Experimental report

13/09/2019

Proposal: **INTER-433** **Council:** 4/2018

Title: Internal time on IN4

Research area:

This proposal is a new proposal

Main proposer: **Pascale Petronella DEEN**

Experimental team: Pascale Petronella DEEN

Local contacts: Bjorn FAK
Stephane ROLS

Samples: Yb3Ga5O12

Instrument	Requested days	Allocated days	From	To
IN4	1	1	10/10/2018	13/10/2018

Abstract:

INTER-433 IN4-183 $Yb_3Ga_5O_{12}$

Bjorn Fak (ILL) and Pascale Deen (ESS)

YggSum.tex 12-Oct-2018

1 Aim of the experiment

Measuring the crystal _eld scheme of ytterbium gallium garnet, $Yb_3Ga_5O_{12}$.

2 Experimental

Exp. No.: INTER-433.
Title: Internal time on IN4.
Instrument: IN4C.
Experimental team: Pascale Deen.
Local contact: Bj□orn F_ak.
Dates: 10-11 October 2018 (1 day was su_cient).
Path for sample data: /net4/serdon/illdata/183/in4/exp_INTER-433/.
Path for vanadium: /net4/serdon/illdata/183/in4/internalUse/.
Data portal: data.ill.eu
Run summary: see Table 1.
Cryostat: Standard Orange IN4, with sample rotation stage and cryofurnace stick.
Exchange gas: Standard amount (30 mbar at T = 300 K).
Sample: $Yb_3Ga_5O_{12}$, single crystal, 5 mm diameter, 15 mm long.
Sample mass (estimated from dimensions of crystal): 1.9 g.
Space group: #230 Ia_3d, Yb^{3+} in pseudocubic point symmetry.
Number of formula units per unit cell: Z = 8.
Lattice parameters: a = b = c = 12:94 _A, _ = _ = = 90_.
Reciprocal lattice: a_ = 2_=a = 0:486 _A□1.
Volume of cubic unit cell: V_0 = abc = 2166:7 $_A^3$.
Number of formula units per cm^3: N = Z=V_0 = 0:00369 _ 10^{24} f.u./cm^3.
Molecular mass: M = 1059:7278 g/mole.
Mass density: _ = MN=N_A = 6:497 g/cm^3.
Sample transmission: approximately 70% (Yb has very strong coherent scattering cross-section).
Mantid version: 3.12.20180706.43 (mantidnightly on in4lnx).
Setup: Cu(220) monochromator, _ = 0:85 _A, FC at 20000 rpm, BC2 at 5000 rpm and phase of 19.2_, M1 only 2.0 cps (mba was rechecked at the end of the experiment).

3 Measurements

Measurements were performed at base temperature T = 1:5 K using one incoming energy, E_i = 113 meV, on a single crystal of $Yb_3Ga_5O_{12}$ aligned with the (H;H; 0) and (L; L; 2L) axes in the horizontal scattering plane. Measurements were performed for three di_erent sample orientations by rotating the crystal by 60 degrees. The measurements are summarized in Table 1. Temperature excursions up to about 15 K were observed with a frequency of about 1h 40min.

5 Inelastic neutron scattering results

The incoming neutron energy was E_i = 113 meV using the Cu(220) monochromator on IN4 and the Fermi chopper spinning at 20000 rpm. This configuration optimizes the energy resolution at energy transfers of about 70 meV. Because of the short wavelength used and the detector geometry on IN4C, the elastic peak shown in Fig. 1d is not very discriminatory. Two non-dispersive crystal field excitations were observed, at 65 and 75 meV, see Fig. 1a,c. They did not change as a function of the orientation of the single crystal, as illustrated by these maps. Temperature excursions up to T = 15 K were observed, but show no discernible difference whether these runs are included (blue) or not (green). The magnetic character is clear from the wave vector dependence of the scattering. The second crystal-field peak at 75 meV is slightly broader than that at 65 meV, possibly indicating a third level, since the energy resolution is not expected to change between these two energies. The Q-scans at energies of 64.6 and 75.1 meV do not display any dependence on the rotation angle. The temperature dependence of the crystal field excitations was not investigated, since the thermal population factor for an excitation energy of 65 meV at a temperature of T = 300 K is only 1.09.

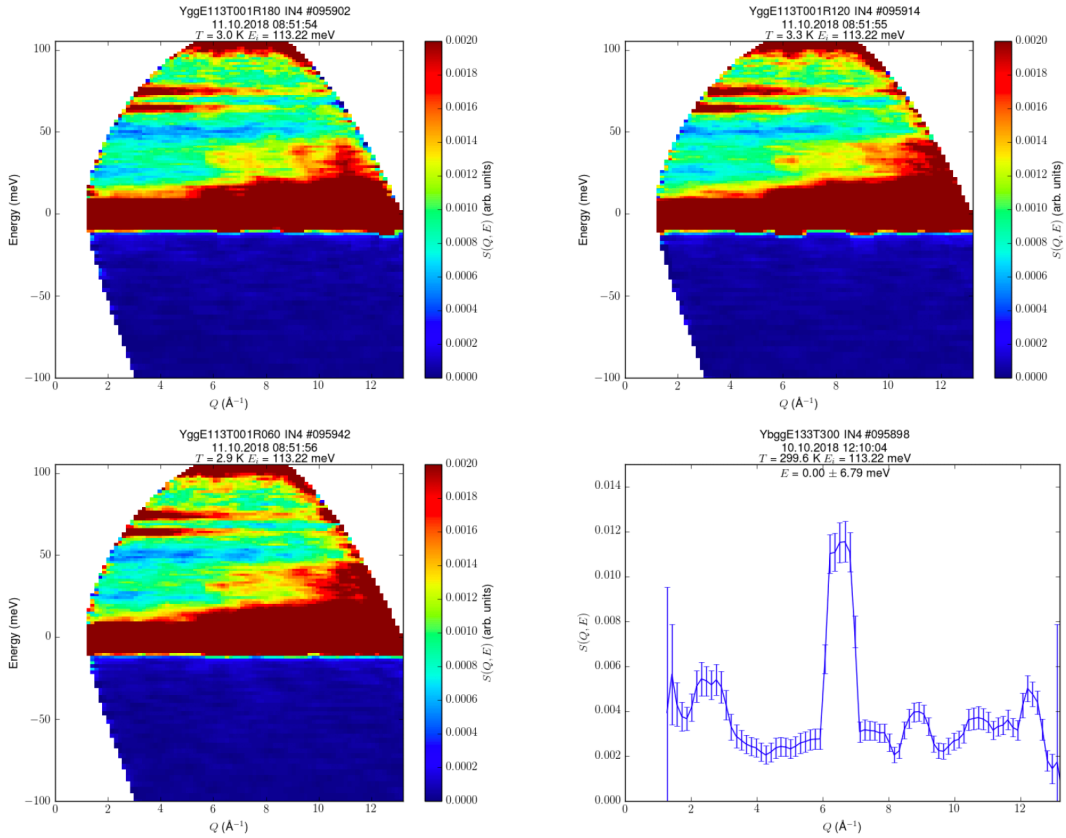

Figure 1: $Yb_3Ga_5O_{12}$, $E_i = 113$ meV, $T = 1.5$ K. The maps show the three different sample rotation angles. Bottom right: elastic peak.