Experimental report

05/09/2022

Proposal: **4-01-1646** **Council:** 10/2019

Title: Spin excitations in the intrinsic magnetic topological insulator MnBi2Te4

Research area: Physics

This proposal is a new proposal

Main proposer: **Huiqian LUO**

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Local contacts: Alexandre IVANOV

Samples: MnBi2Te4
Fe5GeTe2

Instrument	Requested days	Allocated days	From	To
IN8	8	7	11/05/2021	18/05/2021

Abstract:

Magnetic topological insulators (TI) brings many new opportunities to realize exotic topological phenomena through magnetically gapping the topological surface states. In contrast to the inhomogeneity and challenge in magnetic impurity doped TIs, intrinsic magnetic TIs are expected to provide a clean platform to explore topological effects with time-reversal symmetry breaking. Although many magnetic topological materials have been theoretically proposed, the intrinsic magnetic topological materials haven't been realized until the discovery of MnBi2Te4 in recently. First-principles calculations and neutron diffractions suggest the magnetic ground state is A-type antiferromagnetic (AFM) phase with ferromagnetic surfaces, giving an ideal platform for emergent magnetic topological phenomena, such as topological axion state, minimal ideal Weyl semimetal, QAH effect, two-dimensional ferromagnetism,etc. To understand the magnetic interactions and thus the interplay between magnetism and topological states in MnBi2Te4, here we propose to do inelastic neutron scattering experiments to measure its spin excitations.We apply 8 days beamtime on IN8 thermal triple-axis neutron spectrometer.

1 PRINCIPAL INVESTIGATOR
Name and institution of the Principal Investigator
Huiqian Luo, Institute of Physics, Chinese Academy of Sciences

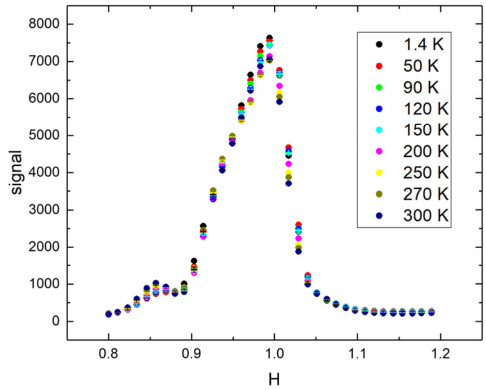
2 EXPERIMENT DETAILS	
Experiment No: 4-01-1646	
Title: Spin excitations in the intrinsic magnetic topological insulator $MnBi_2Te_4$	
Instrument: IN-8 Flatcone	
Dates scheduled: 11/05/2021 to 18/05/2021	No. Days allocated: 8
Date of experimental report: 5, May, 2022	

3 EXPERIMENT OBJECTIVES

By the time the experiment was conducted, the inelastic neutron scattering results of $MnBi_2Te_4$ have been published. It seems all spin excitations are below 4 meV. To obtain the dispersion of the spin excitations is beyond the capability of IN8 using thermal neutrons. Therefore, we discussed with the instrument scientists and decided to measure another material Fe_5GeTe_2, which is a quasi-two-dimensional van der Waals magnet. We planned to figure out the spin excitations at low energy range, to search possible topological magnons, and to get the information about the exchange coupling and magnetic excitation gap. It is also interesting to search possible topological magnons in the dispersions of spin waves in Fe_5GeTe_2.

4 EXPERIMENT REPORT

The experiment was carried out from 11/05/2021 to 18/05/2021.
Elastic scans were conducted at T = 1.4, 50, 90 120, 150, 200, 250, 270, 300 K, and inelastic scans were conducted at 1.4 K, 150 K, ΔE = 2 ~ 32 meV; 300 K, ΔE = 2 ~ 19 meV.
In elastic measurements, the Bragg signals near Q = (1, 0, L) keeps weakening as the temperature rising up to 300 K. But no significant drop showed at around T = 270 K, which should be the Curie temperature of Fe_5GeTe_2 (Fig. 1, 2).
Some signals were detected during inelastic measurements. But only signals positive-wise are obvious (for example, only H > 1 branch of the dispersion originated from H = 1 were found) (Fig. 3, 4).
The detected inelastic signals disperse linearly (Fig. 5, 6). The intensity of the signals at different temperatures are found to remain the same, even above the Curie temperature. This means that what have been measured may not be from magnetic excitations within the sample.
Figures:
Fig. 1, 2 Elastic scans and the integrated intensity.



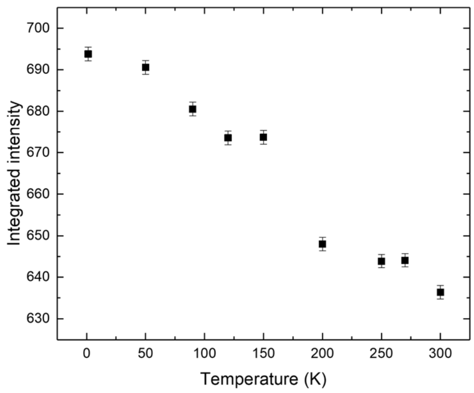
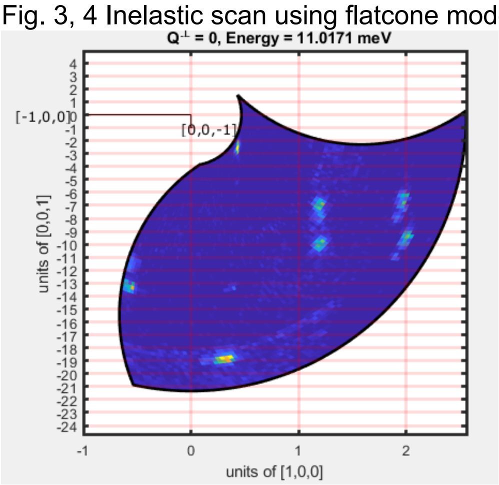


Fig. 3, 4 Inelastic scan using flatcone mode with ΔE = 11 meV, T = 1.4 K, 150 K



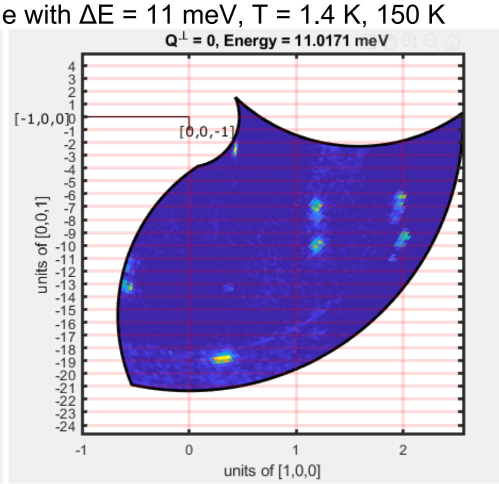


Fig. 5, 6 Analysis of the inelastic data