Spécialité de Master « Optique, Matière, Paris »

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

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition :

Responsable du stage / *internship supervisor*:

Nom / *name*: BRAIVE — Prénom/ *first name* : Rémy

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Nom du Laboratoire / *laboratory name*: Centre de Nanosciences et de Nanotechnologies

Code d'identification : UMR 9001 — Organisme : CNRS

Site Internet / *web site*: c2n.universite-paris-saclay.fr/fr/activites/optomecanique/

Adresse / *address:* Avenue de la Vauve 91120 Palaiseau - France

Lieu du stage / *internship place*: Palaiseau

Titre du stage / *internship title*: Nano-optomechanics for time-frequency metrology and microwave photonics

Résumé / *summary*

Recent advances in nanophotonics have enabled co-design of mechanical and optical resonances in the same device, opening the way to optomechanics experiments at nanoscale [1]. A notable contribution that has come out of this area, is the manifestation of parametric instability, resulting in mechanical amplification and thereby oscillation of the mechanical mode driven purely optically. This ability to achieve self-sustained oscillation with no need for feedback electronics makes optomechanical oscillators compelling for on-chip applications [2] such as microwave clocks, in which directed light energy from a laser is available to fuel the oscillation.

In this project, the photonic clock architecture will rely on an integrated high-quality optomechanical resonator (OMR, see figure below), namely a photonic crystal defect cavity, in order to achieve very stable oscillation in the GHz range, where the lack of good quality and miniaturized sources is a severe issue. Thanks to the strong reduction of the oscillator dimensions down to nanoscale, the resonator will sustain mechanical modes strongly coupled to light up to 3-5 GHz, directly at the operating frequency of interest for optoelectronic microwave oscillators and metrology applications.

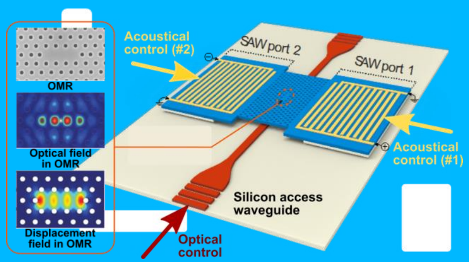

Fig. 1: Sketch of the targeted device with the OMR and the optical and displacement field located in the core of the defect photonic crystal. The OMR could be probed and control by optical means (silicon access waveguide) or acoustically (surface acoustic wave transducers)

One main issue is the stability of the oscillator's output, as gauged over short time spans by its phase noise. Stabilization will be achieved by implementing on-chip optoelectronic loops, exploiting either an optical (silicon access waveguide) or acoustic (surface acoustic wave transducers) control of mechanical motion along different schemes including locking on a reference frequency or self-injection locking (See figure above). This project will be carried out in strong collaboration with Thales-RT for the specifications of the devices and their phase noise measurements.

This work is a multifaceted project which involved nanofabrication in the laboratory clean rooms, laser physics, nanophotonics, high precision optical experiments as well as numerical simulations of the resonators, thus allowing acquiring a broad knowledge in several fields and of many experimental techniques.

The intern will be mainly involved in the investigation of optomechanical effects and their simulations within the device. The training may lead to a PhD work, extending the investigation of optomechanical effects for metrology, in particular assessing their potential for implementing ultra-stable compact microwave clocks for time-frequency metrology.

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : Yes**

Si oui, financement de thèse envisagé/ *financial support for the PhD*: **Yes**

Lumière, Matière, Interactions	**X**	Lasers, Optique, Matière	**X**

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