Experimental report

19/08/2022

Proposal: DIR-258 **Council:** 4/2021

Title: The néel phase in the shastry-sutherland compound SrCu2(BO3)2

Research area:

This proposal is a continuation of 4-01-1655

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Local contacts: Andrea PIOVANO

Samples: SrCu2(BO3)2

Instrument	Requested days	Allocated days	From	To
IN3	7	7	02/09/2021	09/09/2021

Abstract:

The Néel phase in the Shastry-Sutherland compound, $SrCu_2(BO_3)_2$

Proposal no: DIR-258
Instrument: IN3 (7 days)
Experiment team: Gaétan Giriat and Ellen Fogh (École Polytechnique Fédérale de Lausanne)
Local contacts: Andrea Piovano, Martin Boehm

The Shastry-Sutherland (SS) lattice consists of spin pairs (dimers) embedded in a square lattice (see Fig. 1a) and with inter-dimer coupling, J, and intra-dimer coupling J'. It has an exact dimer product ground state for J'/J ≤ 0.675 [1]. Upon increasing the ratio of J'/J, the system goes through a quantum phase transition to a plaquette singlet state followed by a transition to a Néel phase [2]. $SrCu_2(BO_3)_2$ (SCBO) is a unique material since it is topologically equivalent to the SS lattice [3]. With J'/J ~ 0.6 close to the critical point, SCBO presents remarkable experimental testing grounds for the SS model. The ratio J'/J may be tuned by applying pressure and the resulting phase diagram resembles that theoretically predicted for the SS model [4] (see Fig 1b).

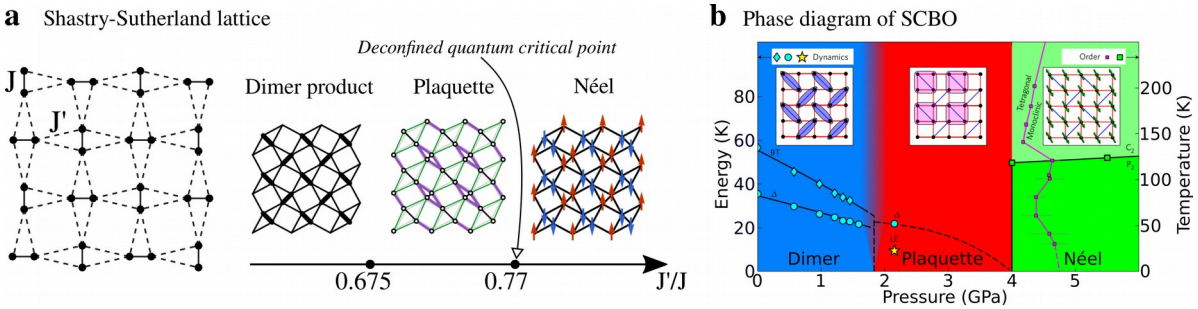

Figure 1: *(a) Illustrations of the SS lattice and the theoretically predicted phase diagram as a function of J'/J [5] (b) Measured phase diagram for SCBO as a function of applied pressure [4].*

In a previous experiment (proposal no. 4-01-1655) we measured magnetic excitations in the Néel phases at 5.5GPa and the current experiment was performed at IN3 to collect supporting diffraction data. The sample was a 60mg single crystal of SCBO in a Paris-Edinburgh pressure cell loaded first to 5.5GPa. The crystal was oriented with (HK0) in the horizontal scattering plane. We collected a selection of magnetic Bragg peaks at different temperatures (Fig. 2) as well as measuring Bragg peak intensity of the (0,1,0) reflection as a function of temperature (Fig. 3).

In summary, we succeeded in obtaining supporting diffraction data for our inelastic neutron scattering data in the Néel phase of SCBO. It shows that we are indeed in the antiferromagnetic phase and will help us in the modeling of the spectra.

