Summer school 5-7 May

Breakfast and Lunch
St-Mathieu / Atwater room at the Nouvel

Talks and panel
Maisonneuve / Dorchester room at the Nouvel

Poster session
St-Mathieu / Atwater room at the Nouvel

4 May Meet & Greet
St-Mathieu / Atwater room at the Nouvel

5 May Social dinner
Bar & Boeuf Restaurant, 500 McGill St, (514) 866-3555

Contact in the organizing committee
Pierre-François Duc (514) 994-0768

Main meeting 8-10 May

Breakfast
Served between 7:00 and 8:00 in the restaurant l'Entracte at the Nouvel in exchange for one of the coupons handed out upon arrival and check-in at the summer school.

Lunch
Saveur at the Hyatt

Talks
Soprano AB room at the Hyatt

Poster sessions
Soprano C and Foyer room at the Hyatt

Emergency (ambulance, police) : dial 911

Nouvel Hotel & Spa
740 René-Lévesque West
Montreal, Qc
1-800-363-6063

Hyatt Regency Hotel
1255 Rue Jeanne-Mance
Montréal, Qc
(514) 982-1234

CIFAR

Quantum Materials Summer School 2014

Montréal
5-7 May 2014

UNIVERSITÉ DE SHERBROOKE

McGill

CIFAR CANADIAN INSTITUTE FOR ADVANCED RESEARCH

ICRA INSTITUT CANADIEN DE RECHERCHES AVANCÉES

Summer school schedule

Sunday 4 May

18:00-19:00	Check-in and document handout
19:00-21:00	**Meet & Greet Buffet (Nouvel Hôtel)**

Monday 5 May

7:00-8:30	**Breakfast (St-Mathieu/Atwater room)**
8:30-9:30	Guillaume GERVAIS
9:30-9:50	**Coffee break**
10:50-11:50	Tami PEREG BARNEA
12:00-13:00	**Lunch (St-Mathieu/Atwater room)**
13:00-14:00	Lillian CHILDRESS
14:00-14:20	**Coffee break**
14:20-15:20	Eduardo H. DA SILVA NETO
15:20-16:00	**Poster setup**
16:00-17:30	Poster session & coffee break
17:30-19:00	Free time
19:00-21:00	**Social Dinner (Bar & Boeuf)**

Tuesday 6 May

8:30-10:00	**Breakfast (St-Mathieu/Atwater room)**
10:00-11:00	Maxime DION
11:00-11:20	**Coffee break**
11:20-12:20	Ion GARATE
12:20-13:30	**Lunch (St-Mathieu/Atwater room)**
13:30-14:30	Catherine KALLIN
14:30-15:00	**Coffee break**
15:00-16:00	Michel GINGRAS
16:00-16:15	**Coffee break**
16:15-17:30	Panel : *Career prospects for physicists*
11:45-12:30	Tami PEREG-BARNEA - Creating & characterizing topological superconductors - in theory
12:30-14:00	**Lunch (Saveur)**
14:00-14:45	Ion GARATE - Phonon-induced topological insulation: theory and (some) applications
15:00-19:00	Poster Session & Coffee Break

Saturday 10 May

7:00-8:00	**Breakfast (Entract at the Nouvel Hotel)**
8:30-9:15	Dave HAWTHORN - *CDW order in YBCO & LBCO studied via resonant x-ray scattering*
9:15-10:00	Seamus DAVIS - Visualizing transitions at the quantum critical point in cuprates
10:00-11:00	**Coffee Break (Soprano Foyer)**
11:00-11:30	Riccardo COMIN - Charge order, Fermi-arc instability, and bond order in cuprates
11:30-12:00	Fazel TAFTI - *A quantitative understanding of superconducting fluctuations in cuprates*
12:00-12:30	*Eduardo DA SILVA NETO* - Interplay between charge ordering and superconductivity in cuprates
12:30-14:00	**Lunch (Saveur)**
14:00-16:00	Business meeting (Program members and Advisors only)
16:00-17:00	**Coffee Break (Soprano Foyer)**
17:00	Departure

