2ND YEAR SCIENTIFIC DAY OF EDPIF

JUNE 20, 2018

Amphi Bliski-Pasquier, Campus des Cordeliers
15 rue de l'Ecole de Médecine, 75006 Paris

Book of abstracts

EDPIF

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Welcome!

For the 4th year, the Doctoral School Physique en Île-de-France (EDPIF) organizes a scientific day made by and for its second year PhD students. This day aims at bringing together young researchers working on various topics of physics: quantum mechanics, soft and condensed matter, nanotechnologies, biophysics and much more. This is an opportunity for students to share their results with their peers, in a friendly and stimulating atmosphere. They can present their latest achievements through either an oral presentation or a poster. Moreover, they can attend plenary lectures by young scientists from Parisian research institutions. Time dedicated to inspiring discussions is also scheduled, including a farewell cocktail.

We are grateful to all directors of EDPIF institutions and their assistants, for giving us the opportunity to participate in the organization of this day and helping us in the process: Jean-François Allemand and Laura Baron-Ledez (Université PSL), Maria Chamarro and Nadine Yassine (Sorbonne Université), Philippe Lafarge and Monia Mestar (Université Sorbonne Paris Cité), Claude Pasquier and Sabine Hoarau (Université Paris-Saclay). Last but not least, our sincere thanks also to all the PhD students who submitted an abstract to present their work, for this day is essentially yours and we hope you will enjoy it!

The organizing committee,
Luca Barberi, Romain Couvreur, Chaima Essghaier, Camille Gaulon and Trinish Sarkar

Program

09:00	**Welcome**		
09:10	Orazio Scarlatella	Institut de Physique Théorique, Saclay	Emergent Finite Frequency Criticality of Driven-Dissipative Correlated Lattice Bosons
09:30	Allegra Calabrese	Laboratoire Matériaux et Phénomènes Quantiques	THz detectors based on optomechanical metamaterials
09:50	***Electronic grounds states in diluted metals***, Benoit Fauqué (ESPCI)		
10:25	Francesco Manegatti	Centre de Nanosciences et de Nanotechnologies	III-V on SOI Photonic Crystal nano-amplifier
10:45	**Coffee break**		
11:20	***Catching drops with fibers***, Camille Duprat (LadHyX Polytechnique)		
11:55	Deliang Zhong	Laboratoire de Physique Théorique de l'ENS	Aspects of Fishnet Feynman Graphs
12:15	Manon Giraud	SPEC, CEA	Detection of Micron to Submicron Biologic Objects with Giant Magneto-Resistive Sensors
12:35	**Lunch & poster session**		
14:05	Rémi Dupuy	Observatoire de Paris	X-ray photodesorption from interstellar water ice analogs
14:25	***Surprises in quantum transport experiments,*** François Parmentier (CEA)		
15:00	Caroline Venet	Institut Langevin	Ultra-narrow spectral filter for ultrasound modulated optical tomography for medical applications
15:20	Xianjie Wang	Laboratoire de Physique des Plasmas	Geocatalytic uptake of ozone onto natural mineral dust
15:40	**Coffee break**		
16:00	Filippo Vicentini	Laboratoire Matériaux et Phénomènes Quantiques	Quantum fluids of light: creating correlations among photons through an out-of-equlibrium transition
16:20	Nicolas Harmand	Laboratoire Matière et Systèmes Complexes	Forces governing the shape of epithelial cells
16:40	Remi Bisognin	Laboratoire Pierre Aigrain	Electron states imaging in a quantum conductor
17:00	Maelenn Chevreuil	Laboratoire de Physique des Solides	Study of assembly and disassembly of viral capsids
17:20	**Farewell cocktail**		

09:10 - 09:30 **Emergent Finite Frequency Criticality of Driven-Dissipative Correlated Lattice Bosons**

Orazio Scarlatella[1], Rosario Fazio[2,3], and Marco Schiró[1]
1. *Institut de Physique Théorique, Université Paris Saclay, CNRS, CEA, F-91191 Gif-sur-Yvette, France*
2. *ICTP, Triestre*
3. *SNS, Pisa*

We introduce a new class of dynamical transitions in a driven-dissipative quantum many body system, that is characterized by finite-frequency criticality with a diverging susceptibility and a corresponding macroscopic order parameter oscillating in time and thus breaking continuous time translational invariance. While these results are potentially relevant for the upcoming generation of circuit QED arrays experiments aiming at realizing Mott Insulator of Polaritons and its transition into a nonequilibrium superfluid it also outlines a more generic framework to study time-domain instabilities in non-equilibrium quantum systems.

09:30 - 09:50 **THz detectors based on optomechanical metamaterials**

A. Calabrese[1], Y. Todorov[1], D. Gacemi[1], A. Vasanelli[1], I. Favero[1] and C. Sirtori[1]
1. *Laboratoire Matériaux et Phénomènes Quantiques, Université Paris-Diderot, Sorbonne Paris Cité, CNRS-UMR 7162, 75013 Paris France*

The THz spectral domain offers a wide range of applications, from medicine to astronomy, security and imaging. Full exploitation of far-infrared radiation, however, is still to achieve, due to limitations in detector technology. State-of-the art THz detectors mostly rely on thermal effects, which impose slow modulation frequencies.
Moreover, high sensitivity is often achieved at the price of cryogenic temperature operation. Our team recently demonstrated[1] the operation of a novel kind of detector, that is based on an optomechanical interaction[2]. The device consists of a sub-wavelength resonator with a flexible part. Forced vibrations of the mechanical element are caused by coupling with far-infrared radiation and read-out optically (*figure 1*).

