NÉEL INSTITUTE Grenoble

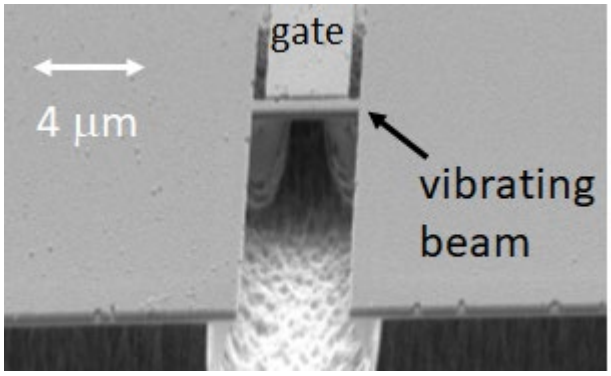
Topic for Master 2 internship – Academic year 2022-2023

Dependence of dissipation of a nanomechanical resonator on its superconducting state

General Scope:
Nanomechanical resonators are sensitive mass and force detectors. They are also used to test theories of quantum thermodynamics and wave function collapse models, and to probe individual atomic scale tunneling systems. The mechanical dissipation determines the sensitivity of the nanomechanical resonator. However, the dependence of the dissipation on the superconducting state of metal in nanomechanical resonators is not well understood: different studies of similar nanomechanical resonators report strikingly different findings [1,2]. The region of the nanomechanical resonator in which dissipation is concentrated and the dependence on resonator material is therefore unknown.

[1] Lulla *et al*., "Evidence for the Role of Normal-State Electrons in Nanoelectromechanical Damping Mechanisms at Very Low Temperatures", *Physical Review Letters* **110**, 177206 (2013).
[2] Kamppinen *et al*., "Dimensional control of tunneling two-level systems in nanoelectromechanical resonators", *Physical Review B* **105**, 035409 (2022).

Research topic and facilities available :
We will study the dependence of nanomechanical resonator dissipation on composition, geometry and superconducting state in order to test potential explanations for the contrasting observations referenced above. The work will be carried out in the Ultra-Low Temperatures group of the Institut Néel. Preliminary measurements will be carried out on a liquid-helium based 1 kelvin cryostat. Tests of the dependence of damping on superconducting state will be made with a cryogen-free dilution refrigerator reaching temperatures below 10 mK. The devices are fabricated in the local Nanofab facility.



Possible extension as a PhD: Yes

Required skills: A strong interest in physics and making challenging measurements at low temperatures.
Starting date: Negotiable

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More information: https://neel.cnrs.fr/equipes-poles-et-services/ultra-basses-temperatures-ubt