XMaS the UK-CRG	**Experiment title:** Polarisation of the 5d band of Dy caused by Cu contamination.	**Experiment number:** 280167
Beamline: **BM 28**	**Date of experiment:** from:20/02/2000 to:22/02/2000	**Date of report:** 13/04/2000
Shifts: 6	**Local contact(s):** Dr Anne Stunault	*Received at XMaS:*

Names and affiliations of applicants (* indicates experimentalists):

Dr B.J. Hickey
Dr C.H. Marrows
Mr D.T. Dekadjevi*
Mr A.T. Hindmarch*

Department of Physics & Astronomy,
University of Leeds,
Leeds,
LS2 9JT
UK

Report: We have investigated the use of the XMaS Beamline to probe the polarisation of the 5d band of Dysprosium. The sample used in this preliminary investigation was a multilayer of structure SiO_2/Ta(30Å)/{Dy(5Å)/Cu(18Å)}$_{10}$/Ta(30Å), grown by magnetron sputtering at Leeds. The sample shows a giant magnetoresistance of only ~0.15% (figure 1), in agreement with what is expected from a multilayer of this type of material. It can be seen that in the ferromagnetic phase, a fairly large magnetic field of order 2T must be applied in order to change the relative orientation of the Dy layers significantly.

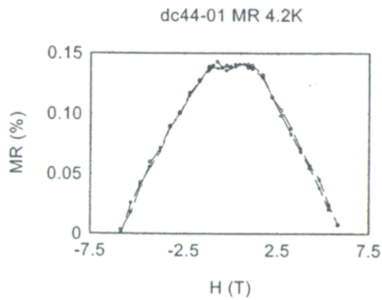


Figure 1 shows the MR(H) loop for the Dy/Cu multilayer used in this experiment.

The experiment we performed at XMaS involved taking reflectivity scans for both σ-σ and σ-π polarisation at a range of temperatures corresponding to the three magnetic phases of Dy, both in zero applied field and in a 1T magnetic field, with the beam incident along the axis of the applied field. We recorded energy scans at positions corresponding to the superlattice peak and the maximum of the Kiessig fringe at L=0.225Å^{-1} in all three magnetic phases. These energy scans were first normalised against the incident beam intensity. The scans in the ferromagnetic (10K) and helicoidal (140K)phases were then normalised against the paramagnetic (250K) phase scan (figure 2) in order to determine any difference in scattered intensity. From this it can be seen that there is a definite decrease by ~20% in

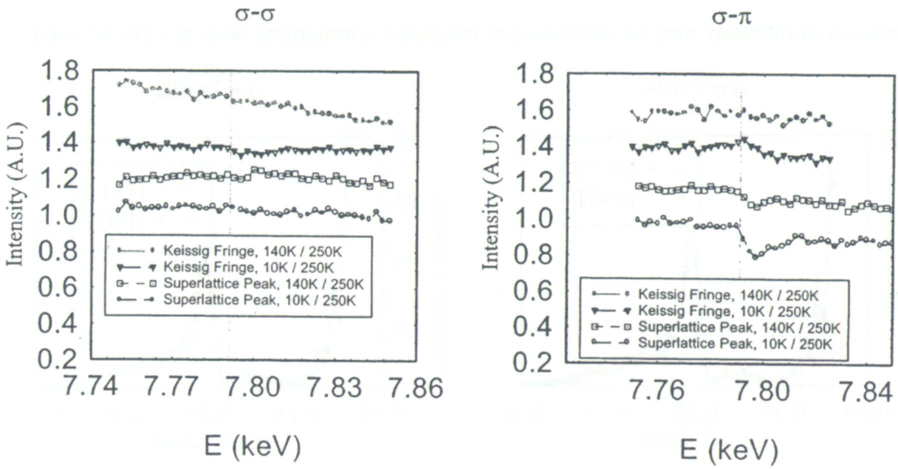
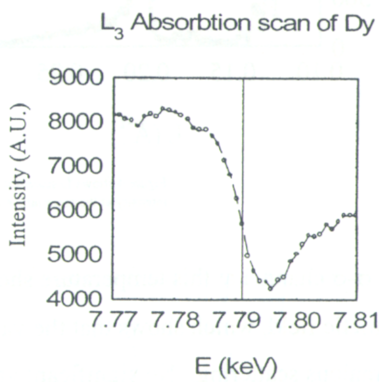


Figure 2 shows normalised energy scans (as described in the text), for both σ-σ and σ-π channels. The vertical line marks the inflection point at the L_3 absorbtion edge of Dy. Each scan is offset as an aid to clarity.

reflected intensity at the superlattice peak in the σ-π channel in the ferromagnetic phase. This decrease in intensity occurs at the energy of the Dy L_3 absorbtion edge, a separate measurement of which is shown in figure 3.



No significant difference is observed at the Kiessig fringe in this channel - or for any scan of σ-σ polarisation. As the only change is seen at the energy of the Dy L_3 edge and in the polarisation corresponding to magnetic scattering interactions, we can reasonably associate this reduction in intensity with the 5d band in Dy.