Main meeting schedule

Thursday 8 May

7:00-8:00	**Breakfast (Entract at the Nouvel Hotel)**
8:30-9:15	Joseph THYWISSEN - *Spin transport in a unitary Fermi gas*
9:15-10:00	Tilman ESSLINGER - *From terminal to terminal with atoms*
10:00-11:00	**Coffee Break (Soprano Foyer)**
11:00-11:45	Mohit RANDERIA - *Skyrmions and spin textures in quantum materials and cold atoms*
11:45-12:30	Lindsay LEBLANC - *Simulating gauge fields in ultracold quantum gases*
12:30-14:00	**Lunch (Saveur)**
14:00-14:45	Jeffrey QUILLIAM - *New experimental routes to quantum spin liquid physics*
14:45-15:45	Poster Ads
15:45-19:00	Poster Session & Coffee Break
19:00-20:30	**Social Dinner (Saveur/Pavillon)**

Friday 9 May

7:00-8:00	**Breakfast (Entract at the Nouvel Hotel)**
8:30-9:15	Darrell SCHLOM - Towards room temperature magnetoelectric multiferroics in superlattices
9:15-10:00	Harold HWANG - Recent progress in high mobility superconducting 2DEGs in $SrTiO_3$
10:00-11:00	**Coffee Break (Soprano Foyer)**
11:00-11:45	George SAWATZKY - Resonant elastic and inelastic x-ray scattering studies in thin films

Wednesday 7 May

7:30-9:00	**Breakfast (St-Mathieu/Atwater room)**
9:00-10:00	Fazel FALLAH TAFTI
10:00-10:20	**Coffee break**
10:20-11:20	Jeffrey QUILLIAM
11:20-11:40	**Coffee break**
11:40-12:40	Joseph THYWISSEN
12:40-14:00	**Lunch (St-Mathieu/Atwater room)**
14:00-15:00	Tilman ESSLINGER
15:00-15:20	**Coffee break**
15:20-16:20	David HAWTHORN

Word from the organizing committee

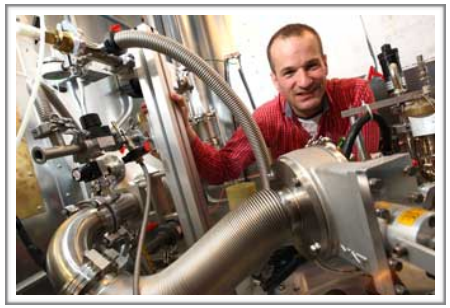
It is with pride and enthusiasm that we welcome you to this edition of the CIFAR Quantum Materials Summer School. We hope that you will take full advantage of this chance to meet and exchange with fellow students as well as to familiarize yourself with the fascinating subjects studied among CIFAR Quantum Materials Program Members. We would like to thank CIFAR for the opportunity to organize this school as well as the speakers for contributing to its success.

In the spirit of the 2013 summer school, this edition features a panel on *Career Prospects for Future Physicists*. We innovate with a talk on an aspect of our field rarely addressed : the *Gender Gap in Physics*. We hope you will appreciate these extra-academic elements of the school as well as the excellent scientific talks !

Sophie Dufour-Beauséjour
Gaël Grissonnanche
Pierre-François Duc
Samuel Boutin
Alexis Reymbaut

Monday 5 May

8:30 - 9:30
Guillaume GERVAIS
McGill University



Electron Drag Strip and Rotten Berry Pie

I will discuss and explain recent results obtained in my laboratory regarding two seemingly disjoint projects, yet both occurring under the same umbrella of the engineering and search of quantum matter "on-a-chip". For more information, please come to the talk!

9:50 - 10:50
Tami PEREG BARNEA
McGill University

Introduction to high temperature superconductivity

Superconductivity was first found in mercury in 1911 by Heike Kamerlingh Onnes. About 46 years later Bardeen Cooper and Schrieffer (BCS) wrote a theory to explain this phenomenon. Today we know that most metals and alloys become superconducting at (ultra) low temperatures (milli-Kelvins to a few Kelvins). They are all conventional in the sense that they are described by the BCS theory and we therefore refer to them as 'conventional' or BCS superconductors. The BCS theory consists of pairs of electrons (Cooper pairs) bound together by phonon exchange processes and forming a collective ground state.

