Spécialité de Master « Optique, Matière, Paris »

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

Proposition de stage

Date de la proposition : 22 octobre 2015

Responsable de stage

Nom : POIZAT *Prénom : Jean-Philippe*

Tel : 04 56 38 71 65

Courriel : jean-philippe.poizat@neel.cnrs.fr

Nom du Laboratoire : Institut Néel

Code d'identification : UPR2940 *Organisme : CNRS*

Site internet : http://neel.cnrs.fr/spip.php?rubrique47

Adresse : 25, avenue des Martyrs, 38000 Grenoble

Lieu du stage : Grenoble

Titre du stage : Coupling a single quantum dot to a mechanical oscillator

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. 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.

We want to explore the reverse aspect of this coupling by investigating how the excitation of the quantum dot affects 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]. A second possibility is to investigate how the quantum dot population influences the mechanical oscillator frequency.

This M2 internship will deal with one of these two experiments, depending on the experimental progress in the next few months. Possibilities to laser cool the motion of the mechanical oscillator will be investigated during the PhD.

References

[1] I. Yeo, et al, Nature Nanotechnology **9**, 106 (2014)

[2] A. Auffèves et M. Richard, Phys. Rev. A 90, 023818 (2014),

Possibility for a Phd : Yes

Financial support for the PhD : Application to Ecole Doctorale or LANEF scholarships