Experimental report

13/09/2019

Proposal: CRG-2577 **Council:** 10/2018

Title: Spin dynamics in a strongly frustrated quantum magnet

Research area: Physics

This proposal is a new proposal

Main proposer: Vivek BHARTIYA

Experimental team: Severian GVASALIYA
Kirill POVAROV
Florian LANDOLT
Vivek BHARTIYA

Local contacts: Stephane RAYMOND

Samples: BaCdVO(PO4)2

Instrument	Requested days	Allocated days	From	To
IN12	6	6	08/07/2019	14/07/2019
IN3	1	1	08/07/2019	09/07/2019

Abstract:

Theory suggests that J1-J2 square lattice strongly frustrated magnets hosts a spin-nematic state- an exotic quantum phase- in an applied magnetic field. In order to realize this exotic phase, BaCd(VO)(PO4)2 is proposed as the best known realization of a J1-J2 square lattice model. We have successfully synthesized single crystals of BaCd(VO)(PO4)2 isotopically enriched in Cd114 to above 98%. In house bulk measurements on this compound indeed show a new emerging phase- potentially spin nematic. The outcomes of these measurements also indicates that the Hamiltonian of the system is not simply of a square lattice. In this proposed study at ThALES, we want to study zero field dispersion relation to understand ground state properties of this system.

Experimental report for CRG-2577

V. K. Bhartiya, K. Yu. Povarov, Z. Yan, A. Zheludev
Neutron Scattering and Magnetism Group, ETH Zürich, Switzerland

The purpose of this experiment was to measure the underlying Hamiltonian of a geometrically frustrated ferro-antiferro square lattice quantum magnet $BaCdVO(PO_4)_2$. Despite the difficulties from, moderate sample mass $\sim$ 300 mg, neutron absorption even in 114Cd enriched compound, $\sim 10^\circ$ mosaic of two co-aligned crystals, we fulfilled the purpose of the proposed experiment to measure spin waves (Fig.1) in the *only* single crystals of $BaCdVO(PO_4)_2$ in the world. These results (V. K. Bhartiya *et al.*, arXiv:1908.01734 (2019)) have already been submitted for publication.

The measured spin waves in the fully polarized state as shown in Fig. 1(b) turned out to be incompatible with the previously thought $J_1 - J_2$ square lattice Hamiltonian. The reason behind this was revealed with the help of a diffraction experiment, it was discovered that the $BaCdVO(PO_4)_2$ goes through a crystal phase transition at 250 K leading to a more complicated Hamiltonian. To estimate this Hamiltonian, a linear spin wave theory fit to the observed intensities requires 4 nn and 4 nnn exchange constants as shown in Fig. 1(b). However it is not possible to uniquely determine 8 different parameters with just three scans along [100], [010], and [110]. Therefore, we need to measure other symmetry inequivalent directions.

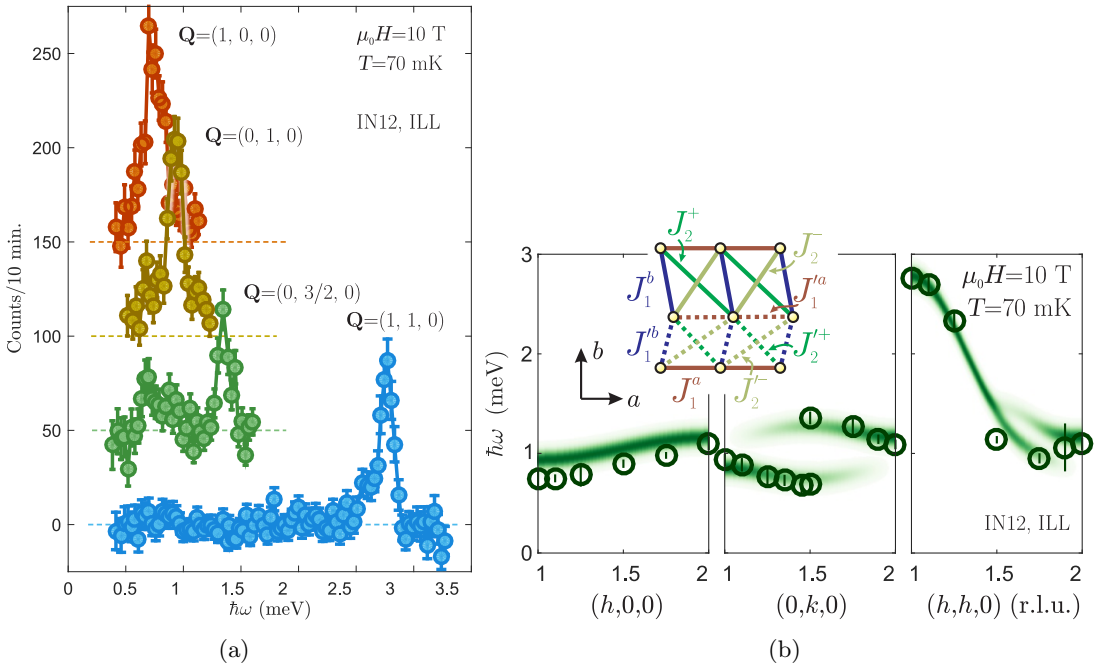

Figure 1: (a) A few representative constant$-Q$ scans taken at CRG-IN12. (b) Spin wave spectra of the fully polarized (H = 10 T) $BaCdVO(PO_4)_2$ single crystals. Symbols are experimental data, the shading in the background shows the intensities from the linear spin wave theory. Inset: schematic of symmetry-allowed Heisenberg exchange interactions in the $P_{ca}2_1$ structural phase of $BaCdVO(PO_4)_2$.