ESRF	**Experiment title:** Resonant and non-resonant x-ray magnetic scattering from $DyFe_4Al_8$	**Experiment number:** HC 202
Beamline: ID20	Date of experiment: from: 2016/96 to: 27/6196	Date of report: 11/7/96
Shifts: 16	Local contact(s): S. Langridge, C. Vettier	*Received at ESRF:* 6 AUG 1996

Names and affiliations of applicants (* indicates experimentalists):

S. Langridge* and C. Vettier*, Magnetic scattering group, ESRF.

G.H, Lander*, EITU, Postfach 2340, D-76125, Karlsruhe, Germany.

J.A. Paixão*, Univ. of Coimbra, Coimbra, Portugal.

S.A. Soerensen* and B. Lebech, Risø Nat. Lab., Dk-4000, Roskilde, Denmark.

D. Gibbs, Physics Dept., BNL, USA.

The site selectivity of resonance x-ray scattering represents a new tool in the study of magnetism in materials that have more than one magnetic atom. We illustrate this with a study of the interactions between the Fe and Dy sublattices in the material $DyFe_4Al_8$ [1]. The material is an antiferromagnet and neutron experiments have shown that the Fe 3d moments order at ~ 170K, and the D y 4f moments order at a much lower temperature of 20K. One major question is how the exchange develops between these two sublattices. Theory suggests that the Dy 5d electrons play a role, and synchrotrons x-rays can give information on this important aspect.
The experiments use an x-ray energy corresponding to the Dy L_{III} edge (7.79keV) in which case the electronic (dipole) transition 2p-5d is allowed, and leads to an enhancement of the magnetic signal. Thus, the experiment is sensitive to Dy only, and it also selects the 5d electrons. In principle quadruple transitions from 2p to 4f states are allowed but they may be distinguished by their energy and polarisation dependence. We have been unable to detect such transitions, so that all the scattering represents dipole transitions involving the 5d transitions.

In Fig. 1(a) is shown the T dependence of the magnetic intensity at the positions of the magnetic satellites. The large value at low temperature corresponds to the polarisation of the 5d band electrons by the ordered Dy 4f electrons.

The rapid decrease on warming to 20K corresponds to the effect of disordering the Dy 4f moments, which is seen very clearly in neutron experiments. However, unlike the Dy 4f moments, the long-time averaged polarisation of the 5d band does not go to zero when the Dy 4f moments disorder.

X-rays can also give valuable, and perhaps unique, information about the arrangements of moments in the unit cell. In Fig. l(b) are shown intensities for the first harmonics in two different orientations of the crystal as a function of the scattering angle 0. The upper line gives a large intensity which is independent of θ. This arises only when the moments are rotating in the scattering plane. However, for the second orientation, the moments are rotating in a plane perpendicular to the scattering plane, and the cross section then goes to zero at $\theta=0$, and follows a $\sin^2\theta$ dependence, which is shown by the lower line.

These experiments give new information on the role of the 5d conduction electrons, which are essentially invisible to neutron scattering, in mediating the interaction between the Dy 4f and Fe 3d electrons.

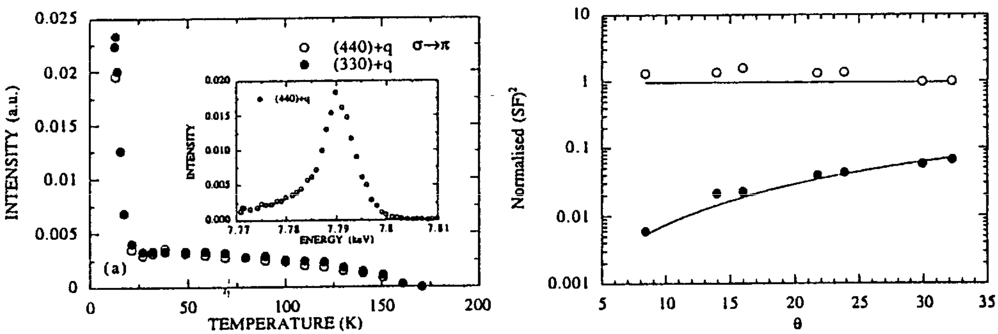

Fig Caption:

(a) Intensity of the magnetic satellite (measured in the σ to π channel) in $DyFe_4Al_8$ as a function of temperature. The insert shows the energy dependence of the signal.

(b) Intensities (normalised to unity) as a function of the scattering angle θ. The open points are taken in the orientation (HKO) and they should be independent of θ. The closed points are in the (HHL) orientation and the line is the calculation for the anticipated intensity with no adjustable parameter once the stronger satellites in the (HKO) orientation are taken as 1.

[1] A. Van der Kraan and K.H.J. Buschow, Physics B 86-88,93 (1977)