INTERNSHIP PROPOSAL

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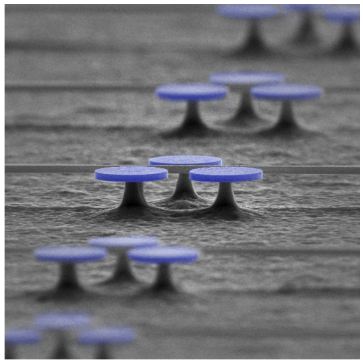
Thesis possibility after internship: YES
Funding: YES, ANR project SINPHONY

Optomechanical nanoscale quantum sensing

Optomechanics, the interaction between light and mechanical oscillators, is a burgeoning field of research at the interface of quantum optics, mesoscopic physics and mechanical micro/nano systems [1].

Using light, it has recently been possible to control and read-out the quantum states of mesoscopic mechanical resonators. This has been notably achieved with nano-optomechanical disk resonators (see image below) fabricated in our team, where the simultaneous confinement of light and mechanical motion in a sub-micron volume enables strong optomechanical interaction [2]. The implications of such developments in the field of quantum sensing remain now to be explored.



This PhD project aims to bring mechanical scanning probes into the experimental quantum domain using optomechanics [3,4]. Quantum theory postulates indeed that energy exchanges between physical systems take place with a certain granularity, in quantities that are multiples of an energy quantum. This quantum regime of interactions has never been illustrated by local mechanical measurements, such as those made with an atomic force microscope (AFM). Detecting the exchange of a single quantum of energy between a physical system and mechanical force probe represents the ultimate level of sensitivity allowed by microscopic laws, and is therefore a considerable scientific and technological stake for sensing applications of optomechanics [5]. This PhD project aims at reaching this experimental regime, before adressing the subject of arbitrary quantum state production, for optimal sensing.

Methods and techniques: Quantum Optics, Nanomechanics, Force Sensing, Low Temperatures

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[2] C. Baker, …, and I. Favero. Opt. Express **22**, 14072 (2014).
[3] P. Allain et al., Nanoscale **12**, 2939 (2020).
[4] L. Schwab et al, Microsystems & Nanoengineering **8** (1) 1 (2022).
[5] S. Sbarra, L. Waquier, S. Suffit, A. Lemaître and I Favero. Nature Communications **13** (1), 6462 (2022)

Condensed Matter Physics: YES	Soft Matter and Biological Physics: NO
Quantum Physics: YES	Theoretical Physics: NO