NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2024-2025

Spectrometers based on Kinetic Inductance Detectors (KID)

General Scope :

Millimeter and sub-millimeter astrophysics is nowadays among the most important pillars supporting our common cosmological model. In particular, the Cosmic Microwave Background, the most primordial electro-magnetic radiation that is observable, is peaking at millimeter wavelengths.

Kinetic Inductance Detectors are state-of-the-art detectors for millimeter wave observations in astrophysics. They are LC resonators made out of superconducting materials. The detection principle is based on the monitoring of the resonator frequency variation $f_0 = 1/(2\pi\sqrt{LC})$. Incident photons break down Cooper pairs, modifying the inductance L and thus the resonance frequency. The superconducting gap Δ sets in the photon detector cutoff frequency to $\nu > \Delta/h$.

Research topic and facilities available:
In this project, we aim to develop a new technology for on-chip spectroscopy using Kinetic Inductance Detectors and a magnetic field (the H-KID projet). The spectral response of the Kinetic Inductance Detectors will be modified by reducing the superconducting gap using the magnetic field. The aim of the project is to design, nanofabricate and test at low temperature a spectrometer based on Kinetic Inductance Detectors.

The student will ensure all the steps of the study from the fabrication up to the measurements. She/he will design and nano-lithography the detectors. Test of the detectors will be realized in an optical dilution fridge refrigerator at 100 mK.

Photo of a Kinetic Inductance Detector.
Grey: silicon substrate. White: superconducting material. The resonator consists of a second order Hilbert shape fractal inductor and an interdigital capacitor. The resonator is capacitively coupled to the transmission line : top straight line.

Possible collaboration and networking :
The project is part of the Institut Néel's collaboration with Alessandro Monfardini, Martino Calvo and Usasi Chowdhury.

Required skills:
Solid state physic knowledge, taste for experimental manipulation and strong motivation.

Starting date : January-April 2025

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