Spécialité de Master « Optique, Matière, Plasmas »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 29/09/2014

Responsable du stage / *internship supervisor*:

POIZAT Jean-Philippe
Tel 04 56 38 71 65
Email : jean-philippe.poizat@neel.cnrs.fr

Nom du Laboratoire / *laboratory name*:

Code d'identification : Institut Néel, UPR2940 Organisme : CNRS
Site Internet / *web site*: http://neel.cnrs.fr/
Adresse / *address:* 25, av des Martyrs, 38042 Grenoble
Lieu du stage / *internship place*: Grenoble

Titre du stage / *internship title*: **Coupling a single quantum dot to a mechanical oscillator**

Résumé / *summary*

Owing to the recent progress in nanotechnology and in ultra-sensitive motion detection methods, it becomes now possible to associate quantum systems such as superconducting qubits, spins, atoms or quantum dots to mechanical oscillators. The issue of these hybrid systems is to transfer the quantum properties of a two-level system to a mechanical oscillator, opening the possibility of storing quantum information on mechanical degrees of freedom.

We have recently realized such an hybrid system made of a vibrating wire and a semi-conducting quantum dot[1]. The very large coupling between these two subsystems relies on mechanical strain (cf figure). The mechanical oscillator is a GaAs conical wire of height 18 µm and diameter from 0.5 to 2 µm. The InAs quantum dot (QD) is located slightly above the base of the wire. Owing to its off-centered position within the nanowire circular cross-section, the quantum dot undergoes periodic strain as the wire oscillates along its fundamental flexural mode at around 500 kHz. The alternatively tensile and compressive strain periodically alters the quantum dot energy levels and therefore the spectral position of the photoluminescence lines. The corresponding coupling reaches almost the ultra-strong coupling regime in which it is in principle possible to separate the rest positions of the wire depending on whether the quantum dot is excited or not.

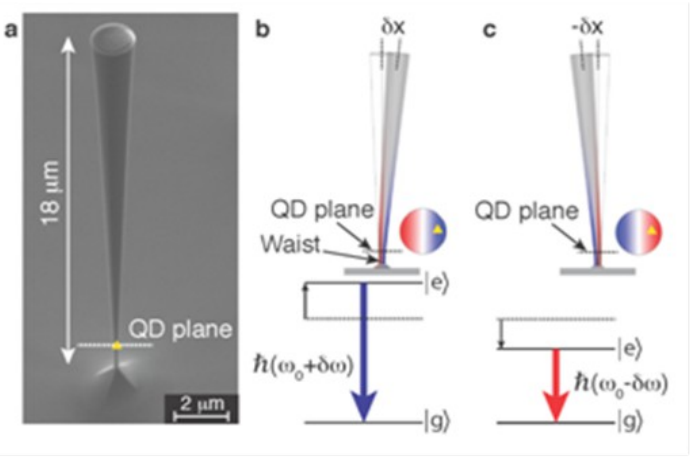

***Fig.** a) Scanning electronic microscope image of the photonic "trumpet". b)-c) Principle of the strain-mediated coupling.*

Project :

We want to explore the reverse aspect of this coupling by investigating how the excitation of the quantum dot can affect the motion of the oscillator. The first possibility is to set the wire in motion by optically exciting a single quantum dot that will act as a "quantum hammer"[2]. The second experiment will be to shift the mechanical frequency of the wire by controlling the quantum dot population using an "optical spring" effect.

This M2 internship will deal with one of these two experiments, depending on the experimental progress in the next few months.

References

[1] I. Yeo, et al, Nature Nanotechnology **9**, 106 (2014)
[2] A. Auffèves et M. Richard, Phys. Rev. A 90, 023818 (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***: Ecole Doctorale or LANEF**

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