Experimental report

19/04/2018

Proposal: 5-32-845 **Council:** 10/2016

Title: Magnetic Correlations in Geometrically Frustrated SrGd2O4

Research area: Physics

This proposal is a new proposal

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Samples: SrGd2O4
SrNd2O4

Instrument	Requested days	Allocated days	From	To
D7	4	4	25/01/2017	29/01/2017

Abstract:

We propose to measure the development of magnetic correlations in SrGd2O4 using the polarised neutron diffractometer D7. SrGd2O4 belongs to a family of compounds with the formula SrLn2O4 (Ln = Lanthanide). The triangular chains of Ln ions along the c-axis make the SrLn2O4 compounds suitable candidates to exhibit geometric frustration. From the recent D20 measurements, we have established that SrGd2O4 undergoes two low-T phase transitions, TN1=2.7 K and TN2=0.5 K (in agreement with our heat capacity results). We have also seen the presence of significant diffuse scattering above the higher temperature transition as well as in the intermediate temperature phase. Using a regular orange cryostat on D7 we will be able to probe the nature of the magnetic correlations on these two phases. It is a unique opportunity to investigate the magnetic diffuse scattering of this powder sample with 160Gd as during the long 2017 shutdown it will entirely be used to grow a single crystal for further investigations.

<u>Experimental report</u>: D7, 5-32-845, Magnetic Correlations in Geometrically Frustrated $SrGd_2O_4$.

We have measured the low temperature scattering intensities of powder samples of $SrGd_2O_4$ (Gd=^{160}Gd at 98 %) and $SrNd_2O_4$ on the D7 instrument at the ILL. The magnetic signal was extracted from the row data by polarization analysis. Measurements were performed at several temperatures allowing for a temperature evolution study of the magnetic properties of these two materials. Double wall Al sample containers were used to reduce the sample absorption. The wavelength was set to 3.1435 Å for these measurements. Attenuation measurements and calibration were performed before starting the data collection. A correction for absorption considering annular cylindrical holder and strong absorbers was applied onto the $SrGd_2O_4$ data. The data will then be treated by reverse Monte Carlo analysis using the Spinvert code.

$SrGd_2O_4$ (Gd=^{160}Gd):

In the case of $SrGd_2O_4$ we have used a sample enriched at 98 % in the non absorbing ^{160}Gd isotope coupled with a double wall container technique in order to significantly reduce the sample absorption. A mass of 4.282 g of powder was folded in three aluminum sachets (chewing gum method) rolled around the inner cylinder and stacked vertically in order to maximize the surface coverage. Measurements were performed at: 1.5 (11 hrs), 2.1 (8hrs 15min), 3 (11 hrs), 4 (11 hrs), 10 (8hrs 15min), 20 (8hrs 15min) and 50 K (8hrs 15min). The polarization analysis allowing for a separation of the different scattering components from the raw signal, we have plotted them individually here after for the data collected at 1.5 K, see fig. 1.

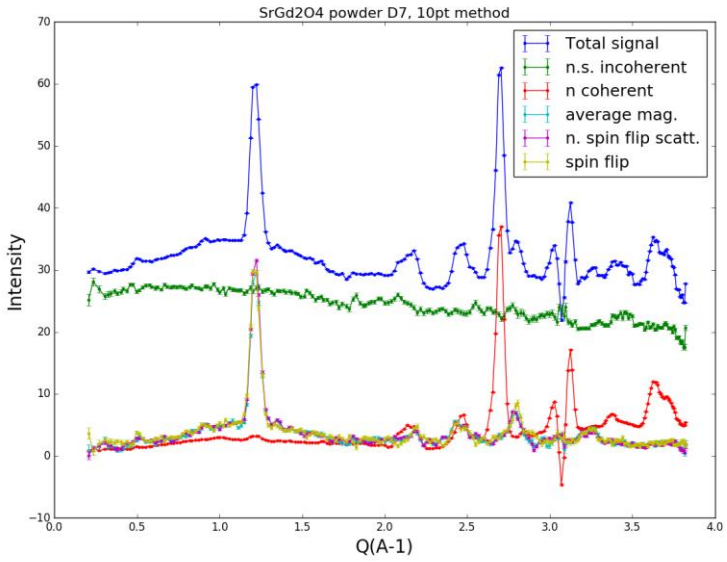

Figure 1 Intensities of the different scattering components of $SrGd_2O_4$ measured at 1.5 K and separated by polarisation analysis. The total scattering signal is represented in blue followed by nuclear spin incoherent in green, nuclear coherent in red, average magnetic in light blue, non-spin flip in purple and by spin flip in yellow.