The origin of the THz optomechanical force was identified as either electrostatic (Coulomb force) or photo-thermal[2], depending on the vibrational mode that is excited. In our first device, the photo-thermal response originated mainly from the bilayer (metal and semiconductor) composition of the mechanical resonating element. Here we exploit further the meta-material concept in a new design (*figure 1*), which allows the mechanical element to be fully metallic. We therefore expect the Coulomb force to be dominant over the photo-thermal effects. This realization is thus closer to canonical quantum optomechanical systems, which are dominated by dispersive, rather than dissipative forces[3]. Our system can be used as a compact detector for THz waves, operating at room temperatureand with virtually no upper limit for the modulation frequencies[2].

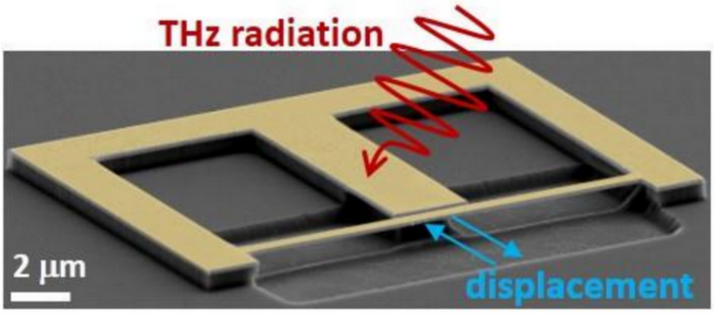

Figure 1: THz optomechanical metamaterial resonator

References:
[1] C. Belacel et al. Nat. Comm. 8, 1578 (2017).
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9:50 - 10:25 **Electronic grounds states in diluted metals**

Benoît Fauqué, Researcher at Laboratoire de Physique et d'Etude des Matériaux, ESPCI

In this presentation I will discuss the fate of the electronic ground state of 3D metal in a presence of a large magnetic field. I will focus in particular in the limit where all the carrier are confined into the lowest Landau levels, the so-called quantum limit. Our works on semi-metals such as graphite have shown, like in 2D electron gas system, that electron-electron interactions are at work to induce original electronic ground states that I will discuss. If time allows I will also introduce you to the enigma of the superconductivity encountered in dilute metals such as doped $SrTiO_3$.

10:25 - 10:45 **III-V on SOI Photonic Crystal nano-amplifier**

F. Manegatti[1], D. Fitsios[1], D. Sanchez[1], R. Raj[1], F. Raineri[1]
1. *Centre de Nanosciences et de Nanotechnologies (C2N), CNRS, Route de Nozay, 91460 Marcoussis, France*

Abstract. We demonstrate the design, fabrication and experimental evaluation of novel compact and power efficient electrically pumped nano-amplifiers based on InP photonic crystal (PhC) nanocavities and integrated on the Silicon-on-Insulator (SOI) platform.

Introduction. As silicon photonics technology is advancing, there is still a critical need to generate optical signals on-chip, increase and preserve their power throughout the whole chip, while having low power consumption and minimal footprint. Within this frame, the emergence of heterogeneously integrated III-V semiconductor lasers on silicon [1] has opened new horizons. However, CMOS-compatible integrated optical amplification at the nano-scale is still missing, with demonstrated efforts having large footprint and power consumption and minimal gain [2-3], without electrical injection.
In this paper, we present our work in the development of electrically injected PhC nanoamplifiers, promising CMOS-compatibility, low power consumption and footprint.

Device structure. For the design of the nanoamplifiers we relied on the use of 2D line defect InP-based PhC waveguides, coupled to the SOI waveguide through optimized highly efficient adiabatic mode transformers [4]. The InP-based slab incorporates a 400 nm PIN junction, with 4 InGaAsP quantum wells emitting around 1.3 µm, drilled with PhCs to form a single mode waveguide (Fig. 1). A half-rib like design was selected, with a periodic array of holes on one side of the waveguide and a sharp sidewall on the opposite side to properly control the carriers' electrical injection inside the active region by manipulating the holes' array, while also increasing its spatial confinement thanks to the Total Internal Reflection (TIR) effect on the sidewall. Through proper positioning of the metallic contacts on the sides of the structure, efficient electrical injection of electron-hole pairs without inducing large optical losses is achieved. Specific efforts were made as well, in order to optimize the stimulated emission efficiency.

