Experimental report

10/09/2022

Proposal:	**4-05-834**	**Council:**	4/2021

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: KBaCaCuVO

Instrument	Requested days	Allocated days	From	To
IN5	3	3	13/09/2021	16/09/2021

Abstract:

KBa3Ca4Cu3V7O28 provides a nice example of quasi-isolated spin 1/2 equilateral triangles, arranged on a triangular lattice and forming a breathing-kagome 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 rise of another low energy scale, of about 1 K, with signatures in NMR, specific heat and magnetic correlations (measured at IN5 and IN6-SHARP). A large signal is observed at about 0.1 meV. The present proposal now consists in measuring those magnetic excitations with the best energy resolution available only at IN5, and at the lowest temperature to fully describe this spectrum and especially check the opening of a spin gap.

Exp report 4-05-834 : Spin dynamics in $KBa_3Ca_4Cu_3V_7O_{28}$

Context

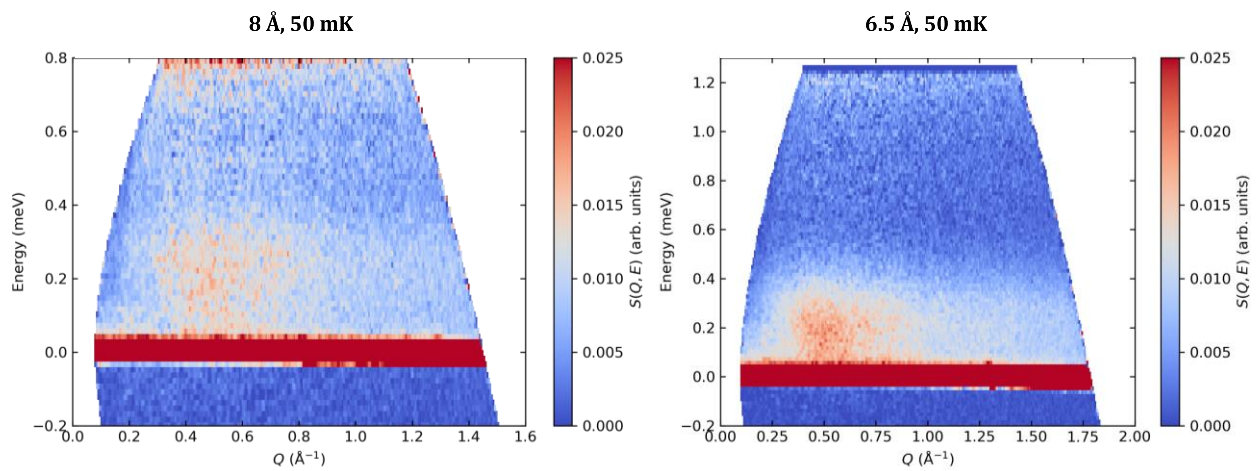
Following a previous IN5 experiment (EASY-397), further inelastic neutron scattering measurements have been performed again on IN5 (4-05-834) to probe the low-energy magnetic excitations in $KBa_3Ca_4Cu_3V_7O_{28}$, this time as a function of temperature. Approximately 6 grams of powder sample were loaded in a double-wall Cu can.

Other related experiments: D7 (5-32-868 and 5-32-929), Panther (4-05-816) and IN6 (CRG-2676).

