Monday, May 29 - BioSci Bldg., Queen's U. - lundi 29 mai

OPENING SESSION / OUVERTURE DU CONGRÈS

BioSci 1101
10h15 - 10h30

Marcel Franz, Univ. of British Columbia

Room: BioSci 1101
10h30 - 11h15

From solids with topology to black holes and back

An intriguing connection was noticed recently by Kitaev between a simple model of Majorana fermions with random infinite range interactions – the Sachdev-Ye-Kitaev (SYK) model – and the horizons of extremal black holes in two-dimensional anti-de Sitter (AdS2) space. This connection furnishes a rare example of holographic duality between a solvable quantum-mechanical model and Einstein gravity. In this talk I will review some of these developments and describe a proposed physical realization of the SYK model in a solid state system. The system employs the Fu-Kane superconductor realized at the interface between a three dimensional topological insulator (TI) and an ordinary superconductor. The requisite Majorana fermions are bound to a nanoscale hole fabricated in the superconductor that is threaded by N quanta of magnetic flux. Under the right conditions the Majorana zero modes are described by the SYK Hamiltonian. Extensive numerical simulations demonstrate that the system indeed exhibits physical properties expected of the SYK model, including thermodynamic quantities and two-point as well as four-point correlators, and suggest ways in which these can be observed experimentally.

Paul François, McGill Univ.

(CAP Herzberg Medal / Médaille Herzberg de l'ACP)

BioSci 1101
17h30 - 18h00

Physics of cellular decision

Subcellular dynamics emerge from the interactions of molecules of many different types, and it seems a priori hopeless to build predictive theories, similar to what is done in physics. In this talk, I will use the example of early immune detection to (briefly) illustrate how approaches inspired by physics -from phenomenology to coarse graining- allow us to untangle the biological interaction "hairball". This led us to the discovery of the so-called "adaptive sorting" principle, and to the experimental validation of some of its most counterintuitive aspects (in collaboration with Grégoire Altan-Bonnet, NIH).

Tuesday, May 30 - BioSci Bldg., Queen's U. - mardi 30 mai

Martin Williams, Univ. of Guelph

(CAP Teaching Medal / Médaille en enseignement de l'ACP)

BioSci 1101
09h15 - 09h45

Undergraduate Physics Labs: Who needs them?

Instructional labs are a major part of the undergraduate physics curriculum. Typically, they involve substantial financial, instructional and infrastructural resources. Do conventional labs contribute significantly to curriculum learning goals, and are they the most effective use of limited departmental resources? In this presentation, I will review the changing role of the undergraduate physics lab as a major teaching instrument in the undergraduate curriculum with emphasis on introductory physics labs. Current trends will be examined and various initiatives that have been undertaken at local and national levels will be discussed.

Wednesday, May 31 - BioSci Bldg., Queen's U. - mercredi 31 mai

Yong Baek Kim, Univ. of Toronto

(CAP Brockhouse Medal/Récipiendaire de la médaille Brockhouse de l'ACP)

BioSci 1101
10h15 - 10h45

Topological Phases in Quantum Materials with Strong Spin-Orbit Coupling

We discuss recent theoretical development in understanding emergent quantum phases of matter in correlated materials with strong spin-orbit coupling, especially in 4d and 5d transition metal oxides. In particular, we explain what kind of material platforms may be promising for discoveries of exotic quantum states such as quantum spin liquid and Weyl semimetal phases. Experimental signatures and possible applications of these phases will also be discussed.

Wednesday, May 31 - BioSci Bldg., Queen's U. - mercredi 31 mai

Mark Sutton, McGill Univ.

(CAP Achievement Medal / Médaille de l'ACP pour contributions exceptionnelles)

BioSci 1101
10h45 - 11h15

XPCS: Past, Present and Future

This talk will describe the basis of X-ray photon correlation spectroscopy (XPCS), and review some of the interesting results it has lead to. It will discuss several XPCS variations and some of its limitations. Finally, a description of some of the new x-rays sources underdevelopment and their potential impact on the future of XPCS will be given.

Laura Greene, APS President

BioSci 1101
17h00 - 17h30

The American Physical Society and Electrons: Interesting Correlations

The American Physical Society (APS) is the largest physics society in the US whose main focus remains our Journals. We also provide four major programs, including international affairs, and we are working towards dynamic correlations with other physics and scientific societies, worldwide. This is almost as exciting as the field of correlated electron matter, which poses fundamental physics questions, with unique applications; we believe on the precipice of breakthrough solutions.