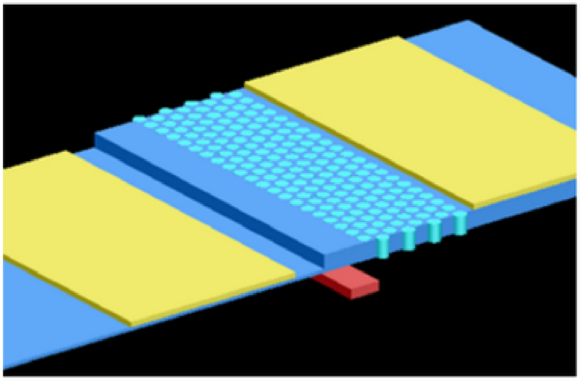

Fig. 1 3D model of the hybrid PhC nanoamplifier

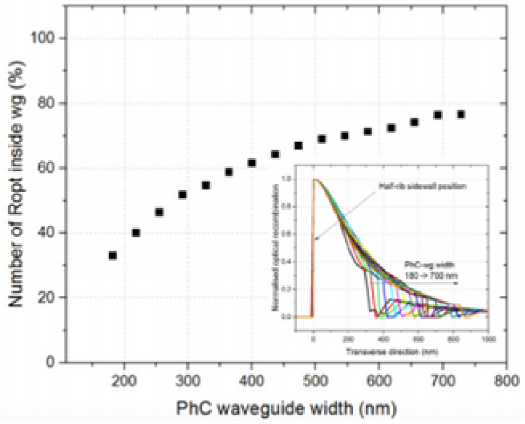

Fig. 2 Transverse optical recombination rate versus PhC-waveguide width

Theoretical and experimental results. By exploiting the asymmetricity of our structure, placing the N-contact and P-contact regions respectively on the holes' array-side and on the rib-side, we compensate for the uneven mobility between electrons and holes. We conducted FEM calculations to study the carrier transport as well as the optical recombination rate in the structure. Fig. 2 shows the percentage of optical recombination taking place inside the waveguide area, with the normalized transverse recombination rate profile along the structure as an inset. The radiative recombination peaks at the rib-sidewall and slowly decays in the transverse direction. When changing the PhC-waveguide width from 180 to 700nm, the optical recombination rate spreads towards the PhC with respectively from 35 to 75% of the total optical recombination happening in the waveguide region. Furthermore, after calculating the confinement of the field in the quantum wells for a PhC waveguide width of ~300 nm to be 16.5% and after showing an absorption from P-and-N-doped sides of ~5 dB/mm, from the simplified rate equations model we can estimate the gain per unit length to be~130 dB/mm.

Preliminary fabricated samples have been characterized in terms of electrical circuit behavior: they exhibit a typical PIN junction diode behavior with a turn-on voltage of around 0.6 V, with an electrical resistance of ~90 Ω. As can be seen in Fig. 3(a), typical optical amplifier spectra were obtained, confirming also the successful electrical pumping operation (Fig. 3(b)). Signal Amplification and dynamic behavior measurements are currently being performed.

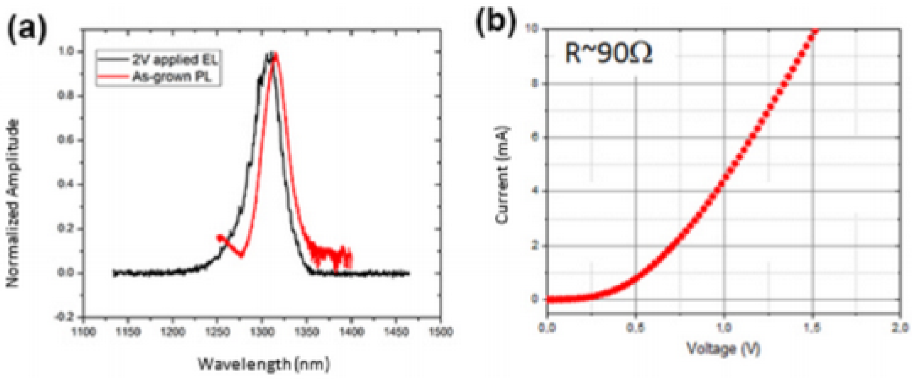

Fig 3. (a) Normalized spectra of the nanoamplifier and As-grown photoluminescence; (b) I-V characteristic curve of the nanoamplifier

Next steps. In order to further reduce the footprint of our nanoamplifier, the slow-light phenomenon will be exploited: the idea is to apply a perturbation on the holes' array periodicity, inducing, in the band diagram, a linearization of the fundamental band. Thus, for a specific range of wavelengths, the propagative mode is slowed-down leading to increased light-matter interaction and, consequently, to the targeted amplification within a shorter distance. Preliminary simulations indicate an increase of the group index by a factor of 10 (from ~3 to ~30) for a range of wavelengths of ~14 nm. Ideally, this could lead to a ten-times-reduced amplification region length for the device.

Conclusions. We have developed PhC nanoamplifiers on SOI and achieved efficient electrical injection and typical photoluminescence response, with thorough static and dynamic optical evaluation underway. We believe that these results can open exciting avenues for constructing on-chip optical photonic platforms with advanced functionalities.

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3 S. Cheung et al, Optics Express, 23 (2015), pages 22431-22443
4 Xiankai Sun et al, Optics Letters, 34 (2009), pages 280-282

11:20 - 11:55 **Catching drops with fibers**

Camille Duprat, Teacher and Researcher at Laboratoire d’Hydrodynamique de l’École polytechnique (LadHyX)

11:55 - 12:15 **Aspects of Fishnet Feynman Graphs**

Deliang Zhong[1]
1. *Laboratoire de Physique Théorique de l'ENS, 24 rue Lhomond , 75005, Paris, France*

In this talk, various aspects of fishnet theory -- a simplified version of the N =4 super Yang-Mills theory will be discussed. I will briefly explain the picture of the AdS/CFT correspondence and then focus on the fishnet limit. The symmetries of such theory, especially the "hidden" symmetry will be discussed in details. Finally, the hint for the holographic dual will be discussed. Consequently, the study of such theory allows us to get deep insights into the integrability of the planar AdS/CFT correspondence.

