

NMR investigation of the BEC-type quantum spin systems

Master 2

Summary (400 caractères maxi)

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 (1200 caractères maxi dont une figure possible)

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.

Examples are the determination of the high-field (upper) part of the phase diagram in the $(C_7H_{10}N)_2CuBr_4$ (DIMPY) compound, a unique strong-leg spin-ladder, or the investigation of a new, two-dimensional spin-dimer model system, the $Ba_2CuSi_2O_6Cl_2$ compound, having its BEC phase in the 13-28 T range, completely accessible to high-field experiments.

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

M. Jeong *et al.*, *Dichotomy between Attractive and Repulsive Tomonaga-Luttinger Liquids in Spin Ladders*, [Phys. Rev. Lett. 117, 106402 \(2016\)](#), [arXiv:1604.05252](#).

M. Jeong *et al.*, *Magnetic-Order Crossover in Coupled Spin Ladders*, [Phys. Rev. Lett. 118, 167206 \(2017\)](#), [arXiv:1702.05273](#).

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.

Supervisor : Mladen HORVATIC

Web-page: <http://lncmi-g.grenoble.cnrs.fr/spip.php?rubrique45>

E-mail: mladen.horvatic@lncmi.cnrs.fr

Tel : +33 (0)4 76 88 74 43