Cécile Fradin, U. McMaster

BioSci 1101
17h30 - 18h00

On the Importance of Diffusion in Biological Systems

In living systems thermal motions become dominant at the nanometre scale, thus protein diffusion must play an important role in cells. But how can stochastic motions at the molecular scale add up to create the exquisite order observed at the cellular scale? Dr. Fradin will present the case of Bicoid, a protein whose concentration acts as a postal code in the fly embryo, by letting cells know what is their exact location. The diffusion of Bicoid across the embryo drive the robust and precise formation of a large-scale concentration gradient, as envisioned by Francis Crick in 1970. Further, the diffusion of Bicoid while searching for its binding sites on the DNA controls how quickly and precisely each cell in the embryo can read the gradient concentration. Bicoid is thus a perfect exemple of how protein diffusion in cells can both drive exquisitely precise pattern formation and support the very rapid transmission of information.

Thursday, June 1 - BioSci / Queen's Univ.- jeudi 1 juin

Jun Ye, NIST

(JILA, National Institute of Standards and Technology and University of Colorado)

BioSci 1101
9h15 - 9h45

Atomic Clock based on quatum matter

Quantum state engineering of ultracold matter and precise control of laser coherence have revolutionized a new generation of atomic clocks with accuracy at the 18th digit. This progress has benefited greatly from microscopic understanding of atomic interactions in the quantum regime. In return, the unified front for precision metrology and quantum physics has enabled exploration of many-body spin systems. Our next clock will have at its core a Sr Fermi degenerate gas configured as a band insulator in a three-dimensional optical lattice. The correlated, high-density atomic system provides a clear path for improving the clock performance to the next decimal point, and sets the stage to advance measurement precision beyond the standard quantum limit. These emerging quantum technologies will allow us to test the fundamental laws of nature and search for new physics.

Thursday, June 1 - BioSci/Humphrey, Queen's U. - jeudi 1 juin

Raymond Laflamme, Univ. of Waterloo

(CAP-CRM Prize / Prix'ACP-CRM)

BioSci 1101
10h15 - 10h45

Scalable Control of Quantum Systems

Quantum information processing promise to develop computing, communication or sensing devices that are more powerful than their classical counterparts. It does so by encoding and manipulating information in states that are either difficult or impossible to reach classically. I will describe how quantum error correction works, as well as recent theoretical and experimental progress in the field.

Simon Fafard, Univ. de Sherbrooke

(CAP Industrial and Applied Physics Medal / Médaille de l'ACP pour réalisations exceptionnelles en physique industrielle et appliquée)

Humphrey Hall 102
10h15 - 10h45

Photon recycling in ultra-thin GaAs n/p junctions based on high-photovoltage vertical epitaxial heterostructure architectures with record optical to electrical conversion efficiencies.

Optical to electrical power converting devices are achieved with breakthrough performance using a Vertical Epitaxial HeteroStructure Architecture (VEHSA design). The III-V semiconductor devices allow achieving a near-optimum responsivity, an improved photovoltage output compared to p/n junctions with standard thicknesses. The ultrahigh conversion efficiencies were obtained by monolithically integrating several thin GaAs photovoltaic junctions tailored with submicron absorption thicknesses and grown in a single crystal by epitaxy. Experimental evidence of the significant impact of photon recycling in these photovoltaic devices has been observed. The devices exhibited a near optimum responsivity of up to 0.645A/W, corresponding to an external quantum efficiency of ~94%. Recent progresses include: -The highest optical to electrical efficiency ever achieved; -The highest output powers ever reported for a high-efficiency monolithic PV cell with 5.87W of converted output from a CW laser; -The highest efficiencies ever reported for any types of optical to electrical power conversion devices simultaneously combining high photovoltage and output powers (> 5W at > 7V with > 60% efficiency and > 3W at > 14V with > 60% efficiency); -The highest photovoltage ever reported for monolithic photovoltaic semiconductor heterostructures with measured Voc > 23V; -the thinnest p/n junctions ever implemented successfully with high-performance, with GaAs bases as small as 24nm.

Charles Gale, McGill Univ.

(CAP-TRIUMF Vogt Medal Recipient / Médaille Vogt de l'ACP-TRIUMF)

BioSci 1101
10h45 - 11h15

Getting to the heart of the matter: Hot QCD and flowing photons

Colliding large nuclei at high energies is the only practical way of studying QCD (Quantum Chromodynamics: the theory of the strong nuclear interaction) under extreme conditions in the laboratory. In doing so, experiments at RHIC and at the LHC have revealed that strongly-interacting matter possesses remarkable fluid-like properties, which this talk will review. In addition, we will show that measurements of photons (real and virtual) emitted in heavy-ion collisions can help to reveal features of the QCD phase diagram.

Chris Quigg, Fermilab

BioSci 1101
17h30 - 18h00

Perspectives and Prospects for Particles Physics

Prof. Quigg will present an overview of where we stand in the physics of high energies and ultrasensitives experiements, mentionning developments from Large Hadron Collider experiements and elsewhere, and give an assessment of what comes next. Prof. Quigg will bring plenty of questions, and looks forward to hearing yours.