12:15 - 12:35 **Detection of Micron to Submicron Biologic Objects with Giant Magneto-Resistive Sensors**

Manon Giraud, François-Damien Delapierre, Guénaëlle Jasmin-Lebras, Cécile Féraudet-Tarisse, Elodie Paul, Grégory Cannies, Stéphanie Simon, Claude Fermon
SPEC, CEA, CNRS, Université Paris-Saclay, CEA Saclay 91191 Gif-sur-Yvette Cedex, France
CEA, institut de Biologie et de Technologie de Saclay (iBiTec-S), Service de Pharmacologie et d'Immunoanalyse (SPI), 91191 Gif sur Yvette, France

Flux cytometry is a precise, highly specific and efficient tool to count cells in a fluid. However the device is extremely bulky and the method requires skilled staff thus this expensive method is for specialized laboratories only. For security and medical purposes, developing a point of care diagnosis tool with comparable performance is of high interest. The presented lab on a chip relies on magnetic detection of single events via a dynamic approach. Cells of interest are specifically targeted by antibodies attached to magnetic beads. Giant magneto resistant sensors are placed underneath a
microfluidic chip in which the sample is introduced. The passage of every single labelled object produces variations of the magnetic field recorded by the sensor. Analyzing the recording, a homemade program attributes each signal to an object: single bead, small aggregate or cell with beads and counts those objects one by one. The presence of aggregates induces false positive events and limits the test sensitivity. Some future improvements of the tool and methodology will be discussed.

12:35 - 14:25 **Poster session**

Non-collinear magnetism in rare earth titanate thin films
Raphaël Aeschlimann, *Thalès, Univ. Paris-Sud*

Towards electron spin hyperpolarization via radiative cooling
Bartolo Albanese, *Quantronics Group SPEC CEA-Saclay*

High Temperature Superconducting nano-meanders made by ion irradiation
Paul Amari, *Laboratoire de Physique et d'Étude des Matériaux*

Development of an XUV beamline for femtosecond time-resolved photoelectron spectroscopy
Manuel de Anda Villa, *Institut des Nanosciences de Paris*

Pure water swimming droplets: from 2D to 1D geometries
Charlotte de Blois, *Laboratoire Gulliver*

Selection dynamics in transient compartmentalization
Alex Blokhuis, *Laboratoire Gulliver*

Collective laser emission in coupled hybrid InP-on-SOI nanocavities
Quentin Chateiller, *Centre de Nanosciences et de Nanotechnologies*

Tunable Single Photon Source with Carbon Nanotube
Theo Claude, *Laboratoire Pierre Aigrain*

Probing the interplay between the conformational dynamics of a bacterial ABC-transporter and its surrounding membrane mechanical properties
Alicia Damm, *Laboratoire Physico Chimie Curie*

Instantons and the Hofstadter Butterfly
Zhihao Duan, *Laboratoire de Physique Théorique de l'ENS*

Improving Contrastive Divergence for Memristor-Based Boltzmann Machines
Maxence Ernoult, *Centre de Nanosciences et de Nanotechnologies*

Towards single spin detection using microwaves
Jéssica Fernanda Da Silva Barbosa, *Quantronics Group CEA-Saclay*

Electron spin dynamics in quantum wells
Guadalupe Garcia, *Institut des Nanosciences de Paris*

Defect-influenced dynamics of Dzyaloshinskii domain walls under perpendicular and planar magnetic fields
Pierre Géhanne, *Laboratoire Physique des Solides*

A Microscopic Theory of Coherent Phonons in a Multiband Metal: Applied to Fe Based Superconductors
Massil Lakehal, *Laboratoire Matériaux et Phénomènes Quantiques*

Migration and deformation of confined cell fragments
Ido Lavi, *Laboratoire Jean Perrin*

Quantum information processing with multimode fiber
Saroch Leedumrongwatthanakun, *Laboratoire Kastler Brossel*

Stimulation of mung bean germination using a Cold Atmospheric Plasma Array
Bo Liu, *Laboratoire de Physique des Plasmas*

Electronic excitations in the ionic irradiation of materials
Ivan Maliyov, *SRMP-CEA*

Propulsion plasma
Florian Marmuse, *Laboratoire de Physique des Plasmas*

Magnetic forces functionalization and rheological measurements of magnetic multicellular aggregates
Gaëtan Mary, *Laboratoire Matière et Systèmes Complexes*

Pan-neuronal calcium imaging during dynamic vestibular stimulation
Geoffrey Migault, *Laboratoire Jean Perrin*

Acoustical engineering for integrated optomechanical oscillators
Giuseppe Modica, *Centre de Nanosciences et de Nanotechnologies*

An analytical model for affinity maturation with application to vaccination
Marco Molari, *Laboratoire de Physique Statistique de l'ENS*

Microfabricated high impedance RF resonators for quantum detection
Jonas Mueller, *Nanoelectronics Group SPEC CEA-Saclay*

Generating entangled photon pairs with a DC-biased Josephson junction
Ambroise Peugeot, *Nanoelectronics Group SPEC CEA-Saclay*

