Experimental report

06/11/2023

Proposal: 4-01-1758 **Council:** 10/2022

Title: Revisiting the low energy spin dynamics in the Tb2Ti2O7 pyrochlore magnet

Research area: Physics

This proposal is a new proposal

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Samples: Tb2Ti2O7

Instrument	Requested days	Allocated days	From	To
THALES	6	5	03/03/2023	08/03/2023
			29/03/2023	30/03/2023

Abstract:

Despite lots of efforts in the last 20 years, Tb2Ti2O7 constitutes a conundrum in the area of highly frustrated magnets. In this proposal, we would like to perform low-energy polarized INS investigations to reveal a dispersive mode, already reported some time ago but which could not be interpreted. We would like to revisit these measurements and carefully measure the dispersion of this mode along different directions of the reciprocal space and eventually compare it with our current model. This experiment could definitely help us to solve the enigma posed by this compound

Experimental report on 4-01-1758
Revisiting the low energy spin dynamics in the $Tb_2Ti_2O_7$ pyrochlore magnet

In this proposal we asked for beam time on THALES polarized triple-axis spectrometer with a dilution fridge to revisit, in $Tb_2Ti_2O_7$, the low-energy dispersion already seen in previous paper [1], that could be related to quadrupolar interactions [2]. The objective was to confirm the propagating excitation in the (hh2-h) high-symmetry direction in the spin flip z channel.

Our PINS experiment has been carried out on THALES in a complex set-up involving a cryopad dilution insert. The measurements were performed with a constant final energy kf=1.2 A^{-1} to be able to resolve the small dispersion of about 0.3 meV. The single crystal used in our previous experiment was aligned in the (hh0) (00l) scattering plane. We first performed polarized scans in each channel (SFx, Sfy and SFz), in order to obtain the flipping ratio R~30, then we performed scans in the spin flip z channel. We did not performed polarization analysis. For each scan, 4 h for counting times were needed to reach enough statistics.

We were able to measure <SySy> spin correlations, thanks to polarized neutrons. Our measurements revealed the low energy-propagating mode out of the spin liquid ground state and visible below 500mK, with an apparent gapped dispersive excitation (of about 0.15 mev) stemming from (111), and dispersing up to 0.3 meV at (2,2,0); this gap has not been seen in previous single crystal measurements [1], but has already been seen in powder measurements [2].

More recently, we have worked out a novel interpretation based on the proximity with a quadrupolar phase driven by a large $J_{\pm}$ coupling [3]. Collective modes emanating from this ground state are S=1 modes, hence are visible by neutron scattering. They consist in two branches, a flat mode with pinch points and a branch whose dispersion is very similar to the observations described above for the My channel.
The analyses are on-going to understand these results, and to check whether they are consistent with the dynamics of S_{swt} quadrupolar interactions.

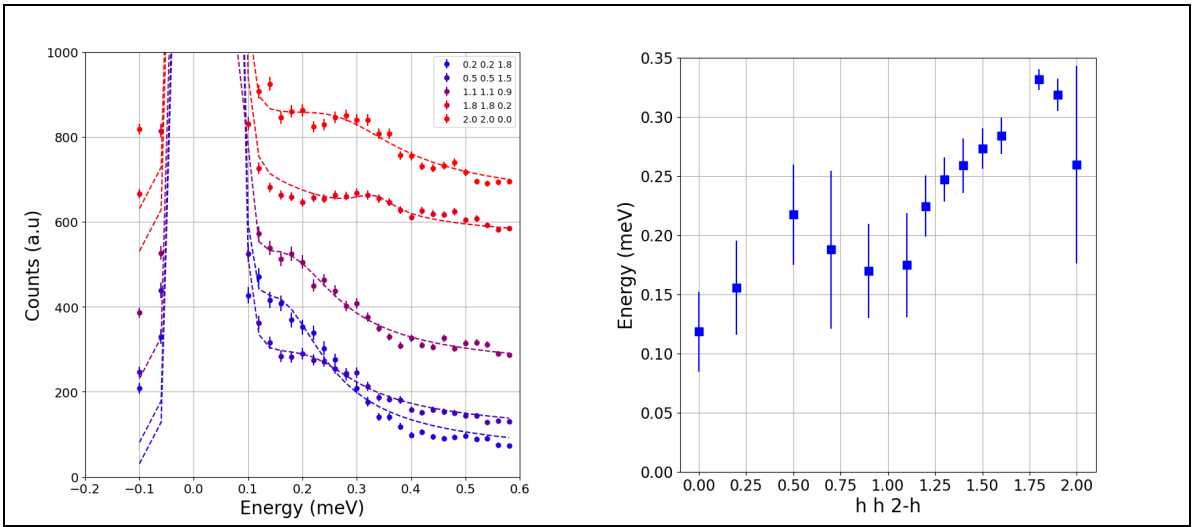

Fig. 1 (left): Polarized inelastic neutron scattering intensity in the SFz channel measured at T = 60 mK for several cuts.

FIG. 2 (right): Dispersion of the low-energy mode along the crystallographic direction (h,h,2-h), in the SFz channel

References:

[1] S Guitteny et al, Phys. Rev. Lett., 111, 087201 (2013).
[2] H.Takatsu et al, Phys. Rev. Lett., 116, 217201 (2016)
[3] S.B. Lee et al, Phys. Rev. B 86, 104412 (2012)