Figure 3 shows the absorbtion spectrum of Dysprosium. The vertical line marks the inflection point at the L_3 absorbtion edge.

It was then decided to record a series of L-scans for the ferromagnetic and paramagnetic phases of the Dy. The incident beam energy was tuned to the Dy L_3 absorbtion edge, and scans were performed both in a 1T magnetic field and with the field off (figure 4). From these scans it can clearly be seen that there is a change in intensity at the superlattice peak in the σ-π channel for the paramagnetic phase. Again, due to the energy of the incident beam, this variation in intensity may be attributed to magnetic interactions with the Dy 5d band.

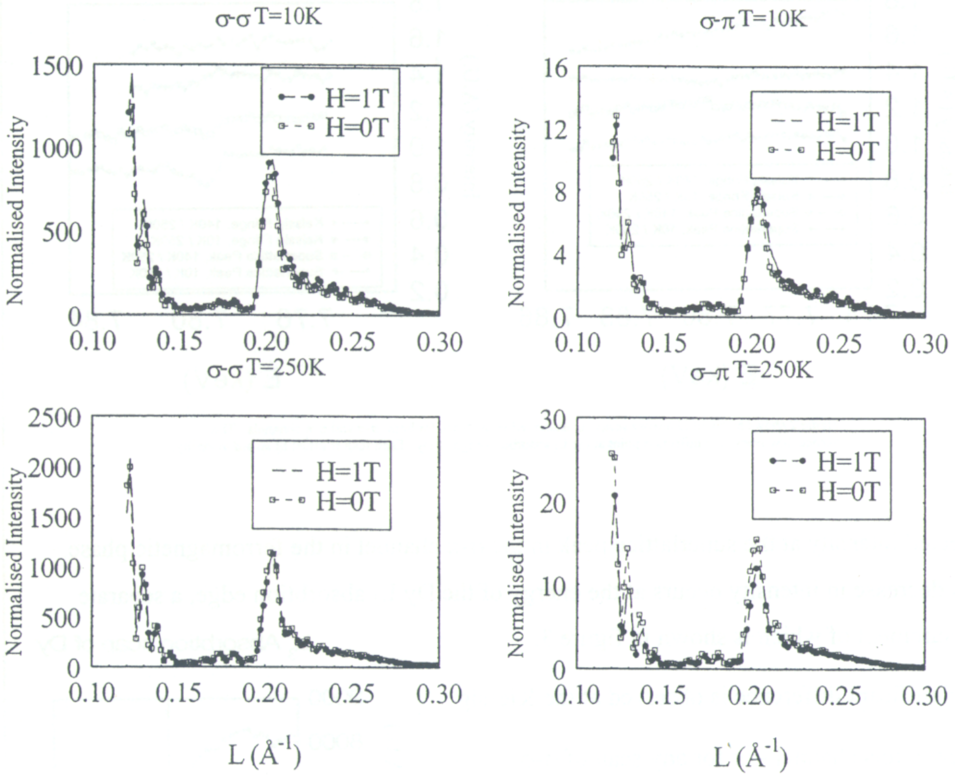


Figure 4 shows L-scans for ferromagnetic and paramagnetic Dy phases. Variation in intensity at the superlattice peak may clearly be seen in the σ-π channel at T=250K.

The σ-σ channel at this temperature shows absolutely no variation in intensity with applied magnetic field, which shows that the variation in the σ-π channel cannot be attributed to anomalous scattering. No significant variation in intensity can be observed in either channel at 10K. This is expected, as it is known that changing the applied magnetic field from

1T to zero has very little effect upon the orientation of the magnetisation in the Dy layers (figure 1). Observation of any intensity change while the Dy is ferromagnetic would require the use of a more powerful magnet in order to cause more realignment of the magnetisation of the individual Dy layers. It is interesting to note that here the scattered intensity is seen to decrease with increasing magnetic order in the sample. This result is similar to the previous case, where there was a decrease in scattered intensity for the ferromagnetic phase in comparison to the paramagnetic phase. Two possible reasons for decreased intensity in these cases are magnetocrystalline anisotropy within the sample, which will be probed by vibrating sample magnetometry here at Leeds, and interference effects between the magnetic and structural scattering.

We have shown that it is possible to use the XMaS beamline to observe polarisation of the 5d band in Dysprosium by performing reflectivity measurements. Our preliminary experiment has shown differences in reflected intensity at the superlattice peak both between the magnetically ordered phases and the paramagnetic phase, and for the paramagnetic phase as a function of applied magnetic field. All of these differences in intensity occur at an energy corresponding to the Dysprosium L_3 absorbtion edge, and in the σ-π channel which corresponds to magnetic dipolar interactions. These factors together suggest that we have seen evidence of magnetic scattering from the Dysprosium 5d band and hence magnetic polarisation thereof.