Active matter programmed by a DNA-enzyme chemical reaction network
Anis Senoussi, *Laboratoire Jean Perrin*

Heat Coulomb blockade of one ballistic channel
Emile Sivré, *Centre de Nanosciences et de Nanotechnologies*

Anderson localization of cold atoms in random potentials
Filippo Stellin, *Laboratoire Matériaux et Phénomènes Quantiques*

STEM/EELS investigations on Local scale charge compensation mechanism in Ca and Y co-doped bismuth iron garnet thin films
Adrien Teurtrie, *Laboratoire de Physique des Solides*

Understanding cell coordination during migration
Kotryna Vaidžiulytė, *Institut Curie*

Probing molecular transport in printed biomimetic tissues
Manon Valet, *Laboratoire Jean Perrin*

Strongly driven quantum Josephson circuits
Lucas Verney, *Laboratoire Pierre Aigrain*

Band engineering and surface magnetism in hybrid systems graphene/ferromagnets
Thomas Vincent, *Laboratoire de Physique et d’Étude des Matériaux*

14:05 - 14:25 **X-ray photodesorption from interstellar water ice analogs**

R. Dupuy[1] , M. Bertin[1] , G. Féraud[1] , M. Hassenfratz[1] , X. Michaut[1] , T. Putaud[1] , L.
Philippe[1] , P. Jeseck[1] , M. Angelucci[4] , R. Cimino[4] , V Baglin[3] , C. Romanzin[2] and JH Fillion[1]
1. *Sorbonne Université, Observatoire de Paris, Université PSL, CNRS, LERMA, F-75005, Paris, France*
2. *Laboratoire de Chimie Physique, Université Paris Sud 11, CNRS UMR 8000, 91405 Orsay, France*
3. *CERN, CH-1211 Geneva 23, Switzerland*
4. *Laboratori Nazionali di Frascati, LNF-INFN I-00044 Frascati*

Cold and dense regions of the interstellar medium are the birthplace of stars and planets. They also host a variety of molecules, which may then end up on comets, planets and other bodies at a later stage of evolution. These molecules can be found either in the gas phase, or frozen at the surface of sub-micrometer sized dust grains. The physics and chemistry of the gas phase and of this solid, icy phase is very different and they can separately, or through their interaction, lead to increasing molecular complexity. These environments can also be exposed to UV or X-ray radiation from nearby stars. These photons induce modifications and chemistry within the ice, but they can also drive the exchanges between the icy mantle and the gas phase. Indeed, in regions where the temperature of dust grains is very cold (<20K), most molecules cannot thermally leave the grain when they are formed on it or accreted. Non-thermal processes then become crucial, and one such process, termed photodesorption, is the ejection of a molecule from the icy mantle following the absorption of a photon.

Here I will present an experimental study of the photodesorption induced by X-rays on a water ice analog, using synchrotron radiation. The SPICES 2 setup, an ultra-high vacuum chamber where ice analogs can be grown on a cooled (15K or 90K) substrate, was brought to the SEXTANTS beamline of the SOLEIL synchrotron, which provided a high flux of tunable X-ray photons in the range of the O 1s core resonance of water (500 – 600 eV). The set-up allows a complete characterization of the desorbed species: we measured and quantified photodesorption of neutral species, positive and negative ions, and the absorption of the ice (through the total electron yield produced by the irradiation). Photodesorption spectra of the species and their comparison with absorption spectra give us insights on the physical mechanisms behind photodissociation and photodesorption, as well as on the X-ray induced modifications in the ice.

14:25 - 15:00 **Surprises in quantum transport experiments**

François Parmentier, Researcher at Service de Physique de l’Etat Condensé (SPEC), CEA

Sometimes even the most meticulously planned experiments lead to unexpected fundamental physics discoveries. I will present two electron quantum transport experiments recently realized in C2N probing very basic quantization effects in quantum conductors, based on an experimental approach originally devoted to the investigation of quantum laws of electricity. In the first experiment, we have quantitatively observed the fundamental limit imposed by quantum physics on the transport of heat in elementary electron transport channels. In the second one, we have fully characterized how quantum fluctuations gradually destroy charge quantization on isolated nodes of a quantum circuits. Those two simple concepts underpin the physics of nanocircuits ; understanding them will allow us to progress towards a new electronics based on quantum mechanics.

15:00 - 15:20 **Ultra-narrow spectral filter for ultrasound modulated optical tomography for medical applications**

Caroline Venet[1,2], Maïmouna Bocoum[1], Jean-Baptiste Laudereau[1], Thierry Chanelière[2], François Ramaz[1], Anne Louchet-Chauvet[2]
1. *Institut Langevin, Ondes et Images, ESPCI ParisTech, PSL Research University,*
CNRS UMR 7587, INSERM U979, Université Paris VI Pierre et Marie Curie, 1 rue Jussieu, 75005 Paris, France
2. *Laboratoire Aimé Cotton, CNRS, Univ. Paris-Sud, ENS Cachan, Université*
Paris-Saclay, Bât.505, Campus d'Orsay, 91400 Orsay France

Nowadays imaging the early liver metastases has to be improved in order to have an easier setup than MRI or to be more discriminant than ultrasound between healthy and diseased tissues. Acousto-optic imaging could solve these issues by coupling itself with ultrasound modality: the additional optical contrast would suppress the indetermination on the health of the biological tissue.

