Experimental report

21/06/2022

Proposal: **DIR-236**

Council: 4/2021

Title: Temperature-induced evolution of topological magnons in $CrBr_3$

Research area: Physics

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Experimental team: Bjorn FAK
Stanislav NIKITIN

Local contacts: Bjorn FAK

Samples: $CrBr_3$

Instrument	Requested days	Allocated days	From	To
PANTHER	6	6	18/05/2021	22/05/2021
			08/07/2021	14/07/2021

Abstract:

Novel phenomena induced by non-trivial topology of the quasiparticle bandstructure remain in the focus of modern solid-state physics. The simplest magnetic system showing topological magnons is a 2D honeycomb-lattice ferromagnet, which exhibits robust Dirac cones at the corner (K-point) of the Brillouin zone. The topological nature of the magnons promotes very characteristic q-dependent temperature-induced renormalization of the self-energy of the magnons including both lifetime and dispersion. In this experiment we propose to measure magnon excitations in a van-der-Vaals honeycomb ferromagnet $CrBr_3$ by means of time-of-flight neutron spectroscopy at several temperatures below T_c, seeking for the unusual q-dependent renormalization. If successful, this experiment would provide a profound insight into the physics of topological magnetic systems beyond a low-temperature limit, which was mainly studied so far.

Temperature-induced evolution of topological magnons in CrBr3.
Experimental team: Stanislav Nikitin; **Local contact:** Björn Fåk

In this experiment, we aimed to measure magnetic excitations of $CrBr_3$ and their temperature-induced evolution using a thermal TOF neutron spectrometer PANTHER. We used high-quality crystal with mass of 2 g. The sample was aligned with its *c*-axis oriented vertically in order to have the hexagonal (*HK*0) plane in the equatorial plane of the instrument and mounted on an aluminum sample holder. The spectra were collected at T = 1.7, 20, 30 and 40 K, each with two incident neutron energy, E_i = 15 and 30 meV

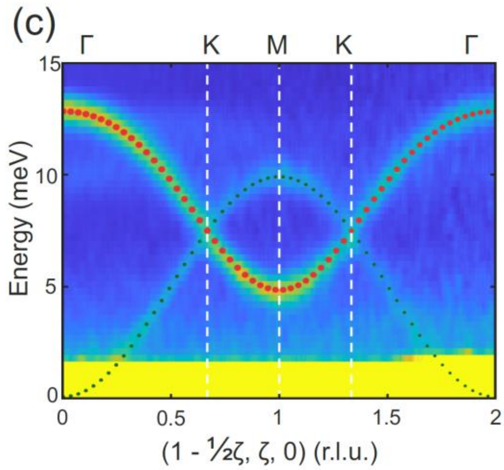

Fig. 1. Spin wave excitations in $CrBr_3$ measured at T = 1.7 K with E_i = 30 meV. Dots show magnon excitations calculated using LSWT [1].

Our data show sharp spin waves at low temperature regime, and we describe the magnon spectrum using linear spin-wave theory (**Fig. 1**). Importantly, we found that the magnons have no spin gap at K-point, which contradicts the recent report [2] and we show that this contradiction was caused by invalid analysis of the experimental data in [2].

Extended spin wave theory predicts that temperature increase shoud cause two effects: (i) decrease of the magnon bandwidth due to renormalization of the dispersion; (ii) broadening of the line width. Both effects should scale with T^2 and have compex **Q** dependence. Our data support the T^2 scaling of both quantities, but show that the predicted **Q**-dependence does not reproduce all features of the data and further theory analysis is required. The results of this experiment are published in [1].

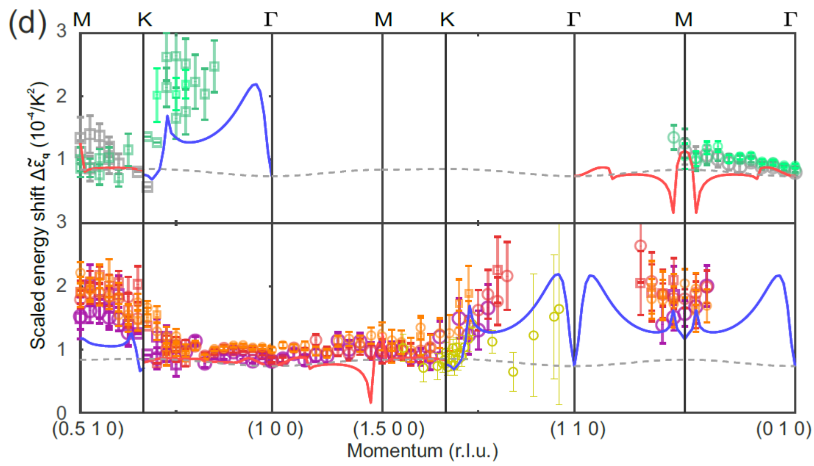

Fig. 2. Temperature-induced renormalization of the measured magnon dispersions for modes 1 (upper) and 2 (lower panel), shown in the reduced form. [1]

References:

[1] S.E. Nikitin *et al.*, arXiv 2204.11355 (2022); [2] Z. Cai *et al.*, PRB **104** 020402 (2021)