Experimental report

23/10/2020

Proposal: EASY-397 **Council:** 4/2019

Title: Inelastic neutron scattering studyof a nearly isolated s=1/2 triangular system KBa3Ca4Cu3V7O28

Research area: Physics

This proposal is a new proposal

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Samples: KBa3Ca4Cu3V7O28

Instrument	Requested days	Allocated days	From	To
IN5	24	24	30/09/2019	01/10/2019

Abstract:

KBa3Ca4Cu3V7O28 provides a nice example of quasi-isolated spin 1/2 equilateral triangles, showing magnetic short range ordering at very low temperature. From an NMR study, the intradimer exchange interaction would yield two quadruplets states separated by about 20-30 meV, while the lowest quadruplet would be splitted in two doublets due to a Dzyaloshinskii-Moriya interaction of about 0.1 meV. As a result, the magnetic short range ordering would correspond to a chiral spin configuration below the corresponding temperature of about 1.1 K. Two related proposals have been submitted in the Autumn 2018 proposal round to study both the magnetic short range correlations on D7 (5-32-868) and the low energy magnetic excitations on IN6-Sharp (4-05-736). The former was accepted but not the latter. Nevertheless, the subcommittee members of college 4 have strongly advised us to submit an EASY proposal on IN5, in order to first check the energy range of interest, hence this submission.

Scientific context

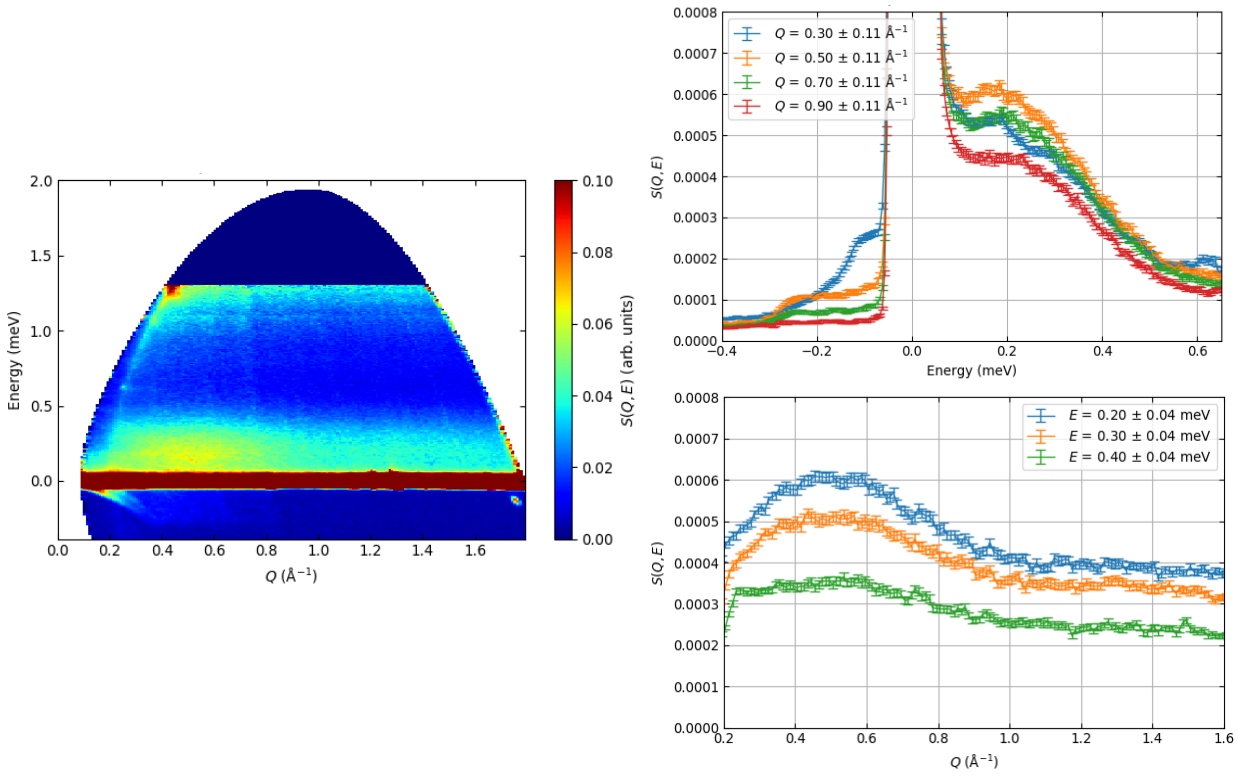
$KBa_3Ca_4Cu_3V_7O_{28}$ provides a nice example of quasi-isolated spin 1/2 equilateral triangles, showing magnetic short-range ordering at very low temperature. From an NMR study, the intradimer exchange interaction would yield two quadruplets states separated by about 15-30 meV, while the lowest quadruplet would be split in two doublets due to a Dzyaloshinskii-Moriya interaction of about 0.1 meV. As a result, the magnetic short range ordering would correspond to a chiral spin configuration below the corresponding temperature of about 1.1 K.

Two inelastic neutron scattering experiments have been performed, on IN5 (EASY-397) and IN6 (CRG-2676), in order to probe the low energy magnetic excitations.

Note that another experiment on D7 (5-32-868) has also been performed to look for magnetic short-range correlations.

Experimental results

The present report concerns the measurements on IN5. We mainly worked at base temperature (around 70 mK) using a dilution insert. We were able to work with different wavelengths: λ = 1.5, 4.8, 6.5, 8, and 10 Å, for different resolutions. It turns out that the results obtained with λ = 6.5 Å are the most promising. We thus focus on these data in this report. The following figures show our results in these conditions for 20 grams of $KBa_3Ca_4Cu_3V_7O_{28}$ powder sample.



The $S(Q,E)$ map on the left suggests the existence of a signal at low Q and at low E, which is further detailed in the figures on the right.

The top right figure shows $S(Q,E)$ as a function of E for the following fixed values of Q: 0.3, 0.5, 0.7, and 0.9 Å^{-1}. Remarkably, one can see a maximum of intensity around 0.2 meV, very close to the energy at which the lowest quadruplet is expected to split in two doublets, because of the Dzyaloshinskii-Moriya interaction. Fits of these $S(Q,E)$ curves are now in progress, in order to determine whether this signal is inelastic (i.e. gapped) or quasielastic.

The bottom right figure shows $S(Q,E)$ as a function of Q for E = 0.2, 0.3, and 0.4 meV. The signal appears to be stronger around Q = 0.5 Å^{-1} and seems to disappear above 1 Å^{-1}. This observation is in good agreement with the results obtained on IN6 (CRG-2676).

To conclude, our results indicate the presence of a -potentially gapped magnetic- excitation around 0.2 meV in the low Q region ($Q < 1$ Å^{-1}).