# Book of abstracts

*Vincent Josse, LCF*

**Title: Direct Observation of the 3D Anderson Transition with Ultracold Atoms**

Anderson localization of particles -- the complete halt of wave transport through multiple scattering and phase coherence -- is a paradigmatic manifestation of quantum interference in disordered media. In three dimensions, the scaling theory predicts a quantum phase transition at a critical energy, the mobility edge, separating localized from diffusive states and underpinning metal-insulator transitions in electronic systems. Despite decades of experimental efforts, a direct observation of this emblematic transition for matter waves has remained elusive. Previous attempts with ultracold atoms were hindered by strong and uncontrolled energy broadening, resulting in indirect, sometimes inaccurate, and model-dependent estimates of the mobility edge.

In this talk, I will present the novel energy-resolved scheme that we have developed to prepare atomic matter waves with a narrow energy distribution and track their expansion dynamics over long timescales. This allows for a direct observation of the three-dimensional Anderson transition in a laser-speckle disordered potential, and for a precise measurement of the mobility edge that is independent of any underlying theoretical modeling. Our measurements show excellent agreement with state-of-the-art numerical predictions over a wide range of disorder strengths, resolving long-standing discrepancies between prior experiments and theory.

*Ulysse Chabaud, INRIA | ENS*

**Title: Quantum computing with bosons**

Bosonic quantum systems operate in an infinite-dimensional Hilbert space, unlike discrete-variable quantum systems. This distinct mathematical structure leads to fundamental differences in quantum information processing, such as an exponentially greater complexity of state tomography [Anna Mele et al. (2024)] or a factoring algorithm in constant space [Brenner et al. (2024)]. Yet, any real-world computation necessarily uses limited energy, and it remains unclear whether the structural difference of bosonic systems may also translate to a computational advantage over finite-dimensional quantum computers when taking such constraints into account. In this talk, I will address this question from a complexity-theoretic point of view by characterizing the computational power of energy in bosonic quantum computations.

*Samuel Deléglise, LKB*

**Title: Probing the quantum motion of a MHz mechanical resonator with a resonant rf-fluxonium**

MHz-frequency mechanical resonators are powerful platforms for quantum technologies and tests of fundamental physics, yet efficient control remains challenging due to their low energy scales and the difficulty of coupling them to well-controlled quantum systems at matching frequencies. Here we demonstrate high-fidelity, repeated interactions between a 4-MHz suspended silicon nitride membrane resonator and a resonant superconducting fluxonium qubit. Over the membrane's 6-ms lifetime, the two systems coherently interact more than 300 times. Using the qubit as a stroboscopic spectrometer, we reconstruct the membrane's position-noise spectrum, revealing its thermal occupation, qubit-induced back-action, and the characteristic emission–absorption imbalance. This asymmetry directly reflects the non-commutation of phonon ladder operators, demonstrating the quantum character of the long-lived, massive mode.