Experimental report

10/05/2017

Proposal: **4-01-1528** **Council:** 4/2016

Title: Magnetic excitation spectrum in a chiral quantum magnet

Research area: Physics

This proposal is a new proposal

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Samples: Ba(TiO)Cu4(PO4)4

Instrument	Requested days	Allocated days	From	To
IN5	5	5	04/11/2016	09/11/2016

Abstract:

Preliminary bulk magnetisation and neutron scattering measurements show that Ba(TiO)Cu4(PO4)4 is a potentially exciting candidate for studies of low-dimensional magnetism. However, currently relatively little is known about the magnetic properties of this system. In this proposal we wish to examine the spin dynamics in single crystal samples of Ba(TiO)Cu4(PO4)4 using the IN5 spectrometer to determine the exchange interaction couplings whose knowledge will be essential for the development in the understanding of this and related systems.

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04-08.11.16

4-01-1528 : Magnetic excitation spectrum in a chiral quantum magnet

Low-dimensional quantum magnets are of great fundamental importance due to strong quantum fluctuations which can produce novel quantum excitations and ground states. The 2D quantum (S = 1/2) Heisenberg antiferromagnet on a square lattice (2DQHAFSL) is one of the canonical interacting quantum systems. Its 1D analogue is known to be quantum disordered even at T = 0, while the weight of evidence for the 2DQHAFSL is that ordering tendencies just overcome the effects of quantum fluctuations leading to a long-range ordered ground state. The family $A(bO)Cu_4(PO_4)_4$ is a very promising candidate to study novel quantum magnetism. Indeed, substitution of the A^{2+} cation controls the strength of the structural chirality in this family and shows a dramatic change in the magnetic interactions. Here, we performed a full mapping of the excitations of *A*=Ba, *b*=Ti (a.k.a. BaTi) at zero field.

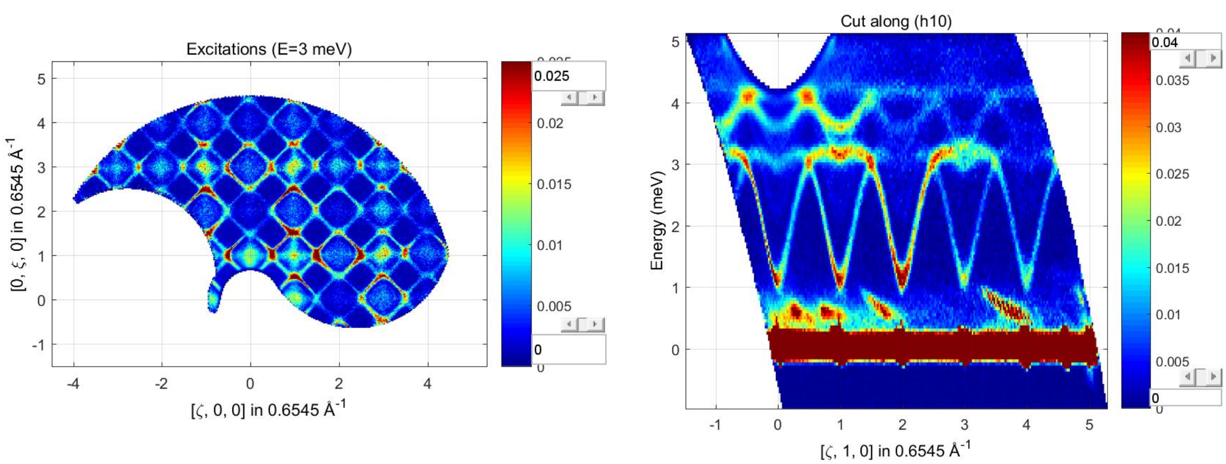

Figure 1 : (left) Q-space mapping of the excitations of BaTi at E=3 meV and (right) dispersion modes along a high symmetry axis.

For the experiment three high-quality single-crystals of BaTi were coaligned with a total mass of 2.5 g. Large portion of reciprocal space was mapped out at high resolution by rotating the sample at 5 K. On cooling below the transition temperature (T_N = 9.6 K) we observed spin-wave excitations between 1 and 4 meV. Figure 1 shows some of the nice data that was obtained using the IN5 spectrometer. Rather unexpectedly we found significant dispersion between 3 and 4 meV. Measurements with higher incident neutron energies did not reveal the presence of any additional modes at higher energy transfers. The presence of a 1 meV energy gap probably results from an anisotropy such as a D-M interaction.

A quantitative model describing the system is currently being developed. Our wish is now to perform several measurements on other compounds from the same chiral magnet family (PbTi, KNb, SrTi, BaV) in order to further develop our understanding of this intriguing family of compounds.

References : K. Kimura, M. Sera and T. Kimura, *Inorg. Chem.* **55(3)**, 1002 (2016)

K. Kimura *et al.*, *Nat. Comm*. **7**, 13039 (2016)

Y. Kato *et al.*, *Phys. Rev. Lett.* **118,** 107601 (2017)