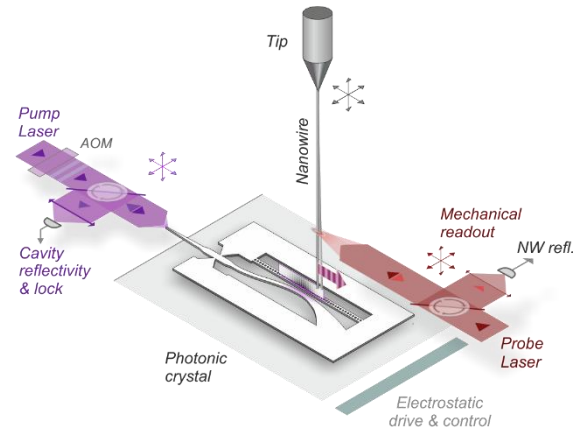


# PhD thesis project

## Nano optomechanics in the single photon regime

### General Scope:

Light is a tool of choice to measure the minute vibrations of mechanical oscillators using optical interferometry. A laser field interacting with a resonator applies an optical force which formally represents the backaction of the measurement process. Optomechanics is the field studying the quantum limits of these precision measurements carried out in interferometers and optical cavities. At the macroscopic level, understanding this light-matter interaction is central to enhance the sensitivity of gravitational wave detectors. At the nanoscale it is possible to employ ultrasensitive force sensors and maximise their optomechanical interaction using high finesse optical micro-cavities where the electromagnetic field of each photon is enhanced. Our experiments allow entering the regime where the optomechanical interaction can be explored down to the single photon level, with sub-wavelength size resolution, opening novel perspectives in quantum optics and cavity nano-optomechanics.



### PhD Subject:

We exploit suspended silicon carbide nanowires as ultrasensitive force sensors, and make them interact with a photonic crystal optical micro-cavity to build a strongly coupled optomechanical system. The nanowire vibrating apex interacts with the light field confined in the cavity mode thus shifting its optical resonance frequency while the photons in the cavity mode apply an optomechanical force on the nanowire. In this setup we are able to monitor in real time the pump light reflected from the cavity and the nanowire vibrations using a separate readout laser. By scanning the nanowire above the photonic crystal, we are able to map the optomechanical interaction with high accuracy. The goal of the PhD project is to study this strong interaction at low photon number in the cavity, when the nanowire position fluctuations are dominated by the quantum fluctuations of the cavity field. The current experiment is carried out at room temperature but it is planned to move to milli Kelvin temperature to gain in sensitivity and reduce the nanowire thermal noise.

This experimental work is carried out in close collaboration with teams in the C2N and LKB laboratories in Palaiseau and Paris, which fabricate and optimise the microcavities. On the theory side, we are collaborating with theoreticians experts in quantum optics and fluctuations at the LKB laboratory in Paris in order to model the optomechanical interaction down to the single photon level.

### Required Skills:

A theoretical background in quantum mechanics, optics and/or nano-mechanics, as well as prior knowledge in programming (Python) are welcome. Experimental work involves optics, nano-mechanics, vacuum technology and microwave design, and advanced interfacing.

**Laboratory:** Institut Néel

### PhD Supervisors:

- Benjamin pigeau, benjamin.pigeau@neel.cnrs.fr
- Olivier Arcizet, olivier.arcizet@neel.cnrs.fr