Unconventional Magnetism Seminars

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Emergence of a dimer physics in the Cairo frustrated pentagonal magnet $Bi_2Fe_4O_9$

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The Fe3+ ions in $Bi_2Fe_4O_9$ materialize the first analogue of a magnetic pentagonal lattice [1]. The unit cell contains two different sites of four iron atoms each, which have different connectivities with the other irons (three or four neighbours for Fe_1 and Fe_2 respectively), and that form a lattice of pentagons. Because of its odd number of bonds per elemental brick, this lattice is prone to geometric frustration. The compound magnetically orders around 240K: the resulting spin configuration on the two sites is the same, i.e. two orthogonal pairs of antiferromagnetic spins in a plane, with a global rotation between the two sites Fe_1 and Fe_2. This peculiar magnetic structure, which is the result of the complex connectivity and magnetic frustration, has opened new perspectives in the field of magnetic frustration.

In my talk, I will present some consequences of the frustrated and hierarchical magnetic interactions in this original system. First, magnetization distribution maps have been obtained using polarized neutrons under an applied magnetic field at the ILL. Remarkably, the magnetic moments of the Fe_1 sites, contrary to Fe_2, are extremely weakly polarized by the field both in the paramagnetic phase and in the ordered one. In order to understand this peculiar behaviour, the magnetic excitations have been investigated by inelastic neutron scattering using triple axis spectrometers at the LLB and the ILL. The confrontation of the experimental results with spinwave calculations allows to determine the Hamiltonian of the system and shows in particular that the Fe_1 forming the orthogonal pairs are coupled to each other by a strong antiferromagnetic exchange, thus materializing isolated singlet dimers in the paramagnetic state. Additionnally, we found in the ordered state a second type of frustrated dimers of parallel Fe_2 whose signature is a flat mode in the magnetic excitations.

[1] E. Ressouche, V. Simonet, B. Canals, M. Gospodinov, V. Skumryev, Phys. Rev. Lett. 103, 267204 (2009).