Experimental report

25/11/2016

Proposal: **4-01-1381** **Council:** 4/2014

Title: Ground state and excitations in the highly frustrated 2D square lattice magnet $PbVO_3$

Research area: Physics

This proposal is a new proposal

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Samples: $PbVO_3$

Instrument	Requested days	Allocated days	From	To
IN6	0	2		
IN4	5	5	05/05/2015	10/05/2015
D20	2	2	24/11/2014	26/11/2014

Abstract:

The J1-J2 model on the square lattice has attracted considerable attention due to many interesting phases emerging as a result of a simple model, including spin-liquid and spin-nematic regimes. We have previously extended the J1-J2 phase diagram by measuring the first-ever frustrated ferromagnets. Here, we are focusing on the theoretically proposed spin-liquid (SL) regime, with no compounds ever measured. There is strong evidence that $PbVO_3$ lies inside (or extremely close) to this SL region. Experiments have been so far hindered due to the problems of insufficient sample size and quality that we have recently been able to overcome. We therefore propose to measure the system on D20, in order to resolve the nature of the ground state, which remains controversial so far. Furthermore, we propose to measure the excitation spectrum and probe quantum fluctuations in $PbVO_3$ on IN4C, which ideally matches the energy scale of this system (~20meV). Theory predicts a gapped excitation spectrum for the SL phase on the square lattice.

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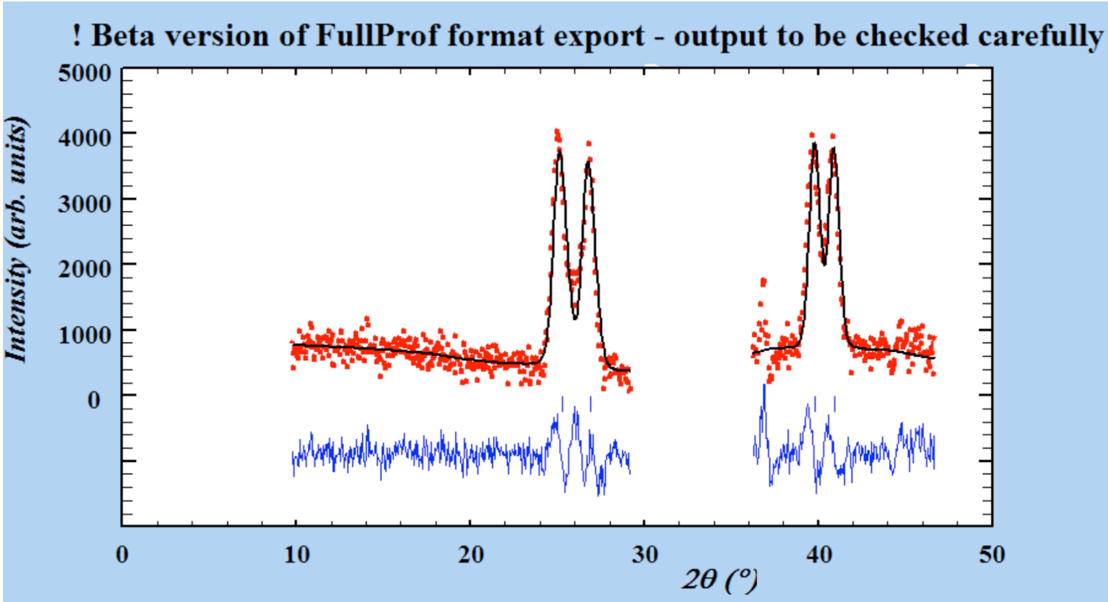
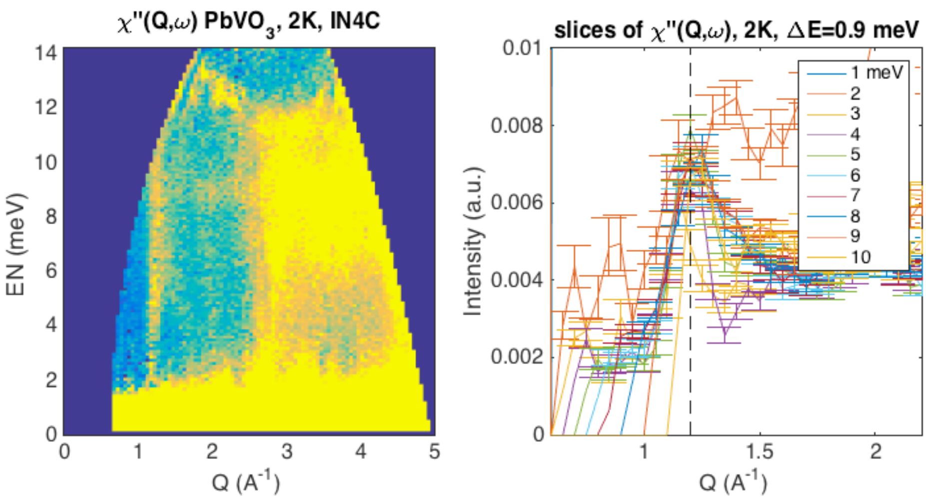
This experiment shed light on the spin structure of $PbVO_3$, since so far it was not clear if it orders or not. Due to previous literature samples having large amounts of impurities, the ordering was not decisive: it could come intrinsically from the sample, extrinsically from impurities or not at all. We were able to unambiguously prove that the sample orders and also uniquely solve the magnetic structure. The graph below shows 4 incommensurate peaks indexed with a propagation vector of k=(0.531 0.5 0).



We could also measure inelastic spectra where a magnetic signal at Q=1.2 $Å^{-1}$ is identified. Further, some of the signal (at higher Q) is proved to be phononic in nature, due to the temperature dependence (not shown here).



Overall we could solve key-questions of this sample, even in the absence of single crystals. One of the reasons is due to the simplicity of the J_1-J_2 system Hamiltonian.