Acousto-optic imaging is a multi-wave technique which localizes light in very scattering media thanks to an acoustic wave: the acousto-optic effect creates frequency-shifted light, carrying local information about the insonified volume. The central challenge of acousto-optic imaging is the detection of the frequency-shifted light, because there are only very few modulated photons and they create a speckle pattern. We choose to explore the detection by spectral filtering using the spectral hole burning process in rare earth doped crystal [1].

Spectral hole burning consists in creating a sub-MHz-wide transparency window in the wide absorption spectrum of a rare earth doped crystal: the crystal becomes transparent at the wavelength of the spectral hole and thus can filter the modulated light. This filtering technique is intrinsically immune to speckle decorrelation and therefore well adapted to in vivo imaging.

We use a YAG crystal doped with thulium ions under a magnetic field which increases the lifetime of the spectral hole from 10ms to longer than a minute. We have undertaken a spectroscopic study to optimize the hole preparation sequence. The long lifetime simplifies the optimization of fast imaging sequences, making real-time acousto-optic imaging reachable. We will present the first acousto-optic images achieved with a long-lived spectral filter in Tm:YAG, in a scattering medium.

[1] Li, Y., Zhang, H., Kim, C., Wagner, K. H., Hemmer, P., & Wang, L. V. (2008). Pulsed ultrasound-modulated optical tomography using spectral-hole burning as a narrowband spectral filter. *Applied physics letters*, 93(1), 011111

15:20 - 15:40 **Geocatalytic uptake of ozone onto natural mineral dust**

Xianjie WANG[1] , Manolis N. Romanias[2] , Frederic Thevenet[2] , Antoine Rousseau [1]
1. *LPP, Ecole Polytechnique, Sorbonne université, CNRS, Université Paris-Sud, Palaiseau Cedex, France*
2. *IMT Lille Douai, SAGE, Université de Lille, F-59500 Douai, France*

Tailored and synthetic catalysts based on metal oxide have been widely studied and industrialized for ozone decomposition, since ozone is a key reactive species for both fundamental and applied research[1-4] . Mineral dusts provide naturally mixed metal oxide materials with some unclear characterizations[5, 6] .

In this work, the steady-state uptake of O 3 onto a mineral dust from Gobi Desert has been evidenced on a wide concentration range at atmospheric pressure, signing the catalytic decomposition of O 3 (in Figure 1). The results of the uptake coefficients of ozone at atmospheric pressure provides information of reference value for atmospheric heterogeneous interaction. Geocatalytic properties of such natural mineral dust also open perspectives in catalytic processes.

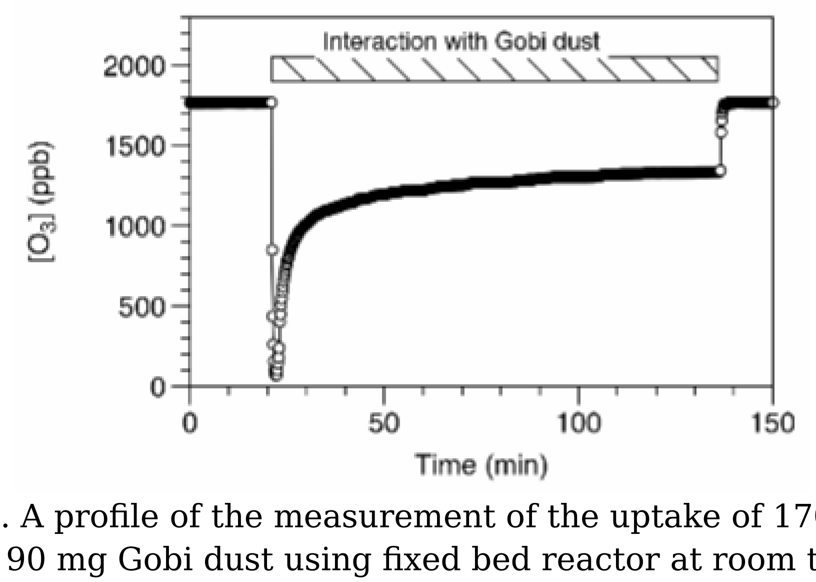

Figure 1. A profile of the measurement of the uptake of 1700 ppb of ozone onto 90 mg Gobi dust using fixed bed reactor at room temperature and atmospheric pressure.

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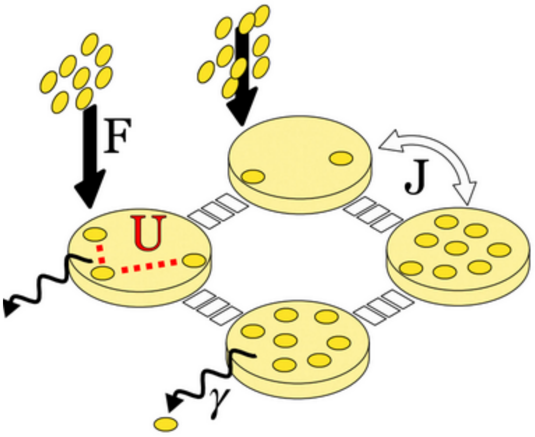
6. A. Michel, C. Usher and V. Grassian, *Atmospheric Environment*, 2003, **37**, 3201-3211.

