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Polarized neutron diffraction and anisotropic exchange in pyrochlores

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Rare earth frustrated pyrochlore magnets are among the materials that exhibit no long range order down to the lowest explored temperatures. To better understand the many complex phenomena observed in the pyrochlores, knowledge of the local interactions present in these materials is necessary. In the pyrochlore lattice, selection between Ising, Heisenberg, or XY types of the anisotropy cannot be based on the analysis of the macroscopic properties because of the presence of four equivalent local anisotropy (<111> - type) axes. Then only an average over the four axes can be measured by classical methods. Polarized neutron diffraction based on the 'site susceptibility approach' (A Gukasov and P. J. Brown, J. Phys.: Cond. Matt., 14, 8831, 2002) allows to determine the local susceptibility tensor on the magnetic site. Its temperature dependence in the paramagnetic phase can be accounted for by the crystal field anisotropy and a molecular field tensor that encompasses exchange and dipolar interactions. It was found that for rare earth pyrochlores an isotropic exchange model is not suitable to explain their magnetic behavior and that, instead, the exchange interaction appear anisotropic to large extent (H. Cao et al., PRL 103, 056402, 2009). The experimental evaluation of the anisotropic exchange in pyrochlores can provide a clue to the richness of the phase diagram observed in rare earth frustrated magnets.

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