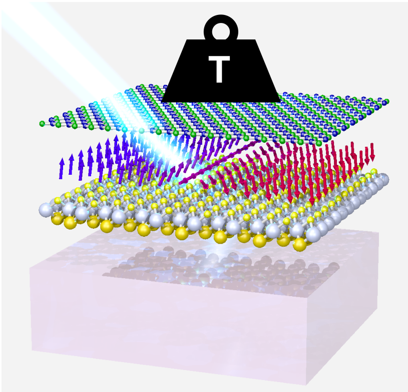
# Master 2 internship (possibly continued with PhD project)
# Academic year 2022-2023

## Physics of magnetic states and their coupling to excitations in two-dimensional crystals

**General Scope:**
The exploration of magnetism at reduced dimensions, especially in dimension 2 (2D), is rich in non-intuitive phenomena. Unconventional kinds of magnetic orders, non-trivial disordered states (analogous to liquids), intriguing phase transitions (described with topology concepts) have been predicted and/or observed. Starting from 2016-2017, new platforms have been discovered with which these phenomena can be studied: they are lamellar materials, that can be thinned down to the ultimate thickness of a monolayer (one/few-atom-thick). These 2D materials can be manipulated in different ways, either by preparing artificial stacks with other kinds of monolayers, or by applying mechanical constraints. Besides magnetic states, they host photonic and phononic excitations that can couple to magnetism, which further enriches the study of 2D magnetism [1,2].

**Research topic and facilities available:**




We propose a fundamental research project, focused on a family of magnetic materials recently discovered in Grenoble [3,4]. These chromium-based compounds are remarquable for their magnetic ordering at room temperature, a very rare property making them promising for future applications in spintronics. The objective is to explore the means to manipulate 2D magnetism in these materials. To reach this objective, we can subtly tailor the material's composition, apply pressure, and use magnetic fields. To understand the magnetic properties, the link between magnons (i.e. spin waves), phonons, and the coupling between these excitations, we will use optical spectroscopy techniques, especially Raman scattering in a very broad range of conditions — down to very low temperature, up to high pressures (giga-Pascals), and in presence of intense magnetic fields (tens of Teslas) [1,2].
The project will be carried out in two laboratories that are implanted on the same geographical site, Néel Institute, where sample fabrication is mastered and advanced magnetic characterisations (imaging, magnetometry) will be performed, and the High Magnetic Field National Laboratory (LNCMI), where spectroscopy will be performed under extreme conditions.

**Possible collaboration and networking:**
The work will be mainly experimental, and will benefit from interaction between local experts in materials synthesis and complementary spectroscopy approaches. The project is part of a large-scale national project, involving seven laboratories.

**Possible extension as a PhD:**
Funding for a PhD grant is secured (funded national-scale project). PhD works may start in Fall, 2023.

**Required skills:**
The applicant should have a strong solid state physics background, and have keen interest for experimental work, which will comprise fabrication of samples suited to different kinds of measurements. This experimental work will require strong commitment, especially for experiments under extreme conditions of temperature, magnetic field and pressure.

**Starting date**: Spring, 2023

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