QUANTUM MATTER

Grand programme de recherche de l'Université Paris Sciences & Lettres

JOURNEE DE LANCEMENT DU PROGRAMME– 28 novembre 2025

Université PSL, 3, rue Amyot, 75005 Paris

PROGRAMME

9:00	**Accueil et présentation du Grand programme de recherche par les porteurs**	
9:20	LKB, ENS-PSL	Nathan Goldman
10:00	LKB, ENS-PSL	Sylvain Nascimbène
10:40	Pause-café	
11:10	LPENS, ENS-PSL	Juliette Mangeney
11:50	LPEM, ESPCI Paris-PSL	Cheryl Feuillet-Palma
12:30	Déjeuner	
14 :00	Lauréat thèse Q-MAT	
14:20	IPCdF, Collège de France	Marco Schirò
15:00	LPENS, ENS-PSL	Angela Vasanelli
15:40	Pause-café	
16:10	LPENS, ENS-PSL	Gabriel Hétet
16:50	LPENS, ENS-PSL et LPEM, ESPCI Paris-PSL	Takis Kontos
17:30	Session de posters et apéritif	
19h00	Clôture	

POSTERS

Anamika Kumari:	High Frequency Josephson Parametric Amplifier
Andolina Gian Marcello:	Quantum Electrodynamics of graphene Landau levels in a deep-subwavelength hyperbolic phonon polariton cavity
Andriani Keliri:	Sambe Approach to Floquet-Lindblad Open Quantum Systems
Antonio Picano:	Quantum Thermalization via Travelling Waves
Chambard Louis:	Spin-mechanics with NV centers : towards nuclear-spin dependent forces in levitated and tethered platforms
Girard Mathieu:	Protecting collective qubits from non-Markovian dephasing
Grandvaux Louis:	Nano-imaging of non-Fourier heat flow using SQUID on tip microscopy
Mandal Soumyajit:	Superconducting Field-Effect transistors using top-gated KTO devices
Nohra Jean-Paul:	Quantum Simulation with Ultracold Fermi Gases in continuous space
Pons Stéphane:	From Kondo to quantum nanomagnet via the charge fluctuation regime in a porphyrin-based molecule on gold
Sergio Vlaic:	Novel two dimensional materials for spintronics
Wang Dan:	Air stable 2DHG in Pt single atomic layer on Ge(111)
Werner Félix:	Three-body contact of the unitary Fermi gas
Yuan Yue:	Low-frequency acceleration sensing using SHB in Eu:YSO

RESUMES

Nathan Goldman

Elucidating topological quantum matter with a thermodynamic relation

Sylvain Nascimbène

Exploring quantum Hall physics with ultracold dysprosium atoms

Ultracold atomic gases offer a versatile platform for exploring various types of quantum many-body physics. Among them, the simulation of the quantum Hall effect remains challenging, because of the charge neutrality of atoms.

In this talk, I will present our experimental realization of a quantum Hall system using ultracold gases of dysprosium atoms. By leveraging the atom's large internal spin (J=8), we encode a synthetic dimension and couple it to atomic motion via two-photon optical transitions, which generates an effective magnetic field. We observe hallmark signatures of quantum Hall physics, including a quantized Hall response and gapless, chiral edge modes. I will also discuss our recent investigation into a topological phase transition, induced by an additional lattice potential. I will highlight the system's behavior in the critical regime and explore the emergent features associated with the transition.

Juliette Mangeney

Two-Level Systems in Graphene Quantum Dots and Tamm Resonators for THz Quantum Technologies

Quantum technologies are experiencing considerable growth in the microwave and optical domains, while their development in the THz spectral range is still in its infancy, but promises significant technological impact. In this context, developing a novel technology to realize two-level quantum systems at THz frequencies compatible with direct on-chip integration would represent a major breakthrough. Here, we demonstrate a two-level system based on a hBN-encapsulated graphene double quantum dot (DQD) exhibiting a tunable transition frequency at THz frequencies. Using low-temperature DC transport spectroscopy combined with non-equilibrium Green's function modelling, we observe the formation of an artificial molecule with bonding and antibonding states separated by up to 0.6 meV, corresponding to a resonance frequency of 0.15 THz. We further show that a single graphene QD exhibits a large THz electric dipole (~230 nm) revealed by photon-assisted tunnelling phenomenon. Finally, we present original hybrid THz Tamm resonators that combine relatively high-quality factors (Q~37) and deeply subwavelength mode volumes. Coupling graphene DQD to these resonators paves the way for generating and detecting nonclassical THz light states, an essential step for future THz quantum technologies.