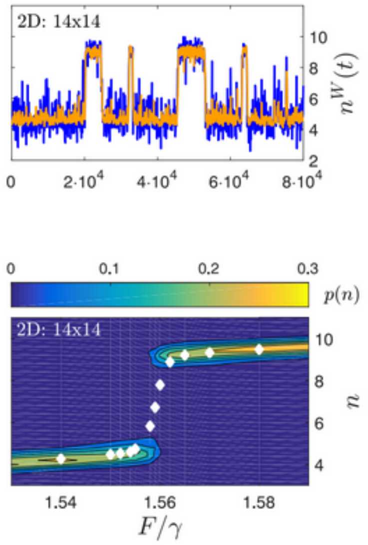
16:00 - 16:20 **Quantum fluids of light: creating correlations among photons through an out-of-equilibrium transition**

Filippo Vicentini
Laboratoire Matériaux et Phénomènes Quantiques, Equipe Théorie

Phase transitions have a fundamental role in technological applications, as they allow us to create devices that respond very differently while only varying slightly a control parameter. And because photons are becoming a central part of our technological infrastructure, it is desirable to investigate how to trigger phase transitions in photonic systems. But those setups are intrinsically different from traditional experiments isolated from the environment: despite our best efforts in confining light inside of optical cavities, it is impossible to prevent photons from (quickly) leaking into the environment. If we want to study the nonlinear behaviour of photons trapped inside such cavities, we must counter the losses through a continuous injection of particles, driving our system out-of-equilibrium.

In this talk I will be briefly introducing the framework of Driven-Dissipative Open Quantum Systems showing how it is naturally suited to describe Experiments in Quantum Optics [1]. I will then present how, through a brutal yet much needed phase-space approximation [2], we were able to show for the first time that a Photonic Lattice undergoing a 1st order phase transition experiences an exponential critical slowing down in the thermodynamic limit [3], and how this behaviour is linked to the dimensionality of the system. Interestingly, this allowed us to suggest an easy to observe transition witness, which we believe can be used to also understand how this transition might disappear when disorder is introduced in the system.





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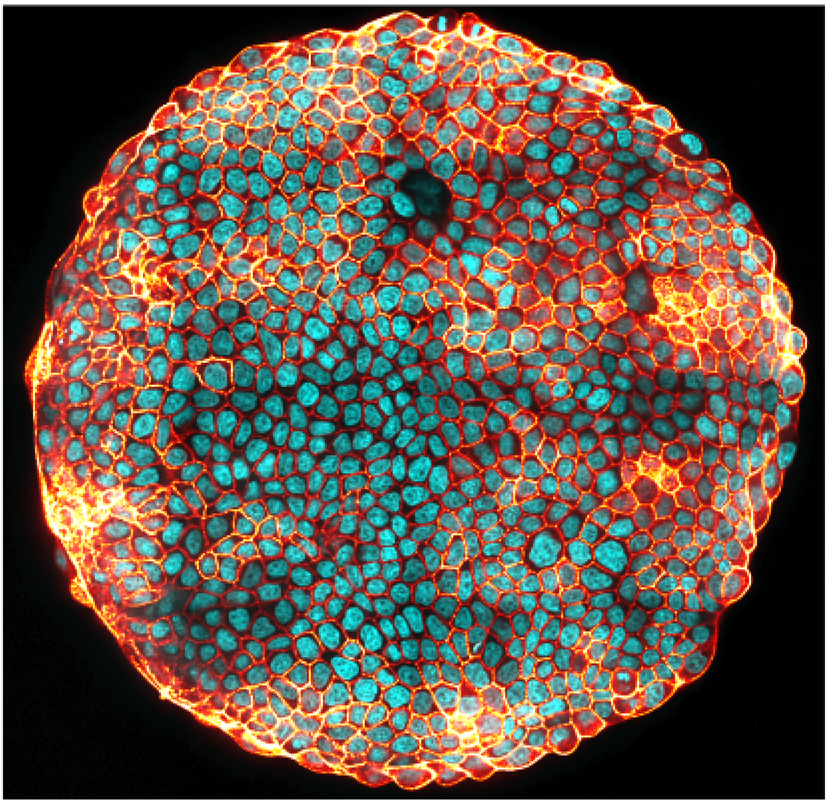
16:20 - 16:40 **Forces governing the shape of epithelial cells**

Nicolas Harmand
Laboratoire Matière et Systèmes Complexes, Université Paris Diderot

All the matter in the universe must follow the laws of physics, and biological objects are no exception. However, the inherent complexity of biological systems makes their physical understanding difficult. I try to decipher the physical forces at play to account for the shape of cells in a particular type of tissue: the epithelium. These biological tissues consist of closely packed cells and their mechanical properties are important in various biological processes such as cancer proliferation or embryogenesis.

By analogy with liquid foams confined in 2 dimensions, I use a simple physical modelling of epithelial tissues. I test this analogy experimentally using microfabricated substrates and advanced microscopy techniques which allow me to image my cells in 3 dimensions. We will see how using this naïve approach can give insights on the biological organizations of cells.



