NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2024-2025

Unconventional magnetism in honeycomb lattice materials

General Scope:
Magnetic frustration, which results from a competition between interactions that cannot be simultaneously satisfied, often leads to unconventional spin states, such as complex magnetic orders or even liquid states (absence of long-range order) [1-2]. These unconventional magnetic states are thus the product of a compromise, but do not necessarily correspond to the lower energy state. Therefore, disturbing the magnetic system may allow to access possible hidden orders and to reveal the complex microscopic mechanisms involved.

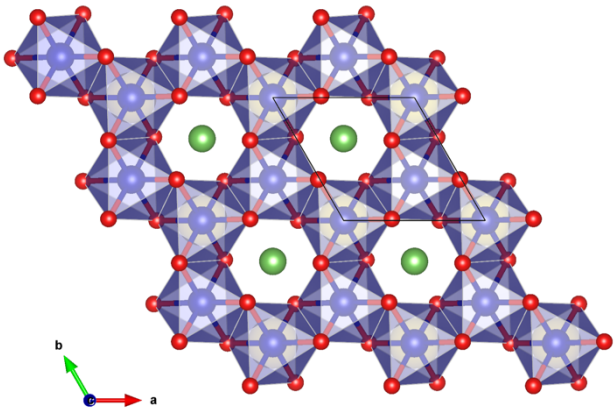

Fig.1: The honeycomb lattice formed by the magnetic ions represented in blue ($BaCo_2(AsO_4)_2$ compound).

Research topic and facilities available:
The material $BaCo_2(AsO_4)_2$ (which crystallographic structure is illustrated in figure 1) displays a very original magnetic order: the spin structure is intrinsically disordered while the crystal structure is perfectly ordered. This magnetic "order" is the consequence of a strong competition between several interactions.
The goal of this internship is to study a family of this compound, where some ions (cobalt and arsenic) are substituted with other elements (nickel, iron, vanadium) in order to disturb the established magnetic order and to reveal other possible hidden orders.
For this study, the student will perform physical characterization (magnetization, specific heat measurements) using the equipment available at Institut Néel, as well as complementary measurements using neutron diffraction, to study the magnetic structures. This part will be performed at the large-scale facility Institut Laue Langevin, located nearby.

Possible collaboration and networking:
The student will interact with several technical groups and platforms (crystal synthesis, magnetometry platform, X-ray diffraction) and the researchers from the MagSup group. He/She will be able to attend scientific seminars that are regularly organized in the institute. Moreover, this work will be in collaboration with the ILL and the student will be in strong interaction with the instrument scientists and will be able to familiarize with the neutron scattering technique.

Possible extension as a PhD: yes (funding not yet available)

Required skills: strong knowledge in solid state physics and magnetism

Starting date: Spring 2025

Contact:
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[1] « Spin liquids in frustrated magnets », L. Balents, Nature, vol. 464, 11 (2010)
[2] « Un nouveau liquide de spins quantique », Pour la Science (2021)