forces

6/Aug/2014: **Dr. Hieu Pham Trung Nguyen**
Department of Physics, McGill University
Phosphor-Free III-Nitride Nanowire White-Light-Emitting Diodes Grown by Molecular Beam Epitaxy

Physics Seminar Series 2014–2015 (continued)

29/Sep/2014: **Dr. Luca Razzari**
INRS - Énergie Matériaux Télécommunications
Intense Terahertz Radiation-Matter Interactions

06/Oct/2014: **Dr. Alex Maloney**
Department of Physics, McGill University
Holography, Black Holes and Quantum Gravity

20/Oct/2014: **Dr. Andrea Bianchi**
Département de Physique, Université de Montréal
Magnetic Properties of a Crystals of the Free Organic Radical Molecule NIT-2Py

27/Oct/2014: **Dr. Sylvain Martel**
Département de génie informatique et génie logiciel, École Polytechnique de Montréal
Medical Nanorobotics: a New Tool for Cancer Therapy

10/Nov/2014: **Dr. Aashish Clerk**
Department of Physics, McGill University
Quantum Opto-Mechanics & Quantum Reservoir Engineering

17/Nov/2014: **Dr. Christophe Caloz**
Department of Electrical and Computer Engineering, École Polytechnique de Montréal
Metasurfaces for Tomorrow's Spatial Dispersion Processing

24/Nov/2014: **Dr. Aycan Yurtsever**
INRS - Énergie Matériaux Télécommunications
Nanoplasmonics with Ultrafast Transmission Electron Microscopy

01/Dec/2014: **Dr. David Plant**
Department of Electrical and Computer Engineering, McGill University
Silicon Photonic Traveling Wave Modulators for 100G/400G/1T Short Reach Inter-connects

10/Dec/2014: **Dr. Rolf Wuthrich**
Department of Mechanical Engineering, Concordia University
Lightening the Spark in Electrochemistry

23/Jan/2015: **Dr. Stéphane Kéna-Cohen**
Department of Engineering Physics, École Polytechnique de Montréal
Mixing Light and Matter

30/Jan/2015: **Dr. Mojtaba Kahrizi**
Department of Electrical and Computer Engineering, Concordia University
Low Cost Fabrication of Metallic and Semiconductor Nanowires

06/Feb/2015: **Dr. Alfonso Díaz Furlong**
Department of Physics, McGill University
The Standard Model and Beyond: A Journey Through the Extra Dimensions

13/Feb/2015: **Dr. Mohammad Ahmady**
Department of Physics, Mount Allison University
The Beauty in B Physics

20/Feb/2015: CAP Lecture tour 2015—**Dr. Melanie Campbell**
Department of Physics, University of Waterloo
Through the Optics of the Eye to a Window on the Brain

06/Mar/2015: **Dr. Paul Charbonneau**
Département de Physique, Université de Montréal
Solar Activity and Climate Change

Contact Us

Give us a call for more information on physics at Concordia!

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