LNCMI-Grenoble

NMR investigation of the BEC-type quantum spin systems

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) and the Bose-glass state.

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 (QSS) of the Bose-Einstein condensation (BEC) type. We focus on the effect of impurities leading to localization and the Bose-glass phase; taking advantage of our previous NMR studies (see references below) of two archetypal BEC systems, $NiCl_2$-4SC$(NH_2)_2$ spin-1 chain called DTN and $(C_7H_{10}N)_2CuBr_4$ spin-1/2 ladder called DIMPY, we investigate the doped versions of these compounds. Exploiting NMR data on the distribution of local spin densities and the modification of spin fluctuations induced by doping, we want to describe the microscopic nature and the dynamical response of the Bose glass. This investigation is supported by our ANR project BOLODISS, Boson Localization in Disordered Spin Systems.

The internship provides an introduction to the NMR technique and its application to the study of 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 a group of several postdocs and permanent researchers. This is also 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.

- R. Blinder, *Etude par Résonance Magnétique Nucléaire de nouveaux états quantiques induits sous champ magnétique : condensation de Bose-Einstein dans le composé DTN*, Ph.D. thesis, Université Grenoble Alpes, 2015, https://tel.archives-ouvertes.fr/tel-01235600.

- R. Yu *et al.*, *Bose glass and Mott glass of quasiparticles in a doped quantum magnet*, Nature **489**, 379 (2012), arXiv:1109.4403.

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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