XMaS the UK-CRG	**Experiment title:** XRES in rare-earth metals: Terbium.	**Experiment number:** 28-01-14
Beamline: **BM 28**	**Date of experiment:** from: 2nd December 1998 to: 9th December 1998	**Date of report:** April 1999
Shifts: 21	**Local contact(s):** Dr. S.Brown	*Received at XMaS:*

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Report:

Aim.

Our aim was to conduct a systematic investigation of the polarization dependence of the XRES scattering at the L edges of the heavy rare earth terbium.

Introduction.

Early x-ray measurements [1,2] of terbium concentrated on XRES at the L_{III} absorption edge. These studies showed the resonant magnetic behaviour near the edge and showed how the integrated intensity increases and then decreases as temperature decreases through the antiferromagnetic region. The next experiment [3] conducted studies at the L_{II} edge where a double peak, of ~5eV splitting, was observed in energy scans at $(0,0,\tau)$ satellites. An explanation, that is similar to the case of Ho [4], that the lower peak is of quadrupolar (E2) origin and the upper peak is dipolar (E1), fails when the Q-dependence of the intensity is considered. However, switching the energies of these E1 and E2 contributions may be possible; this idea is supported by the calculations of Lovesey et al [5]. It proved impossible to obtain an acceptable fit to the data with the E2 energy below the E1 energy. This experiment was meant to provide answers to this problem.

Experimental method.

To allow for absorption effects at the L edges, measurements of the fluorescence from the

crystal at the three absorption edges were made. Also the absorption by a Tb foil (of thickness ~25μm) was measured at the three absorption edges. As a check, measurements of the integrated intensities were made as a function of temperature at the L_{II} edge, (0,0,2+τ) satellite. The main part of the experiment involved a series of polarization analysis measurements which were made at the (0,0,2+τ), (0,0,4±τ) and the (0,0,6+τ) satellites for both L_{II} and L_{III} edges. The L_{III} edge was measured with $\sigma\rightarrow\pi$ and $\sigma\rightarrow\sigma$ polarization, while the L_{II} edge was only studied with $\sigma\rightarrow\pi$ polarization as there was no discernible peak for $\sigma\rightarrow\sigma$ polarization. L and K scans were used at each satellite and the (006) pyrolytic graphite crystal was chosen as the analyser. We also conducted some background scans at the three L edges and looked for 2τ, 3τ, 4τ, etc. satellites, for completeness.

Results.

Fig. 1 shows the results of integrated intensities measured as a function of temperature at the L_{II} edge, (0,0,2+τ) satellite. These results are consistent with those from the last experiment [3] were the magnetic intensity increases as the temperature is lowered in the spiral antiferromagnetic phase, before disappearing at the onset of ferromagnetism (~220K). *Fig. 2* shows the (0,0,2+τ) satellite at the L_{II} edge. The double peaks were seen at all 4 reciprocal space positions, for the L_{II} edge. Detailed analysis of these results are underway, but our preliminary conclusion is that the double peak at L_{II} is still apparent when allowance is made for the rapidly changing absorption coefficient. Measurements at the L_{III} edge showed a single peak, which was in agreement with previous work. So an immediate explanation in terms of an absorption effect does not appear to be valid. The polarisation-dependence may provide more information.

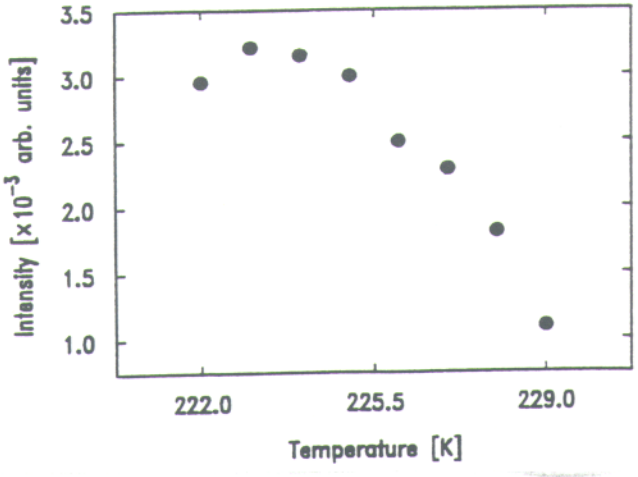

Fig. 1

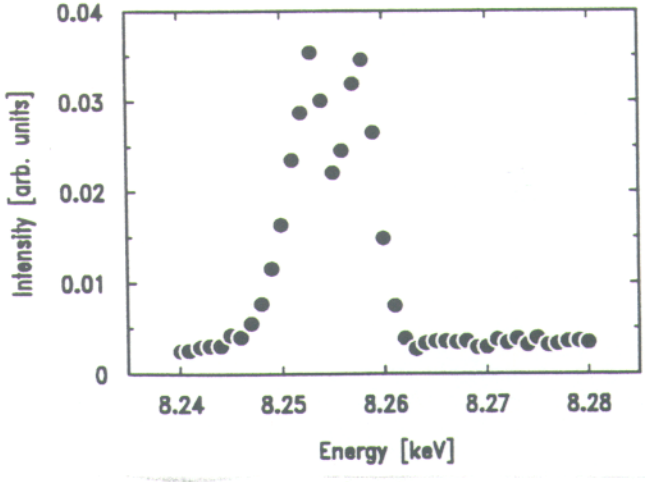

Fig. 2

References.

[1] Tang et al., JMMM **103**, 86 (1992).
[2] Gehring et al., Phys. Rev. **B45**, 243 (1992).
[3] Perry et al., J. Phys. **CM10**, 1951 (1998).
[4] Gibbs et al., Phys. Rev. **B43**, 5663 (1991).
[5] Lovesey et al., J. Phys. **CM10**, 501 (1998).