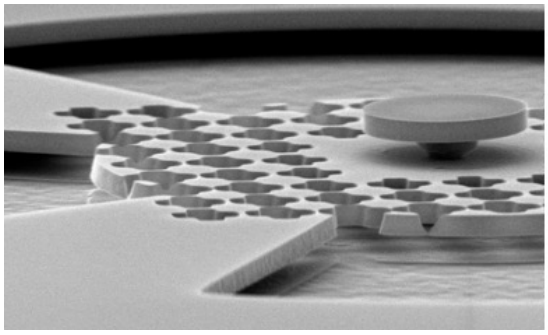
Internship offer 2023/2024

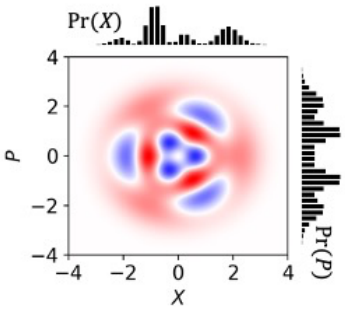
Laboratory: Matériaux et Phénomènes Quantiques
Director: Cristiano Ciuti
Address: Bâtiment Condorcet, 10 rue A. Domon et L. Duquet, 75013 PARIS
Person in charge of the internship: Adrien Borne
Tel: 01 57 27 70 12
e-mail: adrien.borne@u-paris.fr

Quantum states of motion of a mechanical resonator

Scientific project:

Similarly to single atoms, the motion of massive, mesoscopic-scale mechanical resonators can behave quantum mechanically when cooled down to ultra-low temperatures. The study of quantum states of motion of such systems has both fundamental and practical interests: for testing quantum mechanics in systems beyond the few-particle ensembles, its interplay with gravitation; also in force sensing, or as a light-matter interface for the development of quantum communication networks, in particular for storing and transducing the quantum information.





Left: Scanning electron microscope image of an optomechanical disk resonator mechanically shielded from the environment (nanofabrication by our team). Right: Theoretical Wigner function of a superposition Fock state.

This internship/PhD project aims at transforming a given input mechanical quantum state to any arbitrary target state [1] in an optomechanical resonator such as the microdisk pictured above and developped in our group. The mechanical quantum information can be encoded in the device through its interaction with light [2], and then characterized through optical tomographic reconstruction [3]. This work will also consider increasing the dimensionnality by including several optomechanical resonators, thereby involving entanglement between massive objects.

[1] MR Vanner, M Aspelmeyer and MS Kim, PRL **110**, 010504 (2013).
[2] I Favero and K Karrai, Nat. Phot. **3**, 201 (2009). M Aspelmeyer, T Kippenberg and F Marquardt, Rev. Mod. Phys. **86**, 1391 (2014).
[3] MR Vanner, I Pikovski, and MS Kim, Ann. Phys. **527** (2015).

Methods and techniques: Quantum optomechanics, single-photon counting, quantum state tomography, cryogenics

Possibility to go on with a PhD ? Yes
Envisaged fellowship ? Doctoral school, possible ANR grant, …