NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2025-2026

Superconductivity and charge-density waves in kagome lattices under uniaxial stress

General Scope: Solids composed of atoms arranged on a corner-sharing triangular lattice (see Fig. 1A), the so-called kagome lattice, have long attracted attention to the quantum materials community. Originally, the focus was on insulating frustrated magnets in the search for a quantum spin liquid state. More recently, metallic kagome systems are the focus of a growing community, in particular due to the discovery of superconductivity in AV_3Sb_5 (A=K, Rb, Cs) [1].

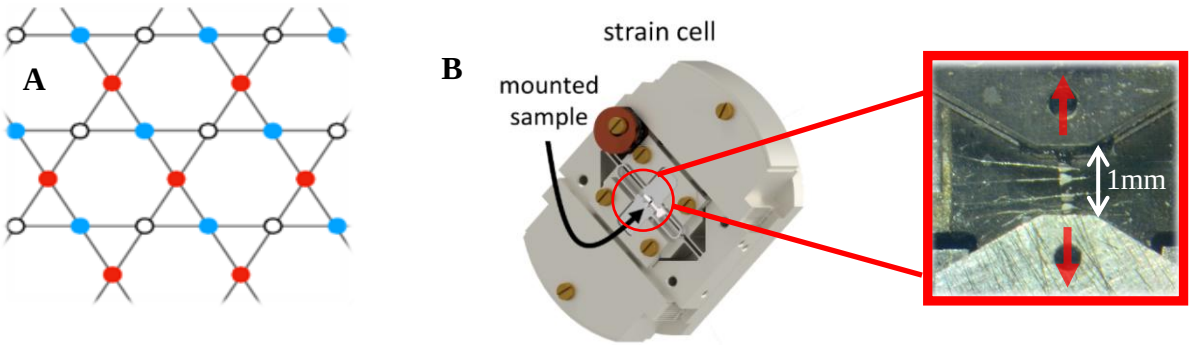

Figure 1. (A) The kagome lattice with three inequivalent sites (B) Setup for electrical transport studies under uniaxial stress. The inset shows a sample under applied uniaxial stress (direction of stress denoted by arrows), with four electrical contacts to extract the elastoresistance.

The superconductivity of AV_3Sb_5 does not stand alone. It has been demonstrated to be in strong interaction with a charge-density wave, another quantum state where the density of conduction electrons is periodically modulated (see Wikipedia). It is now needed to understand more deeply both quantum states and their interaction. We will investigate this interaction in different AV_3Sb_5 single crystals, with the aim to gain a deeper understanding of the superconducting and the charge-density wave states.

Research topic and facilities available: The aim of the internship will be to tune the competition of charge-density-wave and superconductivity in kagome lattices using a powerful tuning knob, uniaxial stress. We recently proven this approach to be particularly suited for the AV_3Sb_5 family [2]. You will benefit from the recent implementation of a uniaxial stress device [3], compatible with low temperatures (<2K) to conduct electrical transport under uniaxial stress experiments (see Fig 1B).

[1] https://arxiv.org/abs/2011.06745
[2] https://arxiv.org/abs/2310.06102
[3] See https://razorbillinstruments.com/

Do not hesitate to contact us for more details!

Possible collaboration and networking: The intern will work in the "Magnetism & Superconductivity" group, a very active team with 20+ permanent researchers that supervise numerous postdoc, PhD students and interns. The current subject is of interest to several team members, such that the intern will have the possibility to interact and learn from other team members. Additionally, he/she will benefit from the lively scientific activity of the Institute.

Possible extension as a PhD: Yes, it is possible to apply for PhD funding through the physics doctoral school (https://adum.fr/), or thanks to the QuantAlps program (https://quantalps.univ-grenoble-alpes.fr/). Please contact us for more details.

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Required skills: A strong background in condensed matter physics, the motivation and perseverance to perform the demanding uniaxial-stress experiments, and the will to perform exploratory experimental physics. Good communication skills are essential.

Starting date: Flexible, ideally February 2026

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