Experimental report

23/10/2020

Proposal: CRG-2676 **Council:** 4/2019

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

Research area:

This proposal is a new proposal

Main proposer: Beatrice GRENIER

Experimental team: Lucile MANGIN-THRO
Beatrice GRENIER
Virginie SIMONET
Yuji INAGAKI

Local contacts: Sylvain PETIT
Jean Marc ZANOTTI

Samples: KBa3Ca4Cu3V7O28

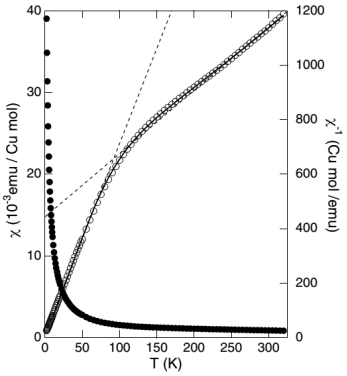
Instrument	Requested days	Allocated days	From	To
IN6-SHARP	3	3	23/09/2019	26/09/2019

Abstract:

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.

Its magnetic susceptibility χ is shown in the opposite figure (closed circles). Its inverse (open circles) shows an abrupt kink at $T \sim 100$ K, between two different linear temperature dependences for $\chi^{-1}(T)$, with a factor 3 between their slopes. This result suggests the formation, below this temperature, of a quantum superposition of states with a spin singlet in each Cu^{2+} triangle, due to an exchange interaction $J/k_B \sim 100 - 200$ K. In addition, no magnetic ordering was observed down to 50 mK by specific heat measurements.



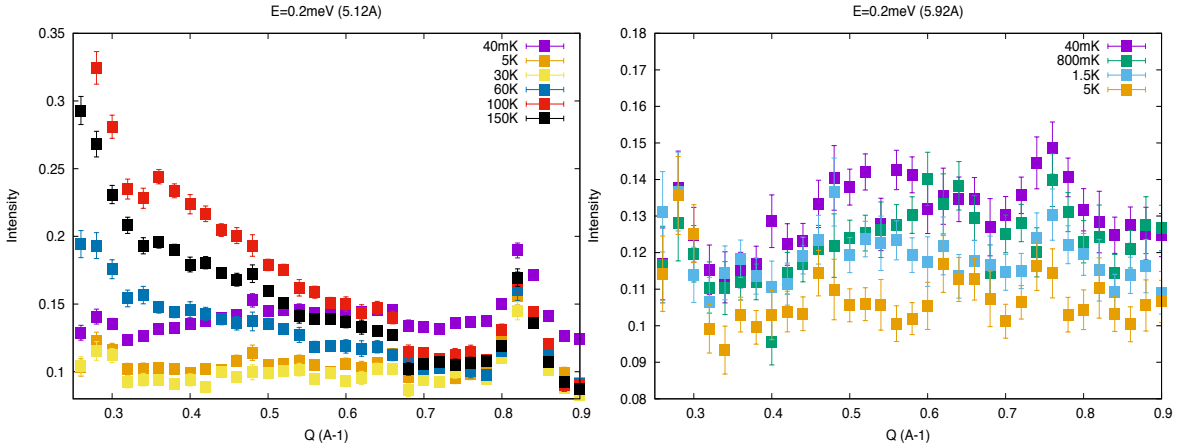
From an NMR study, the intradimer exchange interaction would yield two quadruplets states separated by about 15-30 meV, while the lowest quadruplet would be split in two doublets due to a Dzyaloshinskii-Moriya interaction of about 0.1 meV. As a result, the magnetic short-range ordering would correspond 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. On IN5, only the low temperature has been studied, with several resolutions, while on IN6, the three following temperature regions were explored: below ~ 1 K, between ~1 K and ~ 100 K, then above ~100 K.

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 experiment on IN6. We performed measurements with the wavelengths λ = 5.12 and 5.92 Å. For the first one we were able to work at 40 mK, 5 K, 30 K, 60 K, 100 K, and 150 K, and for the second one we worked at 40 mK, 800 mK, 1.5 K, and 5 K. The following figures show our results for 20 grams of $KBa_3Ca_4Cu_3V_7O_{28}$ powder sample.



Both figures show the intensity as a function of Q for $E = 0.2$ meV at all measured temperatures, for $\lambda = 5.12$ Å (left) and $\lambda = 5.92$ Å (right).

They exhibit a magnetic excitation appearing at base temperature (40 mK) and low Q ($Q < 0.7$ Å^{-1}), with a maximum intensity around $Q = 0.5$ Å^{-1}. These observations are particularly supported by the experiment performed on IN5 (EASY-397).

When heating up, this excitation completely disappears then, from 60 K, a signal with a different shape arises in the same Q-region (see left figure). It is no longer centred around $Q = 0.5$ Å^{-1} but its intensity increases as Q decreases. Note that its magnitude is the highest at 100 K, corresponding to the temperature at which the inverse susceptibility shows a kink.

These changes of behaviour seem to correspond to the two particular temperatures mentioned above: ~ 1 K and ~ 100 K. Nevertheless, further analysis needs to be carried out to establish the nature of this excitation in each of the two temperature regimes.

Note that the sharp signal appearing around $Q \sim 0.8$ Å^{-1} is nearly temperature-independent and is thus probably a spurious.