Experimental report

10/09/2022

Proposal: **5-32-929**

Council: 4/2021

Title: Emergent degrees of freedom in a nearly isolated s=1/2 triangular system KBa3Ca4Cu3V7O28

Research area: Physics

This proposal is a continuation of 5-32-868

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Samples: KBa3Ca4Cu3V7O28

Instrument	Requested days	Allocated days	From	To
D7	8	8	02/07/2021	10/07/2021

Abstract:

KBa3Ca4Cu3V7O28 provides a nice example of quasi-isolated spin 1/2 equilateral triangles, arranged on a triangular lattice and forming a breathing-kagomé network. According to a recent NMR study, the intradimer exchange interaction yields two quadruplet states separated by about 20-30 meV. Effective degrees of freedom, formed by the lowest energy quadruplet, are thus a collection of two effective spin ½ coming in two flavors and corresponding to left and right chiralities. Preliminary measurements indicate the presence of ferromagnetic-like correlations, which decrease with decreasing temperature, almost vanishing in the 1-10 K range, and increasing again but centered at Q = 0.55 Å-1 at dilution temperature. We think this intriguing evolution signals the formation of those emergent degrees of freedom. We would like to tackle this issue at D7.

Exp report 5-32-929 : magnetic diffuse scattering in $KBa_3Ca_4Cu_3V_7O_{28}$

Context

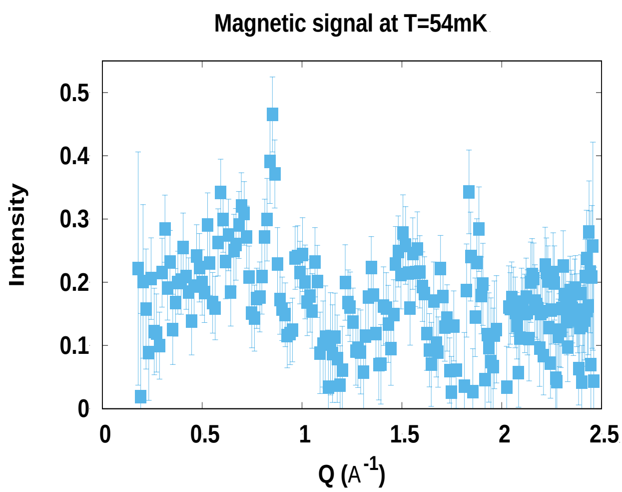
Following a previous D7 experiment (5-32-868), further diffuse neutron scattering have been performed again on D7 (5-32-929) to look for magnetic short-range correlations in $KBa_3Ca_4Cu_3V_7O_{28}$, this time with twice as much sample. 12 grams of powder sample were loaded in a double-wall Cu can.

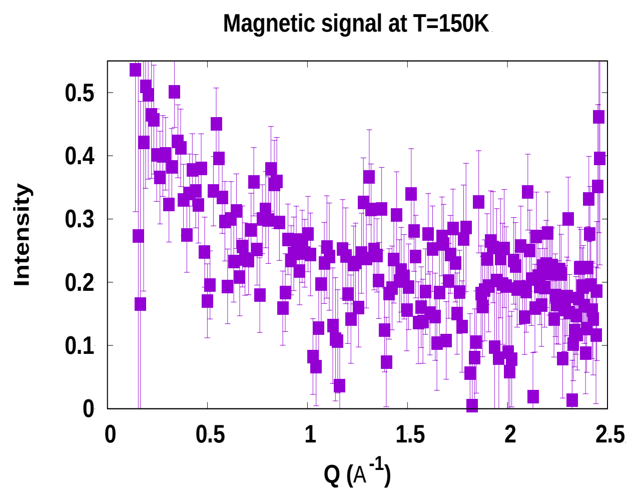
Other related experiments: IN5 (EASY-397 and 4-05-834), IN6 (CRG-2676), and Panther (4-05-816).

Results

We performed measurements with the wavelength $\lambda = 4.8$ Å. As for the previous experiment, we were able to separate the magnetic, nuclear, and incoherent contributions, D7 being equipped with permanent polarization analysis (Z, X, Y)/(SF, NSF). We collected data at 54 mK, 5 K, 100 K, and 150 K, using a dilution insert. Finally, the usual calibration measurements (vanadium, quartz, and backgrounds) have been realised.

The following figures present the magnetic scattering at T = 54 mK (left), and at T = 150 K (right).

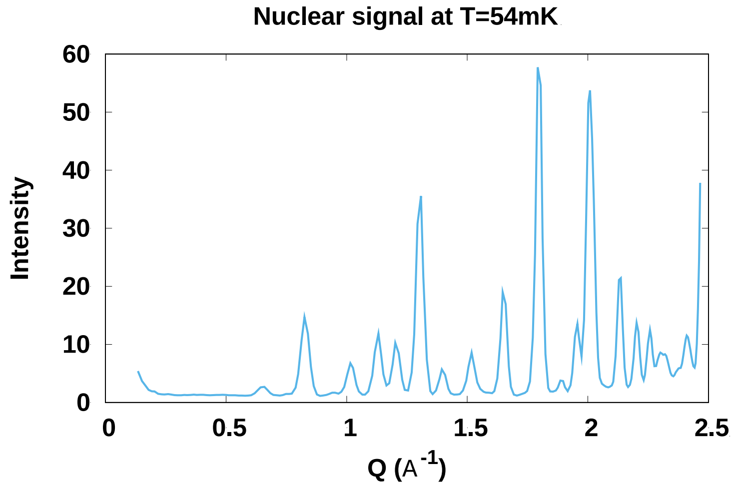




Our data at low temperature suggest there is a broad bump-like magnetic signal around $Q \sim 0.5 - 0.7$ Å^{-1} whereas at high temperature, the signal appears to be paramagnetic-like.

When extracting the magnetic signal, one can afford not applying any background correction, since the method already takes into account a self-subtraction of the background (assuming it is the same in all the three orthogonal directions). It has the advantage to give better statistics. This method, plus the fact we have twice as much sample, improve our data quality compared to the previous experiment.

Nevertheless, one can observe 'peaks' in the magnetic signal, at positions where there are rather strong Bragg peaks (see figure below, particularly around $Q \sim 0.7$ Å^{-1}). These defects are probably due to a leakage from the nuclear scattering.



The following figure shows the magnetic scattering again, but with all the 4 temperatures on the same plot. The bump-like feature gradually disappears towards a paramagnetic-like shape when increasing temperature.