15:20 - 16:20
David HAWTHORN
University of Waterloo

Resonant elastic X-ray scattering

In strongly correlated materials, spin, charge and orbitally ordered phases often occur in association with interesting phenomena such as colossal magneto-resistance, multi-ferroicity or superconductivity. In this talk, I will detail a powerful technique, resonant x-ray scattering, to study these ordered phases. By tuning the photon energy to an x-ray absorption edge (resonance), x-ray diffraction obtains direct sensitivity to spatial modulations of the electronic structure (spin, charge, orbital, …), with the energy and photon polarization dependence of the scattering providing important fingerprints of microscopic character of the order. I will describe the experimental and theoretical basis for the technique and discuss examples of RXS experiments including recent investigations of charge density wave order in cuprate superconductors.

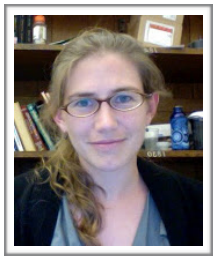
14:00 - 15:00
Tilman ESSLINGER
ETH Zurich

Looking at condensed matter physics with quantum gases

Fermionic quantum gases in optical lattices make it possible to physically construct and study key models of condensed matter physics. The riddle of high temperature superconductivity, or the beauty of graphene, are becoming accessible to experiments, in which the Hamiltonian is a direct result of the optical lattice potential created by interfering laser fields and short-ranged collisional interaction between ultracold atoms. I will give an introduction to quantum gas experiments and report on our most recent results. We have been able to create a honeycomb lattice structure and identify Dirac points, move them within the Brillouin zone and make them appear or disappear. We have recently reached the regime of quantum magnetism in an atomic Fermi Hubbard model, using a dimerized and an anisotropic cubic lattice to locally engineer the entropy distribution of the gas. This allowed us to observe short-range antiferromagnetic correlations.

In 1986 superconductivity was discovered by Georg Bednorz and K. Alex Müller in a ceramic material (LBCO). This material is a part of a large family known as the cuprates which exhibit transition temperatures of up to 150K. The high transition temperatures cannot be explained by phonon coupling and therefore other scenarios are considered. It is widely perceived that strong correlations in the cuprates play an important role in forming the superconducting ground state. However, there is still no consensus on a single theoretical model which can describe the rich phenomenology of this family. Many more materials have been found over the years to be superconducting. Most notable is the recent discovery of superconductivity in the iron-pnictide family (2006). This family most likely belongs to the unconventional class and adds a new ingredient into consideration - the strong magnetic moments of the iron atoms. In this talk I will review the foundation of superconductivity theory and will discuss the phenomenology and theoretical ideas related to the cuprate and iron-pnictide superconductors.

13:00 - 14:00
Lillian CHILDRESS
McGill University



An introduction to the nitrogen-vacancy center in diamond

The nitrogen vacancy (NV) center offers the opportunity to study individual electronic and nuclear spins in diamond. Combining atomic-like optical transitions with long spin coherence times in a solid-state device, the NV center presents a promising platform for quantum information science and metrology. This lecture will explore how the electronic structure of the NV allows optical access to its spin degrees of freedom at both cryogenic and ambient temperatures, consider the mechanisms that govern the coherence properties of its spins, and provide an overview of current research and applications.

14:20 - 15:20

Eduardo H. DA SILVA NETO

University of British Columbia

Charge ordering in the cuprate high temperature superconductors

Key to understanding the superconducting phenomenon in copper-based high-temperature superconductors is the correct identification of coexisting orders, their microscopic nature, and whether they are in competition with superconductivity. Over the last decade there has been an escalating amount of evidence for ordering phenomena coming from different probes and materials, and which were apparently dissimilar amongst themselves. Bulk measurements coming from thermoelectric transport, Hall resistance, and quantum oscillations on $YBa_2Cu_3O_{6+x}$ (YBCO) pointed to Fermi surface reconstruction and indirectly to electronic ordering. Additionally, it had been long known that scattering experiments detected stripe order in La-based compounds. Simultaneous to those discoveries there was an increasing amount of evidence for a propensity toward charge ordering in the pseudogap phase coming from surface sensitive techniques such as angle-resolved photoemission spectroscopy (ARPES) and scanning tunneling microscopy STM, though these were detected in yet another family of cuprate materials, the Bi-based compounds. A common interpretation for all these experiments started to emerge after the discovery of charge ordering by nuclear magnetic resonance (NMR) and x-ray scattering measurements in $YBa_2Cu_3O_{6+x}$, followed by combined resonant x-ray scattering (RXS), STM and ARPES experiments on Bi-based cuprates.