Cheryl Feuillet-Palma - Coming.

Electron Transport and Detection Dynamics in Current-Biased Superconducting Nanowire Photon Detectors

Single-photon detectors based on low-temperature superconducting nanowires have demonstrated unrivalled performances in detection efficiency, count rate, jitter times. While they are commercially available now, the underlying mechanism of detection remains under active investigation, with no consensus in the community.

During this presentation I will address some key aspect of the detection process involved understanding the electron transport in current-biased low and high temperature superconducting nanostructures.

Marco Schirò

Light-Control of Nonequilibrium Quantum Matter

Recent experimental progress in controlling light-matter interactions across condensed matter, atomic physics and quantum optics have opened the way to explore quantum matter in regimes far from thermal equilibrium. In this talk I will review our theoretical work in this field, focusing on the role of external driving and tailored dissipation to engineer new many-body phenomena not possible in thermal equilibrium. In the first part of the talk I will focus on Floquet driven systems and discuss the recent experimental demonstration of a photonic time crystal in a plasmonic metamaterial. Then, I will consider the effect of continuously monitoring the state of a quantum dot coupled to fermionic reservoirs and show how quantum measurements and their back-action provide new light on Kondo physics.

Angela Vasanelli

Tailoring light-matter interaction for mid-infrared quantum optoelectronics

The mid-infrared wavelength range (3 µm << 20 µm) is becoming increasingly attractive for many applications, such as night vision, free-space communications, light detection and ranging, and spectroscopy. Unipolar quantum devices, which exploit optical transitions between confined states in semiconductor quantum wells, are an ideal optoelectronic solution for implementing these applications.

In this talk, I will present several strategies, inspired by atomic physics, to tailor and enhance light–matter interaction giving rise to novel quantum optoelectronic devices. I will show how strong coupling between an intraband excitation and an optical resonance in a metamaterial can be exploited to realise high-frequency amplitude modulators. I will then focus on the enhancement of spontaneous emission to increase the radiative efficiency of mid-infrared light emitters, typically dominated by non-radiative energy relaxation, by discussing Dicke superradiance in highly doped semiconductor quantum wells and Purcell effect in patch-antenna resonators

Gabriel Hétet

Spin-Mechanics with Nitrogen-Vacancy centers

Controlling the motion of trapped macroscopic particles in the quantum regime has been the subject of intense research in recent decades. Especially noteworthy is the recent milestone of achieving ground state cooling for a trapped particle. However, the generation of purely non Gaussian states such as the first phonon Fock state or Schrödinger cat states, is required for further quantum control as well as for realizing quantum interference. One approach is to transfer the quantum state of a well-controlled two-level system to the mechanical degree of freedom, which can in principle be realized by coupling the motion of crystals with embedded spins using magnetic fields.

The coherence time of the spin system stands as a critical factor for this application in particular for the preservation of Schrödinger cat states, which is still a significant challenge in the field of levitodynamics. We will show our progress towards this goal using electronic spins of NV centers in diamonds in Paul traps as well as attached to a cantilever. We will also show recent results on Nuclear Magnetic Resonance (NMR) within a levitating micro-diamond. There, we employ the nuclear spins of nitrogen-14 atoms, offering coherence times up to hundreds of microseconds. This represents the longest coherence time recorded for a controlled two-level system in a levitated particle, surpassing the previously measured coherence time in electronic spins by three orders of magnitude.

Takis Kontos

Hybrid quantum circuits: from manipulation of quantum states in carbon nanotubes to quantum enhanced detection of dark matter.

How hybrid quantum circuits can be used to manipulate quantum states in carbon nanotubes and shape their spectrum, and our prospects for using hybrid magnetic-cavity-superconducting circuits platforms for quantum sensing of dark matter.