Experimental report

13/09/2022

Proposal: 4-05-816 **Council:** 10/2020

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
PANTHER	4	3	15/03/2021	19/03/2021

Abstract:

KBa3Ca4Cu3V7O28 provides a nice example of quasi-isolated spin 1/2 equilateral triangles, showing magnetic short-range ordering at very low temperature. From a NMR study, the intradimer exchange interaction would yield two quadruplet states separated by about 15-30 meV, while the lowest quadruplet would be splitted in two doublets due to a Dzyaloshinskii-Moriya (DM) 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. We have already studied the low energy excitations around 0.1 meV on IN5 and IN6-SHARP to look for the DM interaction. The present proposal now consists in measuring the magnetic excitations spectrum around 15-30 meV, in order to determine the intra-dimer coupling constant. For this purpose, we ask for 4 days of beamtime on PANTHER using a standard orange cryostat.

Exp report on 4-05-816 Spin dynamics in $KBa_3Ca_4Cu_3V_7O_{28}$

Context

Inelastic neutron scattering measurements have been performed on Panther (4-05-816) in order to probe the high-energy magnetic excitations in $KBa_3Ca_4Cu_3V_7O_{28}$. 10 grams of powder sample were loaded in a double-wall Al can.

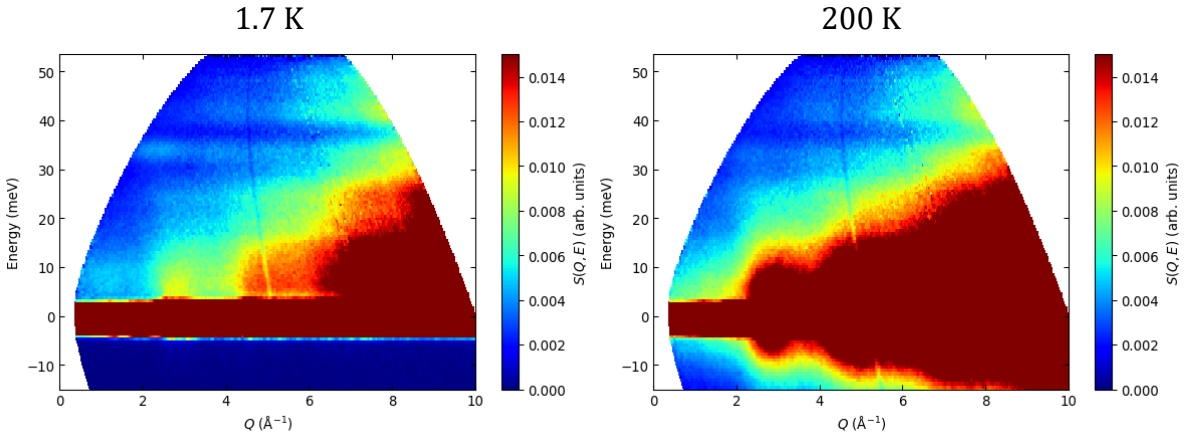
Other related experiments: IN5 (EASY-397 and 4-05-834), IN6 (CRG-2676), and D7 (5-32-868 and 5-32-929).

Results

We first performed several test measurements with different incident energies: E_i = 76, 50, and 60 meV, to look for high-energy modes. The most promising experimental condition was E_i = 60 meV, with which we carried out a temperature dependence: 1.7 K, 30 K, 60 K, 90 K, 120 K, 150 K, and 200 K.

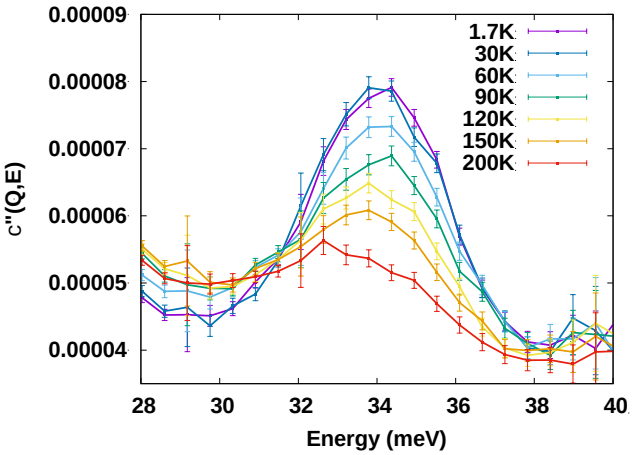
We also measured the signal from an empty Al can for the background estimation.

The following figures present $S(Q, E)$ maps at 1.7 K (left) and 200 K (right) for E_i = 60 meV.

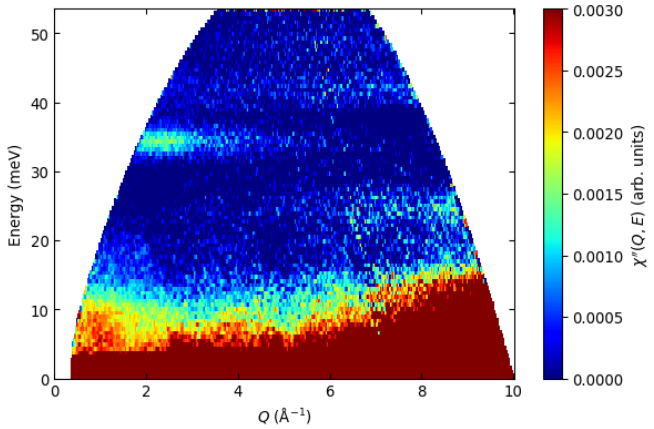


We observe a signal around E = 34 meV at low temperature which vanishes out at high temperature.

To go further, imaginary part of the magnetic susceptibility χ'' can be calculated. Cuts of χ''as a function of E for Q = 2 Å^{-1}, at all the temperatures, are presented below.



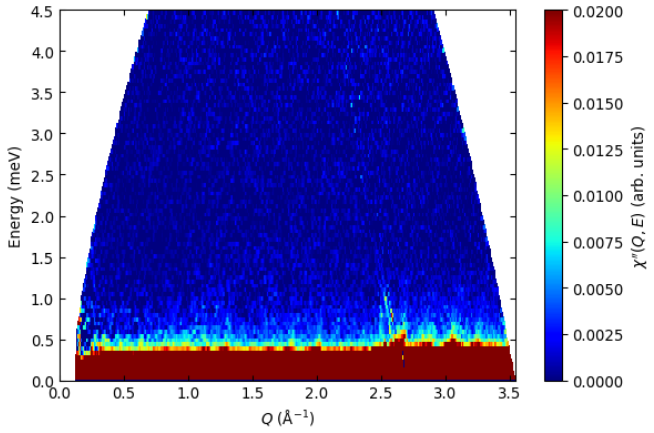
The signal at E = 34 meV gradually decreases when increasing the temperature. One can also perform temperature difference between low and high temperatures. In the next figure, the χ'' map at 1.7 K has been subtracted by the one at 200 K, which clearly show a strong signal at E = 34 meV. The other features, especially at low Q / low E, are due to […] (discussion Björn).



From our IN5 measurements, we know there is a signal around E = 0.2 meV. Thus, we did some tests on Panther at lower incident energies to look for other modes between 0.2 meV and 34 meV.

We performed test measurements with E_i = 12.5, and 7.5 meV. And we finally focused on E_i = 7.5 meV, with which we carried out a temperature dependence: 1.7 K, 15 K, 30 K, 60 K, 90 K, 120 K, and 150 K.

The following figure shows a map of the imaginary part of the magnetic susceptibility χ'' at 1.7 K subtracted by the one at 150 K.



No signal is observed outside the broad elastic line.