Experimental report

09/04/2018

Proposal: **TEST-2844** **Council:** 4/2018

Title: Magnetic excitations in a trigonalspin-1/2 antiferromagnet

Research area:

This proposal is a new proposal

Main proposer: **Irina SAFIULINA**

Experimental team: Irina SAFIULINA

Local contacts: Bjorn FAK

Samples: $CuSb_2O_6$

Instrument	Requested days	Allocated days	From	To
IN4	2	2	27/03/2018	29/03/2018

Abstract:

Experimental report TEST-2844 – Magnetic excitations in a trigonal spin-1/2 antiferromagnet

I. Safiulina, M. Enderle, B. Fåk
Institut Laue-Langevin, France

Scientific context

MSb_2O_6 (M=Co, Ni, Cu, Zn and Mg) usually crystallize in the tetragonal trirutile form[1], $CuSb_2O_6$ slightly distorts into a monoclinic structure due to the Jahn-Teller effect. We have synthesized MSb_2O_6 in a new structure, the rosiaite ($PbSb_2O_6$) structure, space group P-31m. In this structure magnetic cations are arranged in trigonal layers. In M=Co and Ni these layers antiferromagnetically order at low temperatures (11K and 15K respectively), forming spin-frustrated triangles. Neutron diffraction studies confirm the rosiaite-type structure for $CuSb_2O_6$ as well (magnetic cations Cu^{2+}). Lattice constants of CuSb2O6 are a=b=5.054(4) Å, c=4.5881(10) Å[2]. The triangular antiferromagnetic (AF) Heisenberg model is a typical example of two-dimensional geometrically frustrated magnets. With only AF nearest-neighbor interaction the ground state of this system is the three-sublattice 120° structure, which is commensurate to the underlying lattice. With further-neighbor interactions spin liquid or skyrmion phases can be realized[3,4,5]. The absence of long-range order, the isotropy of the Cu^{2+}, the presence of sizable antiferromagnetic interactions in $CuSb_2O_6$[2] could imply a quantum (S=1/2) spin liquid scenario.

Experiment details

We performed a test experiment on IN4 from the 27th to 29th of March 2018 with the aim to identify the energy scale of the magnetic excitations. We used Orange Cryostat reaching a base temperature of 1.5K. We used E_i=67.6 meV and 16.6 meV. We had a powder sample of 3.5g wrapped in Al foil.

Conclusion

With E_i=16.6 meV, we have performed measurements at the base temperature 1.5K and at the 25K – below and above the temperature where the deviation of the susceptibility from the Curie-Weiss law is the most visible. The figure shows the inelastic neutron spectrum obtained by subtracting the 25K spectrum from the 1.5K spectrum. The difference spectrum displays excitations at momentum $\leq 1\AA^{-1}$ reaching out to about 6 meV. This confirms that IN5 would be ideally suited to investigate the magnetic excitations of rosiaite-$CuSb_2O_6$. A larger amount of sample will be prepared for a cold TOF-experiment.

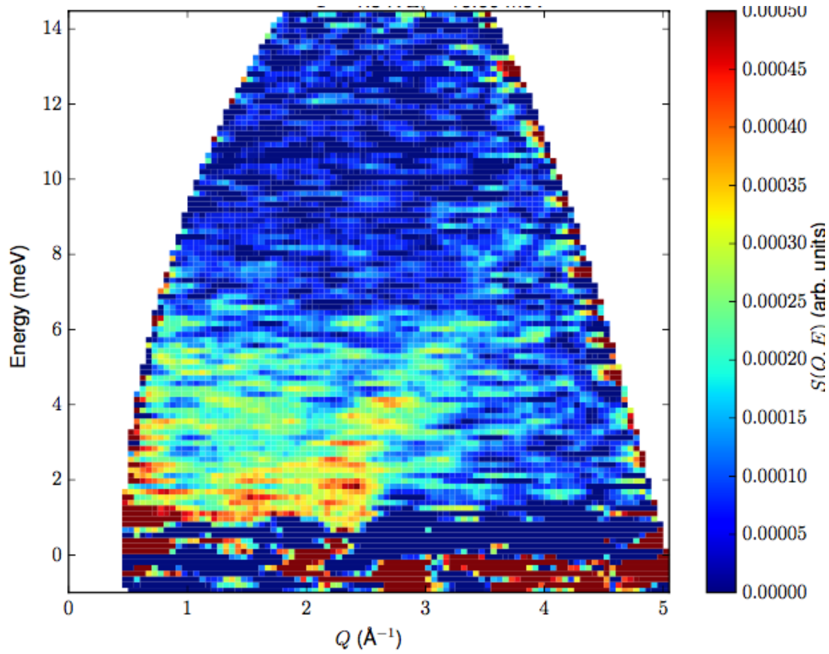

FIG. 1: IN4 inelastic neutron spectrum of rosiaite-$CuSb_2O_6$ obtained by subtracting 25K inelastic spectrum from 1.5K inelastic spectrum at E_i=16.6 meV.

References

[1] Baur, W. H. (2007). The rutile type and its derivatives. Crystallography Reviews, 13(1), 65-113.

[2] Nikulin, A. Y., Zvereva, E. A., Nalbandyan, V. B., Shukaev, I. L., Kurbakov, A. I., Kuchugura, M. D., ... Vasiliev, A. N. (2017). Preparation and characterization of metastable trigonal layered MSb2O6 phases (M= Co, Ni, Cu, Zn, and Mg) and considerations on FeSb2O6. Dalton Transactions, 46(18), 6059-6068.

[3] Kuobo, T., Chung S., Kawaruma H. (2012). Multiple-q states and the Skyrmion lattice of the triangular-lattice Heisenberg antiferromagner under magnetic fields. Physical Review Letters 108, 017206

[4] Li, Peggy HY, Raymond F. Bishop, and Charles E. Campbell. (2015). Quasiclassical magnetic order and its loss in a spin-1/2 Heisenberg antiferromagnet on a triangular lattice with competing bonds. Physical Review B 91.1, 014426.

[5] Rosales, H. D., D. C. Cabra, and Pierre Pujol. (2015). Three-sublattice skyrmion crystal in the antiferromagnetic triangular lattice. Physical Review B 92.21, 214439.