16:40 - 17:00 **Electron states imaging in a quantum conductor**

Rémi Bisognin, Kumar M., Roussel B., Cabart C., Bartolomei H., Bocquillon E., Berroir J.-M., Plaçais B., Chapdelaine C., Mohammad-Djafari A., Cavanna A., Gennser U., Jin Y., Degiovanni P., Fève G.
Laboratoire Pierre Aigrain, ENS, CNRS-UMR 8551

In our team we are studying the electrical current. Most frequently people know that it is the flow of a large amount of electrons and it is related to voltage by the Ohm's law. To look at the issue in more depth, we try to describe it when it is reduced to the flow of a single electron. We can formulated this as the question:

What are the electrical excitation quanta of the current ?

To enhance quantum effects the chosen system is a perfect 1D conductor. I will explain how a two meter high refrigerator, a 40 kg electromagnet, and a AlGaAs/GaAs millefeuille allows us to design µm size perfect conductor. Than when an experimenter says "study", he often means "measure", so I will present you my measurements of single electron flow. This implies that you will learn how a protocol based on a electronic interferometer similar to optic Hong-Ou-Mandel one enable to plot the electron wave-functions. And finally you will note that the Wigner representation of wave-function, on top of displaying beautiful color-map like the one below, is convenient to analyze quantum states.

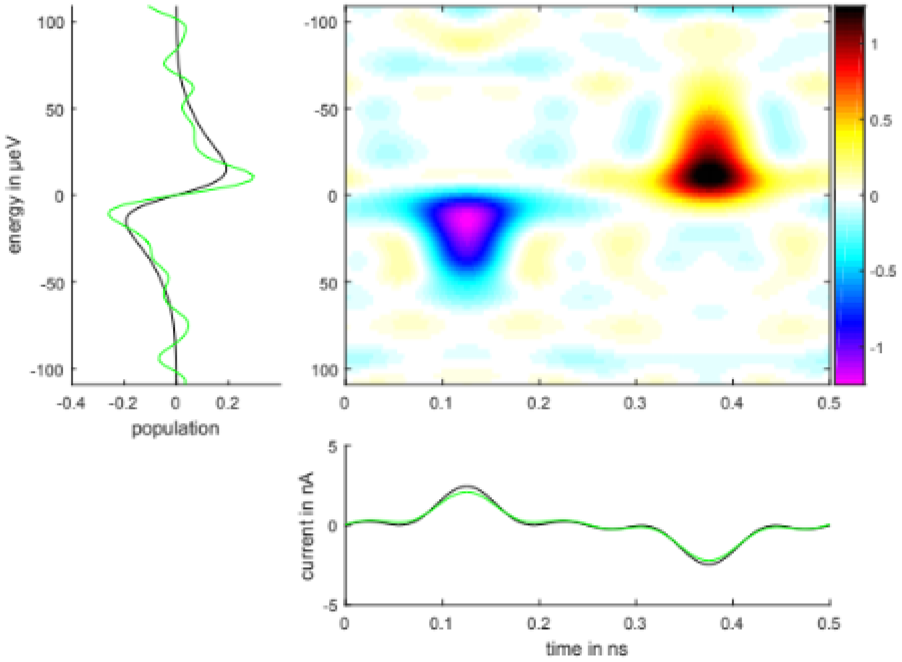


Figure 1: An example of excess Wigner function which I will (try) to explain what it is and how to measure it

17:00 - 17:20 **Study of assembly and disassembly of viral capsids**

Maelenn Chevreuil[1]
1. *Laboratoire de Physique des Solides, Université Paris Sud*

Viruses, described as “organisms at the edge of life”, do not have their own metabolism and require a host cell to replicate. Despite a considerable amount of work dedicated to the viral life cycles, there are currently no physical models accounting for the dynamic pathways along which capsid subunits self-assemble around a nucleic acid substrate to form a viral particle. The main goal of this project is to elucidate the dynamic pathways for the assembly and disassembly of the cowpea chlorotic mottle virus (CCMV) and the hepatitis B virus (HBV).

The accurate and robust self-assembly of viruses is a poorly known process and the nature of the intermediate species is much. To date, no scenario has been validated in any way other than through computer simulations because kinetic data are scarce.

Small-angle neutron scattering (SANS) combined with spectrofluorescence measurements allowed us to study the first-order phase transition occurring in empty and loaded CCMV capsids (Tresset et al. and Chen et al.). Through a mean field theory, we have been able to estimate the interaction energies between the viral components as a function of the ionic strength and pH.

We performed time-resolved small-angle X-ray scattering (TR-SAXS) measurements
with CCMV, and we observed that amorphous complexes were formed by an en masse kinetic pathway. These complexes then relax into virions via a nucleation-growth-like kinetic pathway by reinforcing the interactions via the pH between capsid subunits. The association of the subunits with the genome occurs in a few tens of milliseconds while the structural relaxation of the complexes into virions can take place over several hours. The equilibrium species were imaged by cryo-transmission electron microscopy and corroborated the data obtained by X-ray scattering. Finally, we propose a schematic free energy landscape that summarizes the observed kinetic pathways and emphasizes the pivotal role of the nucleoprotein complexes in the assembly of viruses (Chevreuil et al.).

We plan now to study the same processes with HBV particles by using TR-SAXS, nuclear magnetic resonance (NMR) and total internal reflection fluorescence microscopy (TIRFM). It would be remarkable to unveil the ways that HBV has adopted to ensure its survival. Such a knowledge is a key step to spotting its weaknesses and to develop efficient inhibitors of the packaging of pregenomic RNA.