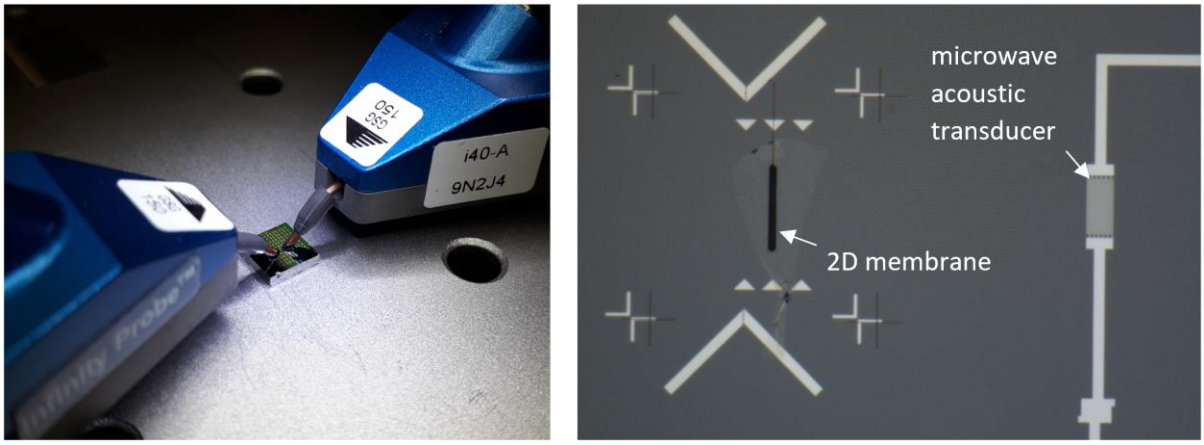
NÉEL INSTITUTE Grenoble

PhD thesis proposal

Hybrid quantum acoustics

Context: Acoustic and nanomechanical systems have recently emerged as a powerful quantum technology, with applications ranging from quantum sensing to quantum information science. Controlling solid-state phonons at the quantum scale is thus opening up exciting new experimental avenues, both for fundamental investigations and for applied technologies. This project aims to develop a hybrid quantum acoustics architecture that will enable us to explore topics ranging from coherent spin-phonon interactions, the acoustics of 2D materials in the quantum regime, to the engineering of devices to interface spin qubits. The design of this novel architecture is enabled by the microwave toolbox recently developed with superconducting circuits.



Left: room temperature characterization of acoustic devices at GHz frequencies, performed before cooling the devices down to mK temperatures. Right: An acoustic device recently developed in the lab. A transducer made out of superconducting circuits (white color) is used to launch and detect acoustic waves, in order to acoustically probe a suspended 2D membrane.

Research topic and facilities available: the student will first learn how to design, fabricate and operate acoustic devices at microwave frequencies (several GHz) and cryogenic temperatures (20 mK). The fabrication takes place in the clean room of the Néel institute, using state-of-the-art nano-fabrication techniques and high-performance materials (such as $LiNbO_3$). The cryogenic microwave measurements will be performed in a dedicated dilution refrigerator.

By mechanically interfacing nanomechanical oscillators with both high frequency and large zero-point motion, our hybrid technology should enable us to explore directions such as quantum acoustics in 2D or the interactions between single molecular spins and single phonons. On the long term, this platform could then be exploited to readout and coherently manipulate molecular spin qubits.

Required skills: We are looking for a motivated student, willing to be part of a project involving both technical and fundamental challenges, and wanting to learn a wide variety of skills in experimental condensed matter physics.

Starting date: Flexible
PhD fellowship: readily available (ANR)
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