10:20 - 11:20

Jeffrey QUILLIAM

Université de Sherbrooke

NMR for the study of magnetism in condensed matter physics

In this talk, I will introduce the technique of nuclear magnetic resonance (NMR) and some related experimental methods. I will then explain how NMR can be used as a highly local probe in materials, primarily exploring magnetic degrees of freedom. Finally, I will give several examples of how it has been employed to study some particularly important problems in modern condensed matter physics with a concentration on the field of frustrated magnetism.

11:40 - 12:40

Joseph H. THYWISSEN

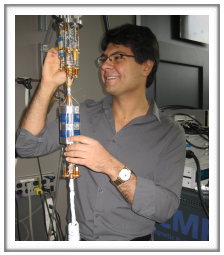
University of Toronto

Unitary Fermi gases

Having a knob with which to tune interactions in a many-body system is a physicist's dream. And yet it is also the reality of ultracold atoms. I discuss both the theory and experimental data on what happens when interactions in a degenerate Fermi gas are tuned to resonance: the so-called unitary regime.

Wednesday 7 May

9:00 - 10:00
Fazel FALLAH TAFTI
Université de Sherbrooke



Thermoelectric transport in cuprate superconductors - Study of superconducting fluctuations

I will give an intuitive understanding of thermo-electric transport in metals and superconductors, followed by an introduction on superconducting Nernst fluctuations. The purpose of the talk is to familiarize students with the current challenges in understanding the organizing principles of the phase diagram of cuprates both at low temperatures where ordered phases exist and at higher temperatures where fluctuations of those ordered states prevail. We start by giving two main pictures: phase fluctuations versus phase competition. We argue the pros and cons of each viewpoint and study the experimental findings that support each scenario. Throughout the class, we will alternate between derivations on the board and powerpoint slides to flash the data.

I will first give a review of these many results from an experimentalist's perspective, emphasizing how each contributed in their own way toward a "big-picture" understanding of the cuprate phenomenology. In doing so I will eventually focus on the STM technique for which I will give a more in-depth description. Nevertheless, the primary goal of this talk is to give the audience a perspective of how several years of research by different groups in different parts of the world, and using different experimental techniques, eventually led to the discovery of charge ordering which has now taken place at the forefront of research in the field of high-temperature superconductivity.

15:20 - 16:00
Poster setup
St-Mathieu and Atwater room

16:00 - 17:30
Poster session & Coffee break
See next page for list of posters

19:00 - 21:00
Social dinner
Bar & Boeuf
500 McGill St,
Montréal, QC
(514) 866-3555

Poster session

A1 **Amorim Cassio (Nagoya University)**
Numerical braiding of Majorana Fermions on finite size nanowires

P2 **Anderson Rhys (University of Toronto)**
Quantum Phase Transitions in an Optical Lattice

A3 **Brian Kim (Stanford University)**
Device Application for Epitaxial Anatase TiO2 Using Termination Layer Control

P4 **Chiu Ching-Kai (University of British Columbia)**
Majorana fermion exchange in strictly one dimensional structures

P5 **Clark Lucy (McMaster University)**
Spin Frustration in Lu2Mo2O7 and Lu2Mo2O5N2 Pyrochlores

A6 **Cook Ashley (University of Toronto)**
Spin-orbit coupled double perovskite bilayers: Tuning magnetism, C=2 Chern bands, and quantum anomalous Hall insulators on the honeycomb lattice

M7 **Fu Mingxuan (McMaster University)**
^{17}O Single Crystal NMR Study on ${S=1/2}$ Kagome Lattice ${ZnCu_{3}(OH)_{6}Cl_{2}}$

P8 **Ghamari Sedigh (McMaster University)**
RG Analysis on a Neck-Narrowing Lifshitz Transition in the Presence of Weak Short-Range Interactions in Two Dimensions

In that context, systems with magnetic moments that reside on the sites of a two-dimensional or three-dimensional network of corner-sharing triangles or tetrahedra and interact with effective antiferromagnetic nearest-neighbor coupling have been the subject of numerous investigations, both on the experimental and theoretical front. Within the realm of three-dimensional systems, the pyrochlore lattice of corner-sharing tetrahedra with antiferromagnetically interacting spins has been recognized since the early 1990s as a unique setting to explore thermodynamic and magnetic phenomena caused by a large degree of magnetic frustration. From this perspective, the R2M2O7 pyrochlore oxides are particularly interesting since the R^{3+} and M^{4+} ions, with either or both being magnetic, reside on two independent and interpenetrating lattices of corner-sharing tetrahedra.

