Experimental report

16/10/2020

Proposal: **4-05-724**

Council: 10/2018

Title: Magnetic excitations in the frustrated system Yb3Ga5O12

Research area: Physics

This proposal is a new proposal

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Samples: Yb3Ga5O12

Instrument	Requested days	Allocated days	From	To
IN3	1	1	04/10/2019	05/10/2019
			09/10/2019	10/10/2019
THALES	6	6	11/02/2020	17/02/2020
IN12	6	0		

Abstract:

The use of magnetic frustrated compounds has been proposed for low temperature refrigeration applications. Indeed, the presence of soft modes in such systems enhances magnetocaloric effects as compared to usual paramagnets. The garnet Yb3Ga5O12 (YbGG) is a potential candidate for these applications. It is proposed to investigate the low energy spin dynamics of YbGG using single crystal neutron spectroscopy and to follow its evolution as a function of temperature (0.2-10 K) and magnetic field (0-2 T).

Experimental setup

THALES was used in the classical single detector mode and setup in W configuration. The incident beam was provided by the Si monochromator with the velocity selector. A Be filter was put in the scattered beam and a radial collimator was placed before the graphite analyzer. Most of the data were taken at fixed k_f=1.2 A^{-1}. The single crystal sample of $Yb_3Ga_5O_{12}$ was mounted in dilution inset inside the 2.5 T vertical field magnet. The sample of cylindrical shape with long axis near [001] was embedded in a Cu foil glued with Fomblin oil and tighten with Teflon tape in order to ensure good thermalization. The scattering plane is [100]-[010].

Results

The magnetic excitation spectrum was investigated by constant **Q**-scans performed at symmetry points and symmetry directions in the Brillouin zone and through several constant energy scans. The spectra consist of essentially dispersionless modes and hints of weak dispersion may be "hidden" in some broadening and intensity modulation. A representative energy spectrum is shown in Figure 1 for **Q** = (3,0,0) at 50 mK. A high intensity mode is observed at 0.05 meV followed by a much smaller one at 0.1 meV. A broad band of excitations is seen at around 0.7 meV. The two low energy modes are characteristic of the low temperature correlated state of $Yb_3Ga_5O_{12}$ since it is found that they disappear at 1.4 K while the band around 0.7 meV shifts to lower energy.

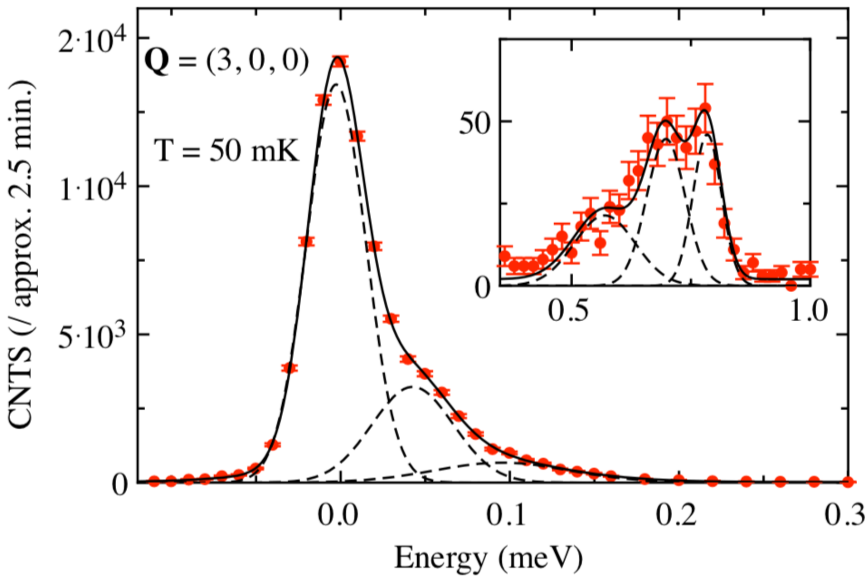

Fig.1 : Energy spectra at **Q**=(3,0,0) at 50 mK.

