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Inelastic neutron scattering as a means for determining the magnetic exchange interactions in the frustrated quantum spin chain, Linarite.

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One of the simplest models exhibiting one dimensional (1D) frustrated quantum interactions is the so called J1-J2 model. In this model competing ferromagnetic nearest-neighbour interactions (J1>0) and antiferromagnetic next-nearest-neighbours (J2<0) can give rise to novel phenomena such as multiferroicity for spiral spin states. Linarite, PbCuSO¬4(OH)2 is a natural mineral ideally suited to the study of frustration in J1-J2 systems due to an accessible saturation field and the availability of large single crystals well suited to neutron investigations. In this material the Cu2+ ions form spin S = 1/2 chains along the b direction with dominant nearest-neighbour FM interactions and a weaker next-nearest-neighbour AFM coupling, resulting in a magnetically frustrated topology [1, 2].
We present a neutron scattering study of linarite revealing a helical magnetic ground state structure with an incommensurate propagation vector of (0 0.186 ½) below TN = 2.8K in zero magnetic field [3]. From detailed measurements in magnetic fields up to 12 T (B || b), a very rich magnetic phase diagram will be presented. In particular we will present new inelastic neutron scattering data and compare this with theoretical modelling of the spin Hamiltonian. These theoretical calculations imply that linarite possesses an xyz exchange anisotropy. Our data establish linarite as a model compound of the frustrated one-dimensional spin chain, with ferromagnetic nearest-neighbour and antiferromagnetic next-nearest-neighbour interactions.

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