LNCMI-Grenoble

NMR investigation of the BEC-type quantum spin systems

Master 2

Summary

Quantum spin systems are insulating crystals containing regular array of atoms carrying spin S = 1/2 or 1, which can be described by simple spin Hamiltonians. In low-dimensional model compounds we study by Nuclear Magnetic Resonance (NMR), which is a microscopic probe to magnetism, the magnetic-field-induced "exotic" phases, such as the Bose-Einstein condensate (BEC).

Detailed subject

Based on the microscopic information obtained from nuclear magnetic resonance (NMR) measurements, coupled to advanced theoretical numerical analysis, we aim at understanding of topical, magnetic-field-induced phenomena in antiferromagnetic quantum spin systems of the Bose-Einstein condensation (BEC) type.

Having so-far covered in great detail quasi-one dimensional materials such as spin ladders [1,2] and chains [3], we will now focus on two-dimensional model systems. We will investigate the $Ba_2CuSi_2O_6Cl_2$ spin-dimer compound, a new archetypal 2D system that has its BEC phase completely accessible to high-field NMR experiments, in the 13-28 T range.

The internship provides an introduction to the NMR technique and its application to study one BEC-type system. It involves all aspects of the work: preparation of experiments, NMR measurements, cryogenics, analysis of the results, numerical simulations, and will be performed in an internationally recognized research group. The investigation of the $Ba_2CuSi_2O_6Cl_2$ compound can also be recommended as an excellent subject for an experimental thesis, strongly coupled with theory.

Publications linked to the theme

[1] M. Jeong *et al.*, *Dichotomy between Attractive and Repulsive Tomonaga-Luttinger Liquids in Spin Ladders*, Phys. Rev. Lett. **117**, 106402 (2016), arXiv:1604.05252.
[2] M. Jeong *et al.*, *Magnetic-Order Crossover in Coupled Spin Ladders*, Phys. Rev. Lett. **118**, 167206 (2017), arXiv:1702.05273.
[3] Anna Orlova *et al.*, *Nuclear Magnetic Resonance Reveals Disordered Level-Crossing Physics in the Bose-Glass Regime of the Br-Doped* $Ni(Cl_{1-x}Br_x)_2$*-4SC*$(NH_2)_2$ *Compound at a High Magnetic Field*, Phys. Rev. Lett. **118**, 067203 (2017), arXiv:1607.02360.

Background and skills expected :

The candidate should be motivated for topical research in a high-level international laboratory and is expected to have a solid knowledge of solid state physics and quantum mechanics. Experimental skills and some knowledge of electronics and/or NMR technique will be an advantage.

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