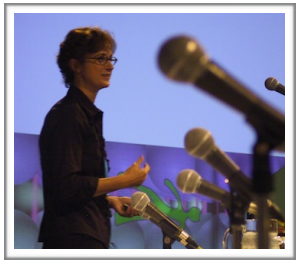
In this talk, I will review the evolution of our understanding of the R2M2O7 compounds from the late 1990s, when classical spin ice physics was discovered, to the current search for a U(1) quantum spin liquid, with deconfined "magnetic" and "electric" gauge charges and with the accompanying gauge photon, in the quantum material cousins of classical spin ices.

16:15 - 17:30
Panel : Career prospects for futur physicists
Catherine KALLIN and Michel GINGRAS

Étienne BOAKNIN - Director of Corporate Strategy and Development at SNC-Lavalin

Pascal LAPOINTE - Chief Editor of the Agence Science Presse (Science Press Agency)

13:30 - 14:30
Catherine KALLIN
McMaster University



The gender gap in physics

The proportion of women in physics in Canada, at each educational or career level, has increased over the past few decades. However, recently the increase has slowed and the participation of women in physics still lags behind that in other areas of science. This talk will include some data on this gender gap, as well as some observations, anecdotes, ideas, and advice relating to why there is a gender gap, why it matters and what to do about it on a personal and on a collective level. This talk is meant to stimulate questions and discussion on this topic so please come prepared to participate.

15:00 - 16:00
Michel GINGRAS
University of Waterloo

Magnetic pyrochlore oxides compounds : beyond Ising with hbar zero

Magnetic materials and models of magnetic systems have long afforded physicists with an exquisite platform to study the fundamental and generic, and at times even universal, principles that govern collective phenomena in Nature. The 1987 proposal by Philip Anderson that geometric frustration may lead to the discovery of magnetic systems disordered by large quantum fluctuation triggered the modern age of experimental and theoretical study of highly frustrated magnets and the search for quantum spin liquids.

A9 **Granstrom Chris (University of Toronto)**
Point-Contact Andreev Reflection Spectroscopy of Bismuth-Chalcogenide Topological Insulators

P10 **Grissonnanche Gaël (Université de Sherbrooke)**
Thermal Hall effect in underdoped cuprates

P11 **Hallas Alannah (McMaster University)**
Incipient Ferromagnetism in Tb2Ge2O7: Application of Chemical Pressure to the Spin Liquid, Tb2Ti2O7

P12 **Huang Wen (McMaster University)**
Non-topological nature of the edge current of chiral p-wave superfluids

P13 **Komijani Yashar (University of British Columbia)**
Quantum critical point in singe channel normal and topological superconductor junctions

P14 **Lithgow Calum (University of St Andrews)**
Hall Effect Measurements on Ferromagnetic Superconductor UGe2

A15 **Lu Di (Standford University)**
Phase Transition in Strain Relaxed (100)-Oriented Nd0.5Sr0.5MnO3 Thin Films

P16 **Maharaj Dalini (McMaster University)**
Neutron Spectroscopic Study of Crystal-Field Excitations of Yb2(Ti2-xYbx)O7-x/2

A17 **S. Mahyad Aghigh (University of British Columbia)**
Anisotropy Study of Microwave Electrodynamics in Tl-2201

P18 **Noad Hilary (Stanford University)**
Stripes of enhanced transition temperature in superconducting strontium titanate

A19 **Nowadnick Beth (Columbia University)**
Phase competition in the Hubbard-Holstein model

A20 **Petrescu Alexandru (Yale University and Ecole Polytechnique)**
Bose-Hubbard Haldane Model

P21 **Roncaioli Connor (University of Maryland)**
Thermal Treatment and the Collapse Transition in Sn-flux grown CaFe2As2

P23 **Savary Lucile (University of California)**
A New Type of Quantum Criticality in the Pyrochlore Iridates