[1] B. S. Shastry and B. Sutherland, Physica **108B**, 1069-1070 (1981)
[2] A. Koga and N. Kawakami, Phys. Rev. Lett. **84**, 4461–4464 (2000)
[3] S. Miyahara and K. Ueda, Phys. Rev. Lett. **82**, 3701 (1999)
[4] M. E. Zayed et al. Nature Physics **13**, 962 EP (2017)

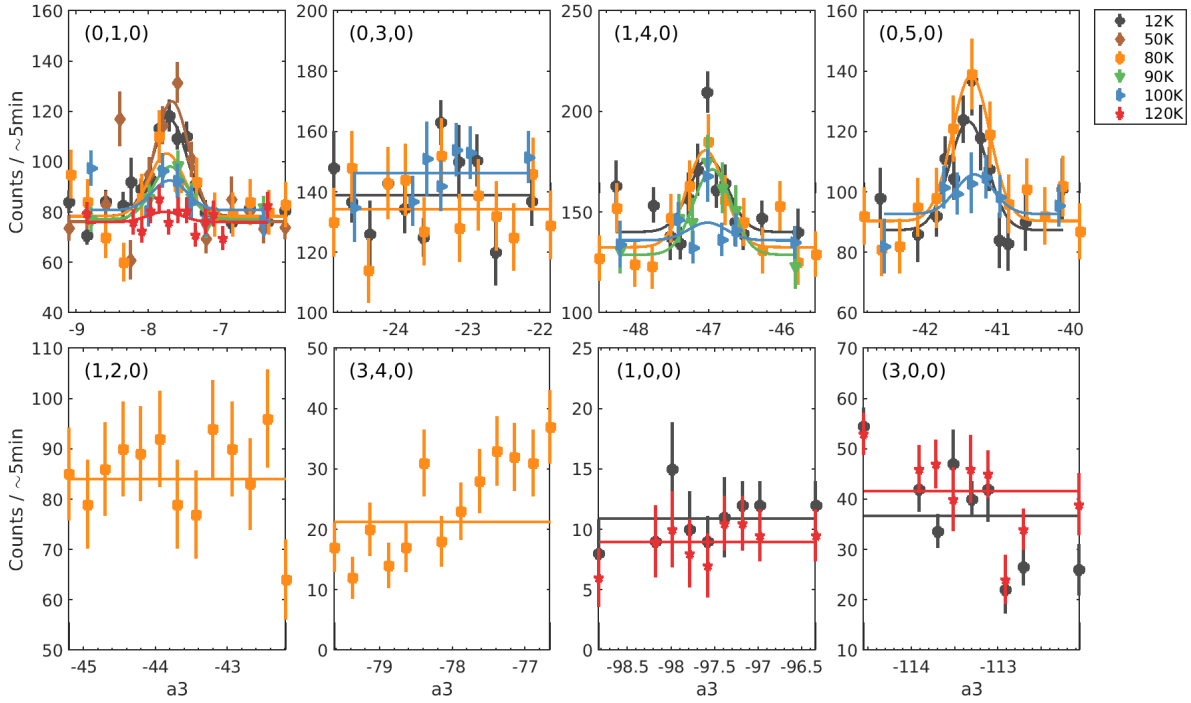

Figure 2: *a3 scans of various magnetic Bragg peaks at selected temperatures and 5.5GPa.*

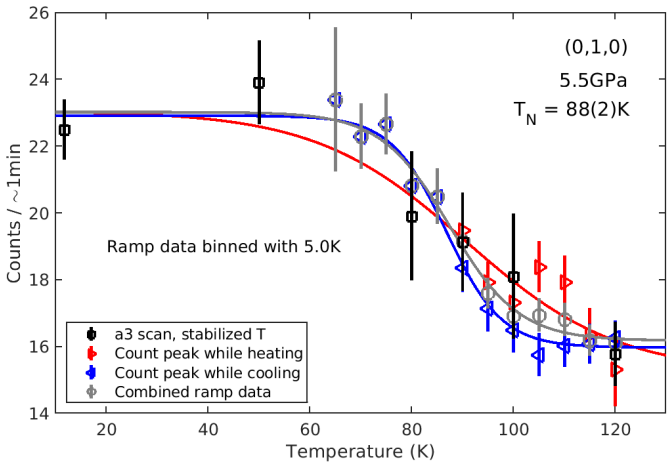

Figure 3: *Temperature dependence of the (0,1,0) intensity. The transition is around 90K.*