

An x-ray spectroscopy study to determine the local Hamiltonian in a model antiferromagnet, the kagome system iron jarosite.

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In this talk I describe an experiment using polarised x-ray spectroscopy at the Fe $L_{2,3}$ edges to determine the local Hamiltonian in the geometrically frustrated magnetic insulator, iron jarosite $[\text{KFe}_3(\text{OH})_6(\text{SO}_4)_2]$. Despite the geometric frustration in jarosite which is an ideal model of a kagome antiferromagnet with $s = 5/2$ coupled by strong antiferromagnetic exchange, the spins freeze into a 120° spin structure at a 64 K, roughly $1/10^{\text{th}}$ of the Weiss temperature of -800 K. By a detailed comparison of the polarisation dependent x-ray absorption spectra with ligand-field multiplet calculations the ionic state of the Fe ions was determined as $+2.7$. The $1/3$ extra electron weight in the $3d^5$ shell due to anisotropic and mainly σ -type ligand-to-metal hybridisation allows for a finite orbital angular momentum to be induced by the spin orbit coupling. The strength of the resulting single-ion anisotropy is in agreement with values obtained from spin-wave analysis of neutron spectroscopy data. This confirms for the first time the origin of the magnetic anisotropy and magnetic ordering in iron jarosite. This result also illustrates the physical significance and interpretation of non-integer valencies in local moment systems.

References

M.A. de Vries et al., *Determination of the single-ion anisotropy energy in a $S = 5/2$ kagome antiferromagnet using x-ray absorption spectroscopy*. Phys. Rev. B **79**, 045102 (2009).

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