SR1. Controlling the phononic environment of a single quantum dot

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State of the art: Many key features have been demonstrated with semiconductor quantum dots (QDs) showing their potential for quantum information processing: ultra-bright single photon sources, spin-photon or spin-spin entanglement, few photon optical non-linearity… In these systems, acoustic phonons are usually seen as a source of unwanted decoherence that limit the fidelity of a quantum gate or the coherence of a spin qubit. However recent advances in nanophononics suggest that it would be actually possible to control phonons the way we currently control photons.

In semiconductor systems based on GaAs/AlAs, one can create acoustic phonon cavity in the 20-200 GHz range using acoustic distributed Bragg reflectors (Physical Review Letters 110 (3), 037403 (2013)). Like for optical cavities, etched micropillar structures have very recently been shown to sustain confined phonon modes (unpublished).

Objectives: This project aims at launching a new research activity to gain control on the QD-acoutic phonon coupling. Like in optics, our objective is to position a single QD in an acoustic cavity and demonstrate the preferential coupling of the QD to the engineered acoustic cavity mode. The control of the QD acoustic environment will be probed by measuring the phonon assisted emission of the QD under resonant excitation in electrically controlled tunable devices.

The research line will be led by N. D. Lanzillotti-Kimura, an expert in nanophononic who recently obtained a permanent position at CNRS. This activity will also benefit from all the technological tools existing in the team to deterministically couple a QD to an optical cavity mode (in-situ lithography), directly transferred to the acoustic cavities.

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