INTERNSHIP PROPOSAL

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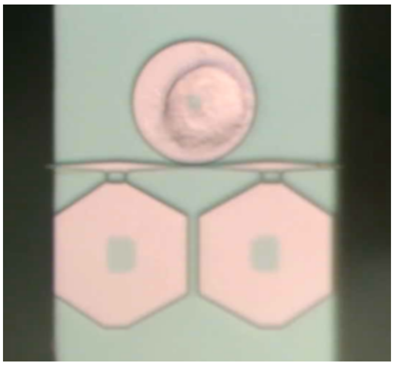
Thesis possibility after internship: YES
Funding: YES

Optomechanical coherence in a single living cell

Coherence can provide functional advantage. In the field of quantum technologies, quantum computation algorithms use coherence to beat classical algorithms, while quantum protocols secure communications thanks to coherence. In classical optics, coherent light can be tightly focused, providing resolution in imaging or surgery applications. What about coherence in living systems: is classical or quantum coherence playing a role in biology? Does it provide functional advantage? Are living systems actively preserving the coherence of some degrees of freedom?



This internship/PhD thesis aims to explore these questions at the level of a single live cell, using the tools of quantum optomechanics, which enable unprecedented sensitivity and time-resolution [1]. In the last years, our team carried the first optomechanical experiments on biological objects, albeit in a dry environment where the biological functions were turned off [2,3]. More recently, we immersed optomechanical experiments in a physiological liquid medium in order to measure a living object in action, when biological mechanisms are this time turned on. The image shows an individual live cell deposited on the surface of an optomechanical disk (radius 11 µm) fabricated in our clean-room. The disk is evanescently coupled to a nanophotonic waveguide hold by two hexagonal pads, enabling real-time time optomechanical measurement of the cell. Building on this approach, the project will investigate active biological mechanisms in the cell and link them to the capacity to sustain or degrade the coherence of mechanical and optical degrees of freedom, hence exploring a practical interface between quantum science and biophysics.

Methods and techniques: Quantum optics, nanomechanics, biophysics, coherence

References:
1-I. Favero and K. Karrai, Nat. Phot. 3, 201 (2009).
2-E. Gil-Santos et al, Nature Nanotechnology 15 (6), 469-474 (2020).
3-O. Alvar, et al. IEEE 36th International Conference on Micro Electro Mechanical Systems (MEMS 2023).

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