A24 **Schaffer Robert (University of Toronto)**
Spin-orbital liquids in non-Kramers magnet on Kagome lattice

P25 **Shibata Daisuke (Kyoto University)**
AC susceptibility of Sr2RuO4 under various field-thermal treatments

P26 **Smale Scott (University of Toronto)**
Spin Transport Analogues in Quantum Gases

P27 **Takashima Rina (Kyoto University)**
Electrodynamics in Skyrmions Merging

11:20 - 12:20
Ion GARATE
Université de Sherbrooke

Topological insulators and superconductors : a brief introduction

The development of quantum physics in the beginning of the 20th century revolutionized people's understanding of materials. Based on the laws of quantum physics, solids were classified into insulators, semiconductors, metals, and superconductors. For decades, it was believed that all insulators were similar to one another when it came to their inability to conduct electricity, and that all superconductors were also similar to one another when it came to their extreme ability to carry electrical current.

Such belief was first shaken in 1980, and then shattered seven years ago, when it became apparent that the behavior of electrons in solids can also be classified using a branch of mathematics known as topology. For example, according to the topological classification of solids, some insulators (dubbed "topological" insulators) conduct electricity on their surfaces whereas others (dubbed "non-topological" or "ordinary" insulators) do not. The metal at the surface of a topological insulator is quite special: electrons behave as relativistic Dirac fermions, their conduction of electricity is remarkably robust, and their magnetic properties peculiar. Partly due to these features, topological materials have attracted enormous interest in the physics community.

This talk will constitute a "crash course" to some basic ideas behind topological insulators and superconductors, at a level that is accessible both for theorists and experimentalists.

Tuesday 6 May

10:00 - 11:00
Maxime DION
Université de Sherbrooke

Introduction to the ultrasonic measurement technique

The ultrasonic measurement technique is not as often used as other techniques in solid state physics. Nevertheless, it is still a very powerful tool that gives a lot a valuable informations, especially on phase transitions taking place in solid. The basic idea of this probe is that any order that lives in a solid and that couples to its lattice will modify how distortion waves propagate.

In this introductory talk I will explain how we can use an acoustic interferometer to measure sound speed and sound attenuation in solids. I will show how we can use these measurements to acquire precious knowledge on phase transitions taking place in solid matter. To do that I will begin by reviewing the elastic theory in solid and then I'll use a simple Ginzburg-Landau coupling model with the help of symmetries and group theory. The whole presentation will be using measurements on the superconducting transition of 2D organics compounds of the kappa-$(BEDT\text{-}TTF)_2X_2$ family to illustrate the technique and its analysis.

A28 **Venkataraman Vijay Shankar (University of Toronto)**
αRuCl3 - Spin orbit assisted Mott Insulator on the honeycomb lattice

P29 **Yasui Yuuki (Kyoto University)**
Search for Half-Quantum-Fluxoid States in a Micro-Ring of Sr2RuO4

