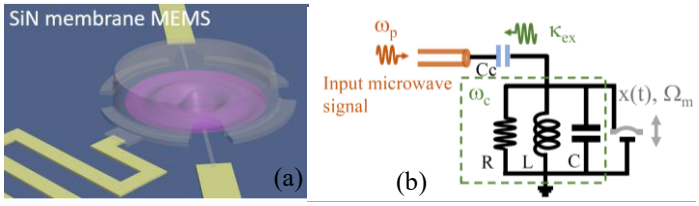
Internship offer 2023

Laboratory: CNRS, IEMN (The Institute of Electronics, Microelectronics and Nanotechnology)
Address: Avenue Poincaré CS 60069, 59652 Villeneuve d'Ascq Cedex (Lille), France

Design of microwave optomechanical quantum circuits to integrate and operate multiple nanoelectromechanical resonators

Scientific project:



Microwave optomechanics, which studies interactions between micro/Nano- electromechanical systems (MEMS/NEMS) and microwave photons, offers an interesting platform to manipulate and to detect nano-scle mechanical displacements [1]. They have exhibited potential in serving for signal processing and sensing in the quantum region. The target of the project is to develop novel NEMS/MEMS hybrid microwave quantum circuits that allow to have strong coupling between NEMS arrays and the microwave cavity and to manipulate mechanical motions by both radio frequency signals and microwave photons at the same time. This project is based on our recent achievements in both silicon nitride (SiN) membrane nanoelectromechanical resonators [2-3] and electrical circuit modeling of microwave optomechanics [4], as shown in Fig.(a) and (b).

Objectives: The goal of this internship is to perform both COMSOL multi-physics simulations and simple analytical calculations in order to improve microwae optomechanical circuit design. For the part of simulation, he/she will focus on simulating electromagnetic fields of the microwave cavities (resonance frequency in GHz range) and the mechanical properties of the SiN membranes (with resonance frequency in MHz range), in order to improve device performance. For analytical calculations, students will be involved in developing RLC circuits [4] to model optomechanical features and to evaluate the accessibility of circuit parameters which will be used for nanofabrications in the future, such as phonon and photon numbers, coupling rate, damping rate, and so on. Both numerical simulations and analytical calculations will help students to understand basic principles of microwave optomechanical quantum circuits and give students an access to this challenge domain. The achievement of this internship work will serve for the following Ph.D project.

Candidate: (1) Master 2 or 3rd year of engineering school, (2) Background in physics or engineering and you can solve easily basic second order equations, (3) Knowledge of python/matlab coding, or experience of numerical simulations in electromagnetic fields, (4) Knowledge of high frequency electronics, (5) Experimental skills, working in team, speak&write English.

Duration: 4~6 months, starting between January and April of 2023 (to be contacted). In case of mutual satisfaction, this work will be extended to a PhD thesis (**for experiment**) for which the financial support is already ensured within an accepted ANR project.

Related reference of the team:
[1] Physical Review Applied 12 (4), 044066 (2019), [2] Nano Letters, 21 (13), 5738–5744 (2021), [3] Nano Letters, 22 (18), 7351–7357 (2022), [4] Journal of Applied Physics 129, 114502 (2021)

Methods and techniques: COMSOL multi-physics, analytical calculations, circuit modeling

Possibility to go on with a PhD ? Yes
Envisaged fellowship ? Yes (400 ~ 600 euros /month)

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