Experimental report

14/09/2022

Proposal: CRG-2774 **Council:** 4/2020

Title: Spin dynamics in rare-earth Dy3Ga5O12 garnet

Research area:

This proposal is a new proposal

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Samples: Dy3Ga5O12

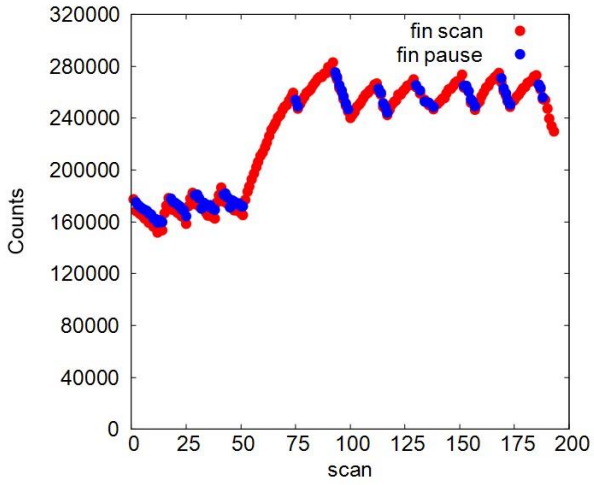
Instrument	Requested days	Allocated days	From	To
IN12	6	6	11/03/2021	17/03/2021

Abstract:

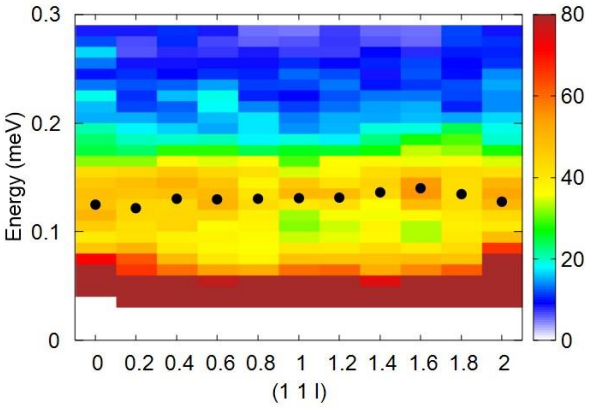
Exp report CRG-2774: Spin dynamics in the Dy3Ga5O12 garnet

This proposal received beamtime to study in principle the dysprosium garnet $Dy_3Ga_5O_{12}$. Unfortunately, we were compelled to study this particular sample during a further experiment, on IN5 (see the experiment report 4-01-1686), because the single crystal of $Dy_3Ga_5O_{12}$ was not available in time. The present IN12 experiment was thus devoted to the study of another rare earth garnet, namely $Nd_3Ga_5O_{12}$. Because the IN12 experiment was successful and did not require further investigations on IN5, it was decided to use the IN5 beamtime on $Dy_3Ga_5O_{12}$.

IN12 was operated with final kf= 1.05 $Å^{-1}$, using the MDN dilution fridge, PG/PG, velocity selector and Be filter. The experiment was successful, yet the thermalization of the sample proved extremely difficult, for reasons that we could not understand. Either the cooling power of the fridge was insufficient, or the flux was too intense, or the heating of the sample too strong because of absorption/ Gamma emission. We eventually decided not only to put the curvature of the mono back to flat, hence reducing the flux as well as the heating of the sample, but also decided to close the beam periodically to maintain the sample temperature below the ordering transition. The figure below shows a survey of the largest magnetic Bragg peak (110) as a function of time. The saw tooth profile is due to closure of the beam. We started to measure the inelastic response once the magnetic peak intensity reached saturation (after scan #100).



With this set up, we could measure the excitation spectrum along (hh0) and (11l) smoothly. Below is the map of those excitations along (11L):



This is an interesting result for several reasons

- First, it shows that the dispersion is almost flat, which indicates very weak magnetic interactions.
- Next, it shows that the doublet spanning the CEF ground state is a mixture of different Jz : $|GS> = \sum_{n=-J,J} a_n \ |J, Jz = n>$ Otherwise, the matrix element of the magnetic moment J would have been zero.

Consistency with available CEF data is currently checked. We are also performing spin wave calculations to provide an interpretation of these results.