Experimental Report

Proposal: **4-03-1702** **Council:** 10/2012

Title: Low energy excitations in Tb2Ti2O7 spin liquid in applied field: evidence of a local symmetry breaking

This proposal is continuation of: 4-03-1691

Researh Area: Physics

Main proposer: **MIREBEAU Isabelle**

Experimental Team: MIREBEAU Isabelle
PETIT Sylvain
ROBERT Julien
GUITTENY Solène

Local Contact: MUTKA Hannu
OLLIVIER Jacques

Samples: Tb2Ti2O7

Instrument	Req. Days	All. Days	From	To
IN5	7	7	15/05/2013	22/05/2013

Abstract:

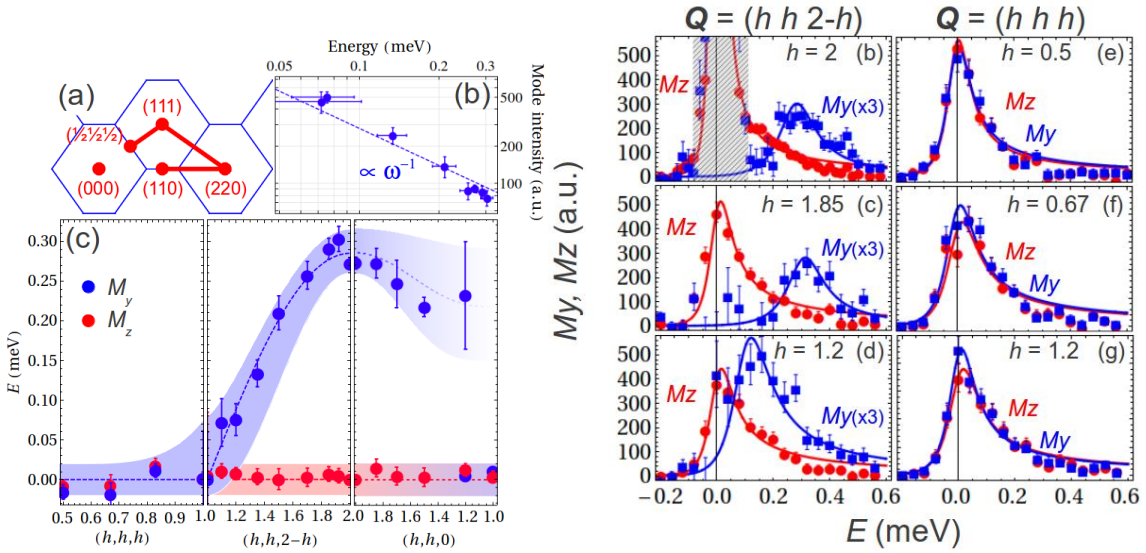
Understanding the spin liquid ground ste of Tb2Ti2O7 has been one of the main challenges in geometrically frustrated magnets for more than a decade. We recently proposed an explanation based on a local symmetry breaking by a Jahn-Teller distortion. Our model is supported by extended mean field calculation which reproduce well our INS data in zero field, together with IN5 data on Tb2Sn2O7 ordered spin ice. The best way to check this model is to measure the low energy excitation (around 0.1-0.2 meV), related to the degeneracy lifting of the ground state doublet by the distortion, in applied field through out the quantum critical point (H=2T). Our first attempt on IN5 was only partly sucessful, showing the strong effect of the field on the INS spectrum, but failing to measure the low energy region due to a strong background. We propose to repeat this experiment in better conditions, order to give a definite answer to this question.

Neutron data taken at IN14 and IN5 during this experiment have been published in PRL **111**, 087201 (2013):

Anisotropic propagating excitation and quadrupolar effects in Tb2Ti2O7
Solène Guitteny, Julien Robert, Pierre Bonville, Claudia Decorse, Paul Steffens, Martin Boehm, Hannu Mutka, Jacques Ollivier, Isabelle Mirebeau, and Sylvain Petit

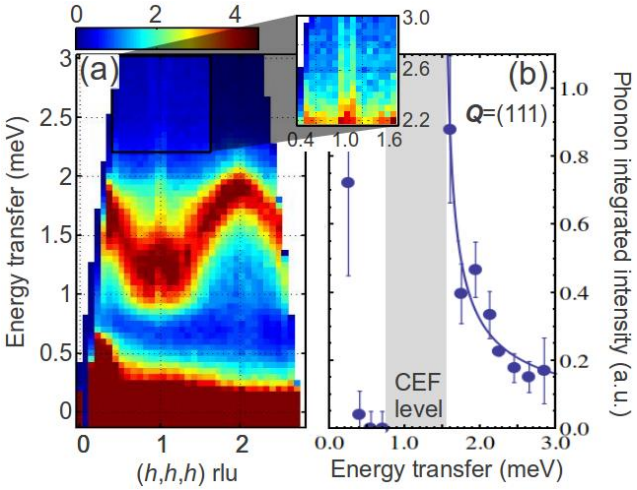
With the following abstract:
We investigate the dynamical magnetic correlations in Tb2Ti2O7. Using polarized inelastic neutron scattering. Our results provide experimental evidence for dispersive excitations emerging from pinch points in reciprocal space and characterized by an anisotropic spectral weight. Anomalies in the crystal field and phonon excitation spectrum at Brillouin zone centers are also reported. These findings suggest that Coulomb phases, although they present a disordered ground state with dipolar correlations, are stiff enough to allow the propagation of collective excitations. They also highlight a strong spin-lattice coupling which is likely driven by interactions between the 4f quadrupolar moments.

Main figures:



Left: Sketch of the Brillouin zone indicating the directions of the scans carried out in the present study. (b) shows the evolution of the intensity of the dispersing inelastic mode as a function of ω along (h,h,2-h). (c) shows the dispersion of the mode along the three high symmetry directions. The inset is a schematic picture to emphasize the fact that the dispersion is mostly visible along (h,h,2-h) and likely connected to the pinch point structure as it avoids regions where the elastic correlations are strong.

Right: IN14 data at various Q positions.



IN5 data showing the inelastic scattering as a function of energy transfer ω and Q. The data have been taken at 1.5 K but similar results are already obtained at 10K. The crossing of the acoustic phonon mode and of the dispersing CEF occurs close to Q=(1,1,1). At this point, the CEF shows an upwards dispersion, as if it was repelled by the phonon stemming from the Bragg position. Simultaneously (b), the intensity of the phonon as a function if energy drops abruptly and recovers its normal behavior at energies above the CEF line.