The spectra are also highly modified by a modest magnetic field. Figure 2 shows how the lowest mode evolves under magnetic field. The peak position increases with field following a

Zeeman splitting compatible with the crystal field ground state paramagnetic moment of $Yb_3Ga_5O_{12}$. Finally at 2 T in the polarized phase where the magnetization is almost saturated, a clear slitting of the mode is observed. It is found that this double mode is dispersionless along the [100] and [110] directions as shown in Figure 3.

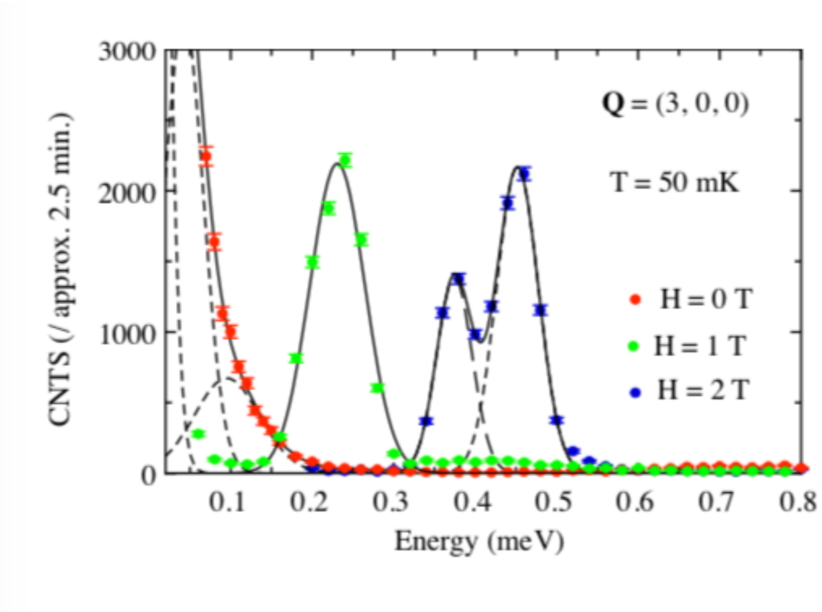

Fig.2 : Energy spectra at **Q**=(3,0,0) at 50 mK for H= 0, 1 and 2 T.

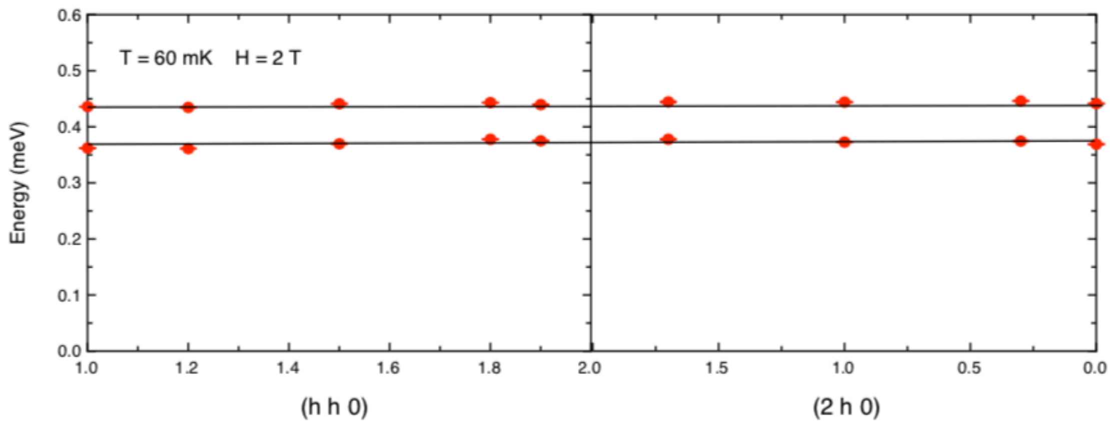

Fig.3 : Dispersion of the lowest energy modes in the saturated phase at 2 T.