The temperature evolution of the magnetic scattering intensities of this compound is then presented considering intensities shifts for clarity reasons, see fig. 2. We report the apparition of a broad diffuse magnetic signal already at 50 K revealing the presence of strong magnetic correlations in the system. We then observed the emergence of Bragg peaks below 3 K (T_{N1}=2.72 K) inducing a decrease

of the diffuse signal intensity. Diffuse signal however remains present down to 1.5 K, the lowest measured temperature. $SrGd_2O_4$ is known to undergo a second magnetic transition toward a long range ordered state at 0.47 K, diffuse scattering signal is thus expected to be fully replaced by Bragg intensities below this temperature.

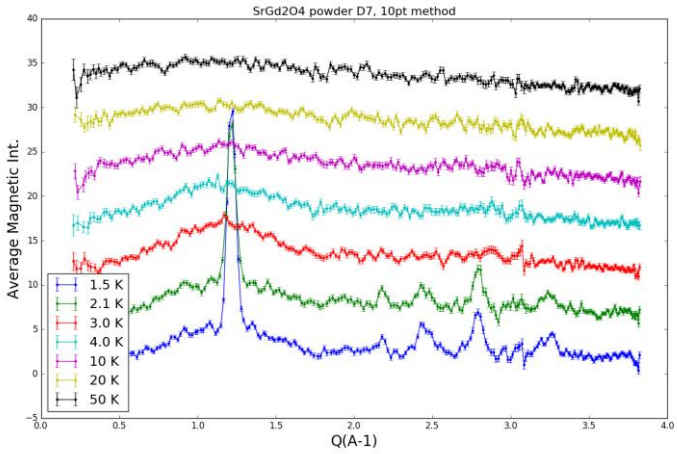

Figure 2 Temperature evolution of the $SrGd_2O_4$ magnetic scattering. Intensity shifts are used for clarity reasons.

$SrNd_2O_4$:

The double wall method was also implied for this measurement however the $SrNd_2O_4$ powder was directly introduced between the two walls of the Al cane (without using Al sachets as preliminary containers). The homogeneity of the sample was checked by performing scans at several position on the sample cane. Data have been collected at 1.5, 3 and 20 K for 16 hrs and 30 min, 16 hrs 30 min and 11 hrs, respectively. The temperature evolution of the magnetic component of the scattering is plotted here after, see fig. 3. We report the absence of a clear magnetic signal at 20.0 K, the presence of broad diffuse scattering features at 3.0 K and finally, the apparition of sharp Bragg reflections sitting on top of a diffuse signal at 1.5 K. These measurements confirm previous observations. i.e. $SrNd_2O_4$ is known to undergo a magnetic transition below 2.3 K toward a long range ordered magnetic phase established on Nd1 sites only, Nd2 sites displaying only short ranged order down to the lowest temperature.

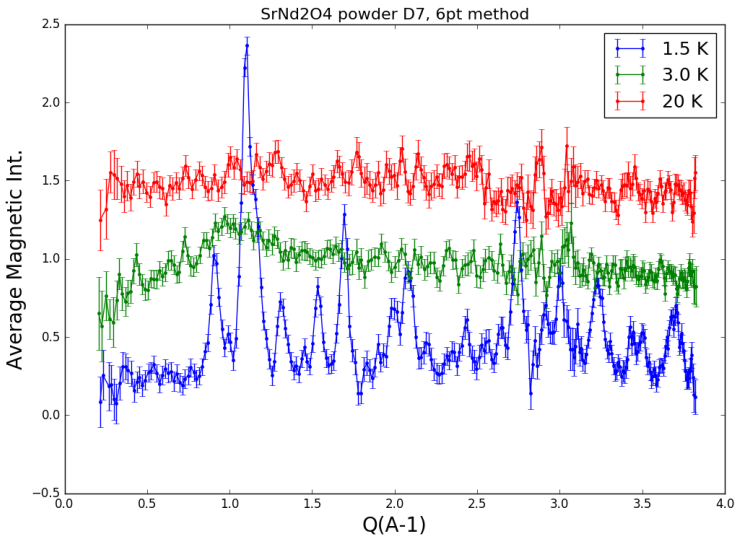

Figure 3 Temperature evolution of the $SrNd_2O_4$ magnetic scattering. Intensity shifts are considered for clarity reasons. We report the absence of clear magnetic signal at 20.0 K, broad diffuse features present at 3.0 K and a combination of both diffuse and Bragg intensities at 1.5 K.