Spécialité de Master « Optique, Matière, Plasmas »

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 22/10/2014

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Nom du Laboratoire / *laboratory name*: **Laboratoire Matériaux et Phénomènes Quantiques**

Code d'identification : UMR 7162 Organisme : Université Paris Diderot, CNRS

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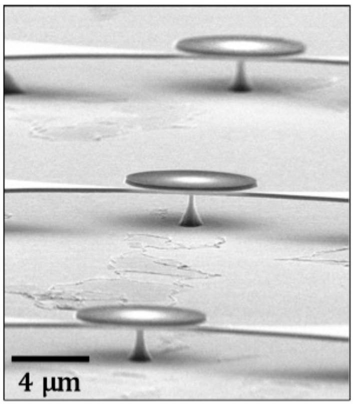
Adresse / *address:* 10 rue Alice Domon et Léonie Duquet 75013 Paris

Lieu du stage / *internship place*: 10 rue Alice Domon et Léonie Duquet 75013 Paris

Titre du stage / *internship title*: **Quantum nano-optomechanics on a semiconductor chip**

Optomechanics studies the coupling between light and mechanical oscillators. It is a burgeoning research field at the interface of quantum photonics, mesoscopic condensed matter physics, and mechanical micro/nano systems [1]. In a way analog to Doppler laser cooling of atoms [2], mechanical oscillators are today optically cooled to ultra-low temperatures where their quantum behavior is revealed despite their macroscopic mass scale [3]. This regime opens a new area of quantum physics research: how does a macroscopic mechanical oscillator loose its quantum coherence to become classical? Can we generate and use non-classical states of mechanical motion? What are the limits of performance of a nanomechanical sensor operated in this quantum regime? Can we teleport the state of a mechanical quantum system?



In our team, we combine nanomechanical devices with on-chip integrated optics architectures, in order to develop optical/mechanical resonators operating at their quantum limit of sensitivity. Our optomechanical oscillators are miniature GaAs semiconductor disks with ultra-low dissipation (see picture) [4]. In these resonators, optical and mechanical energy are stored together in a sub-micron interaction volume, giving rise to an ultimate optomechanical coupling strength up to 4 MHz [5]. With their mass of a few picograms, their high mechanical frequency of several GHz, these miniature optomechanical disks are approaching the quantum regime and naturally lend themselves to the devolvement of quantum sensors. Being compliant with the insertion of single photon emitters (Quantum Dots), they also lead to hybrid situations where such emitter interacts both with a mechanical oscillator and with photons stored in a cavity [6]. Using these unique features, the perspective of our research is to explore a novel playground at the crossroads of quantum nanophotonics and optomechanics; in view of implementing (quantum) forces sensing protocols on a semiconductor chip. The team is currently looking for a PhD candidate to join this research program.

[1] Favero, Karrai. *Nat. Phot.* 3, 201 (2009). Aspelmeyer, Kippenberg, Marquardt. arXiv:1303.0733 (2013).
[2] Karrai, Favero, Metzger. *Phys. Rev. Lett.* 100, 240801 (2008).
[3] Chan et al. *Nature* 478, 89–92 (2011). Teufel et al. *Nature* 475, 359–363 (2011).
[4] Ding et al. *PRL* 105, 263903 (2010). Ding et al. *APL* 98, 113108 (2011). Baker et al *APL* 99, 151117 (2011). Parrain et al. *APL* 100, 242105 (2012). Nguyen et al. *APL* **103**, 241112 (2013).
[5] Baker et al. *Opt. Exp*. 22,14072 (2014).
[6] Restrepo, Ciuti, Favero, *Phys. Rev. Lett.* 112, 013601 (2014).

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : YES**

Si oui, financement de thèse envisagé/ *financial support for the PhD*: projet ERC

Lasers, Optique, Matière	**YES**	Lumière, Matière, Interactions	**YES**
Plasmas : de l'espace au laboratoire			