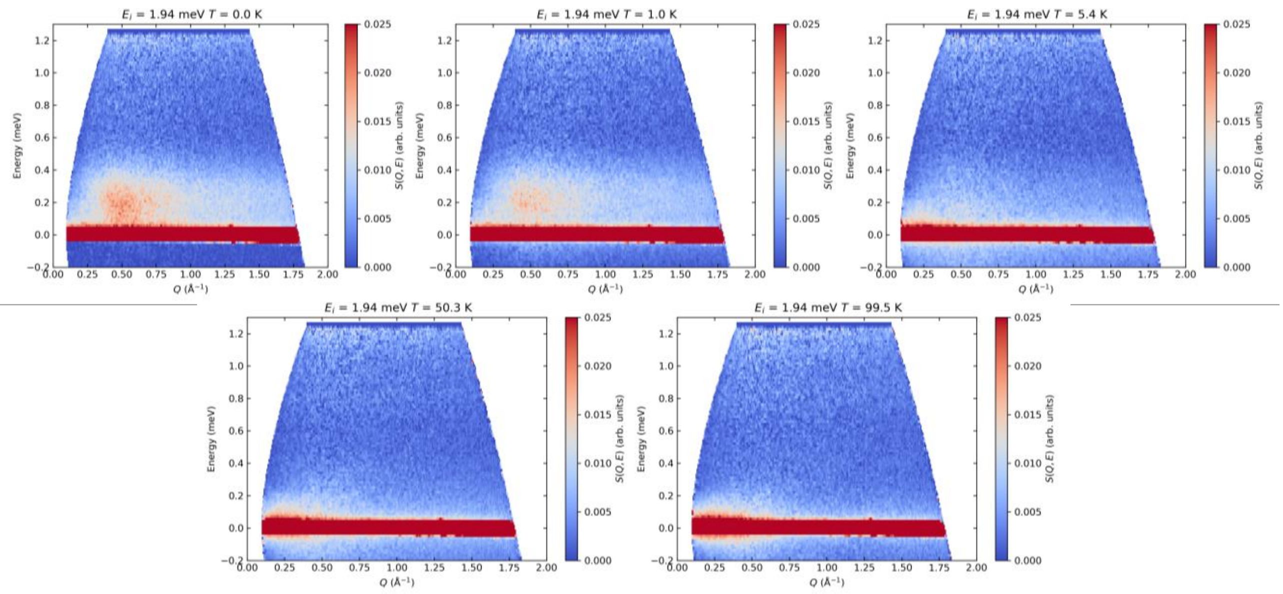
Results

We collected data at temperatures ranging from 50 mK to 100 K using a dilution insert, and we accessed different wavelengths λ = 6.5 Å and 8 Å for different resolutions, 36 μeV and 20 μeV respectively. At λ = 6.5 Å, we did measurements at 50 mK, 1 K, 5 K, 50 K, and 100 K. At λ = 8 Å, 50 mK, and 1 K. We also measured the signal from an empty Cu can for the background estimation. At λ = 6.5 Å, 1.5 K, 50 K, and 100 K. At λ = 8 Å, 1.5 K.

The following figures present $S(Q, E)$ maps at 50 mK for λ = 8 Å (left) and λ = 6.5 Å (right).

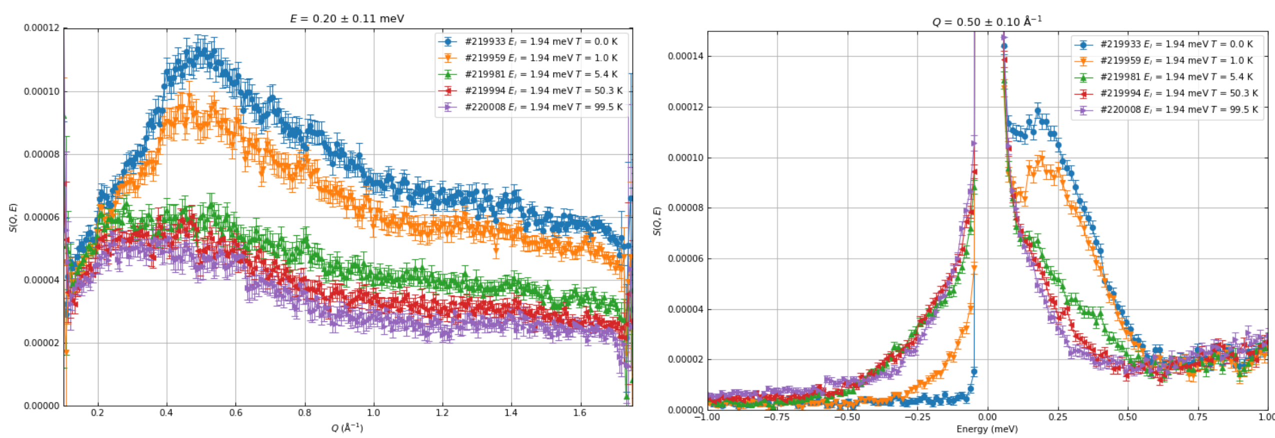


Both maps show a broad signal at low Q and at low E. The resolution at λ = 8 Å (20 μeV) could have allowed us to estimate a gap. However, there is no obvious difference between the two maps. Thus, our measurements suggest an absence of gap greater than the resolution. The quality of the data at λ = 6.5 Å appearing better, we followed the signal as a function of temperature in this condition.



The signal centred around E = 0.2 meV and Q = 0.5 Å^{-1} at low temperature decreases when increasing the temperature and seems to disappear above 5 K, replaced by a quasielastic signal.

In order to follow more closely the evolution of this signal, one can extract cuts from these maps. The figures below present $S(Q, E)$ as a function of Q for E = 0.2 meV (left), and as a function of E for Q = 0.5 Å^{-1} (right), for all the temperatures.



These cuts, bringing further detailed information about the signal, confirm it decreases from 50 mK to 1 K, and decreases even stronger above 5 K. It seems to be peaked around 0.5 Å^{-1} at low temperature and to shift at lower Q when increasing temperature. It also confirms the signal is peaked around E = 0.2 meV.