ESRF	**Experiment title:** **On the nature of the multiple order parameters in multiferroic $DyMnO_3$**	**Experiment number**: HE 2294
Beamline: ID20	**Date of experiment**: from: 22/11/06 to: 28/11/06	**Date of report**: 22/02/07
Shifts: 18	**Local contact(s)**: L. Paolasini	*Received at ESRF:*

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Report:

$DyMnO_3$ is an example of a magnetoelectric multiferroic, a class of materials in which ferroelectricity and magnetism coexist and interact, and therefore which may be of great importance to the *spintronics* industry. The development of a microscopic theory of the coupling mechanism is fundamental to understanding the properties of these multiferroics. The properties of resonant X-ray scattering make it an ideal tool to be exploited towards this goal. $REMnO_3$ multiferroics have recently attracted much scientific attention due to their gigantic magnetoelectric properties [1,2]. Our experiment on $DyMnO_3$ is a continuation of the work done on $TbMnO_3$ [3] and is part of a programme to ascertain ascertain a more generalised picture of low temperature magnetoelectric order parameters in $REMnO_3$ multiferroics.

$DyMnO_3$ is magnetically speaking similar to $TbMnO_3$ [5]. Below T_{N1}(Mn)=39 K the incommensurate magnetic is formed with wavevector Q_{Mn}=(0 q_{Mn} 1) with q_{Mn}=0.72 and the magnetic moment is oriented along the b axis. At T_{N2}=18 K the wavevector locks into a value of q_{Mn}=0.77 and the material becomes ferroelectric, in a similar way to $TbMnO_3$ below its T_{N2} value. The ferroelectric polarisation response under applied magnetic field is also generally very similar to that of $TbMnO_3$, with the applied fields along the b and a axis the ferroelectric polarisation switches from the c axis to the a axis. At T_{N3}=6 K, the dysprosium orders in a commensurate magnetic structure.

Measurements were made on the ID20 beamline using a single crystal prepared in Oxford, cut with a b-face, in the low temperature displex cryostat, at the manganese K-edge and dysprosium L_{III}-edge, in zero applied field. The high flux of the ID20 beamline make it uniqely suitable for the study of the manganese sublattice, which would otherwise be difficult due to the small enhancement observed at the Mn K-edge. Polarisation analysis was performed using the appropriate analyser crystals. The temperature dependence of the incommensurate and commensurate satellites were measured at the relevant energy. Figure 1 shows an example of such a temperature dependence, which reveals the intensity of the commensurate magnetic reflection at (0 2.5 0) disappearing at 8 K as opposed to 6 K, which may indicate that the sample oxygen stoichiometry is incorrect, since we would expect the signal to disappear at 10 K. The azimuthal and energy dependence of a range of reflections was also investigated.

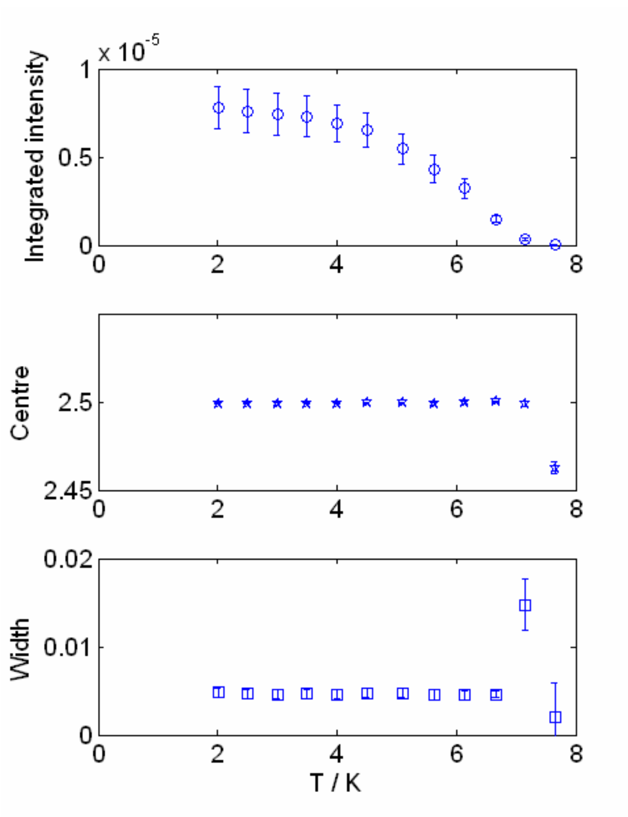

Figure: Temperature dependence of the commensurate magnetic reflection (0 2.5 0) in the σπ channel at the dysprosium L_{III} edge (E=7.790 keV)

Analysis of the data is ongoing. We plan to continue the experiment to investigate the field dependence of the XRS, since the polarisation flop occurs at 6 T [1].

References:

[1] N. Hur et al. Nature 429, 392 (2004).

[2] T. Kimura et al., Nature 426, 55 (2003)

[3] D. Mannix et al., to be submitted to Phys. Rev. B