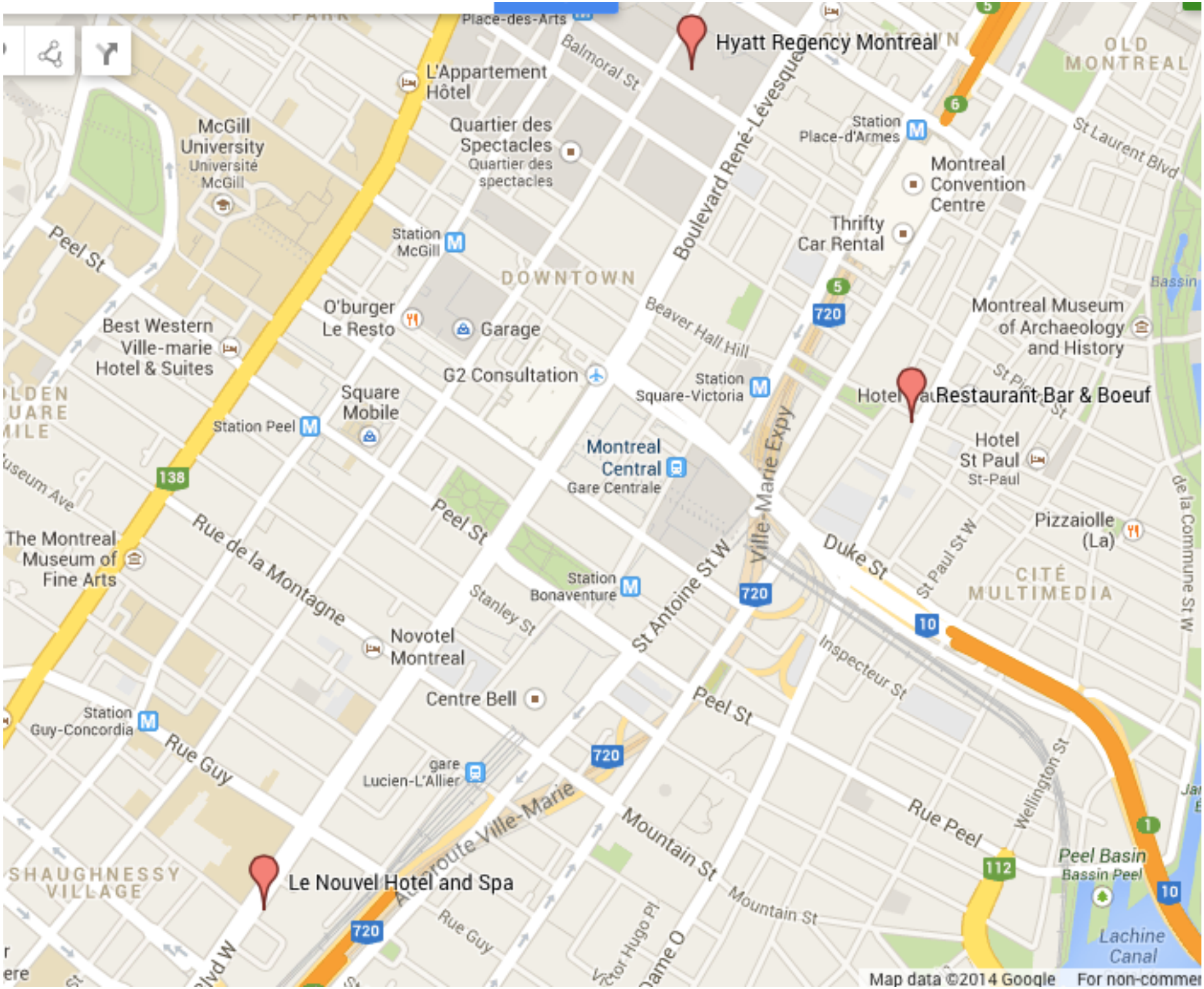
A30 **Zhang Hao (University of Toronto)**
Dependence of interfacial conduction on oxygen annealing in MBE-grown LaAlO3/SrTiO3 heterostructures

A : Summer School only
St-Mathieu / Atwater room at the Nouvel Hôtel

M : Main Meeting only
Soprano C and Foyer room at the Hyatt

P : Summer School and Main Meeting

Poster abstracts can be found on the summer school website :
http://www.physique.usherbrooke.ca/cifar2014/poster.html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Restaurant Bar & Boeuf
Le Nouvel Hotel and Spa
Place-des-Arts
L'Appartement Hôtel
McGill University
Université McGill
Quartier des Spectacles
Quartier des spectacles
Station McGill
Station Place-d'Armes
Montreal Convention Centre
Thrifty Car Rental
Boulevard René-Lévesque
St Laurent Blvd
OLD MONTREAL
DOWNTOWN
Peel St
Best Western Ville-marie Hotel & Suites
O'burger Le Resto
Garage
G2 Consultation
Square Mobile
Station Peel
Station Square-Victoria
Beaver Hall Hill
Montreal Museum of Archaeology and History
Hotel St Paul
St-Paul
Montreal Central
Gare Centrale
Ville-Marie Expy
Pizzaiolle (La)
CITÉ MULTIMEDIA
Duke St
St Paul St W
de la Commune St W
The Montreal Museum of Fine Arts
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Station Bonaventure
Stanley St
St Antoine St W
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Centre Bell
Inspecteur St
Station Guy-Concordia
Rue Guy
gare Lucien-L'Allier
Autoroute Ville-Marie
Mountain St
Rue Peel
Wellington St
Peel Basin
Bassin Peel
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