

Unconventional magnetism and new spin excitations in honeycomb-lattice materials

General Scope :

The Kitaev model [1] has been recently proposed to realize a new state of matter, the quantum spin liquid [2,3], which definition goes beyond the conventional Landau formalism. This magnetic state is characterized by a correlated disorder, i.e. the absence of a long-range magnetic order down to $T = 0\text{K}$ but the persistence of strong correlations between spins. For the first time, the Kitaev model proposes a solution for realizing a quantum spin liquid in a 2D system with a honeycomb lattice, and provides an exact theoretical framework to describe this system. Furthermore, the excitations associated to this quantum spin liquid display particular statistic properties that are currently generating a lot of interest for applications in quantum computation.

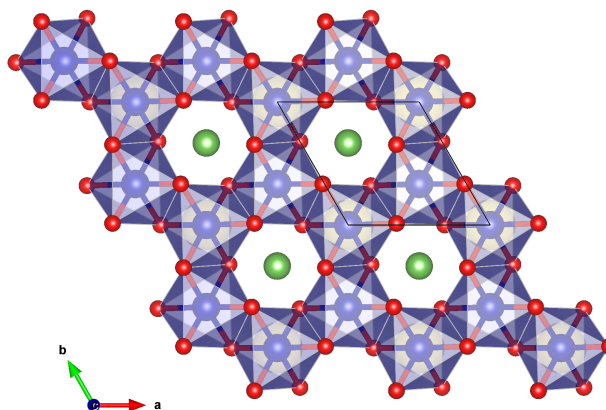


Fig.1 : The honeycomb lattice formed by the magnetic ions represented in blue ($\text{BaCo}_2(\text{AsO}_4)_2$ compound).

Research topic and facilities available :

It was recently suggested that this theoretical model can be experimentally realized in materials in which the magnetic ions host a large spin-orbit coupling and form a 2D honeycomb lattice. The goal of this internship is to study the structural and magnetic properties of a family of honeycomb-lattice compounds and check if these compounds display the necessary features to realize the Kitaev model.

The student will perform the physical characterization (magnetization, specific heat measurements) using the equipments available at Institut Néel, as well as complementary measurements using optical spectroscopy techniques (infra-red, THz, Raman) to study the dynamical properties of the compounds.

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.

Possible extension as a PhD : yes (funding already available)

Required skills: solid knowledge in solid state physics and magnetism

Starting date : Spring 2022

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[1] A. Kitaev, *Anyons in an exactly solved model and beyond*, Annals of Physics **321**, pp2-111 (2006)

[2] M. Mourigal, *The two faces of a magnetic honeycomb*, Nature **554**, pp 307-308 (2018)

[3] F. Alet, *Exotic quantum phases and phase transitions in correlated matter*, Physica A **369**, pp122-142 (2006)