ESRF	**Experiment title:** Resonant x-ray magnetic scattering from MFe_4Al_8 compounds (M=Dy, Lu)	**Experiment number:** HE-109
Beamline: ID20	**Date of experiment:** from: *7* May to: 12 May 1997	**Date of report:** 12 August 1997
Shifts: 18	**Local contact(s):** Dr C. Vettier	*Received at ESRF:* 2 2 AOUT 1997

Names and affiliations of applicants (* indicates experimentalists):

*S. Langridge, ESRF and European Commission, JRC, EITU, Postfach 2340, Karlsruhe, Germany.

*J.A. Paixão, Departmento de Fisica, University of Coimbra, P-3000 Coimbra, Portugal.

*G.H. Lander, European commission, JRC, Institute for Tramuranium elements, Postfach 2340, Karlsruhe, Germany.

*C. Vettier, *N. Bernhoeft, A. Stunault, D. Wermeille, ESRF.

S Aa. Sorensen, Solid state physics department, Risø National Laboratory, DK-4000, Denmark.

D. Gibbs, Brookhaven National Laboratory, Long Island, NY 11973.

E. Talik, Institute of Physics, University of Silesia, Katowice, Poland.

Report:

The exchange interactions in the heavy rare-earths are mediated indirectly by an induced polarisation of the *5d-6s* conduction band electrons due to the localised *4f* electrons. Interesting effects are observed when the rare-earths are alloyed with *3d* transition elements, primarily resulting in materials with a high magnetic ordering temperature. Using x-ray resonant exchange scattering (XRES) at the Dy L edges we have studied the exchange splitting of the Dy *5d* states in the presence of a second *3d* magnetic sublattice. Our previous measurements on $DyFe_4Al_8$ ($ThMn_{12}$ structure) coupled with both neutron [1] and Mössbauer measurements show that the Fe sublattice orders at T_N=165K whereas the Dy *4f* moment do not exhibit long-range order until T_{Dy}=20K. Figure 1 shows the temperature dependence of the integrated intensity at both the L_3 and L_2 Dy edges. Concentrating on the L_3 signal; $(2p_{3/2} \Rightarrow 5d_{5/2})$ below T_N there is resonant intensity due to a small splitting of the *5d* states through an induced polarisation from the *3d* electrons.

At T_{Dy} the intensity rapidly increases commensurate with the ordering of the *4f* electrons. At the L_2 edge ($2p_{1/2} \Rightarrow 5d_{3/2}$) the situation is significantly different. Again the exchange splitting goes to zero at T_N but also decrease at the lowest temperature. To characterise this effect Figure 2 shows the ratio of the integrated intensities (the "branching ratio") of the two edges. At low temperature the branching ratio is -5 consistent with measurements on ordered Dy materials [2,3] but decreases to -0.2 at higher temperatures. In addition a shift in the energy position (~2eV) of the centre of mass of the resonant line shape (at both Dy edges) in the temperature range 10K to 50K was also observed. To study the effect of the *4f* electrons complementary measurements were made on the isostructural compound $LuFe_4Al_8$. Since Lu has a filled *4f* shell any observed magnetic intensity must arise from the polarisation of the *5d* levels. No magnetic intensity was observed at either of the Lu edges although *non-resonant* scattering was observed presumably from the Fe sub-lattice. An explanation of these remarkable results will hopefully result from our current detailed band-structure calculations.

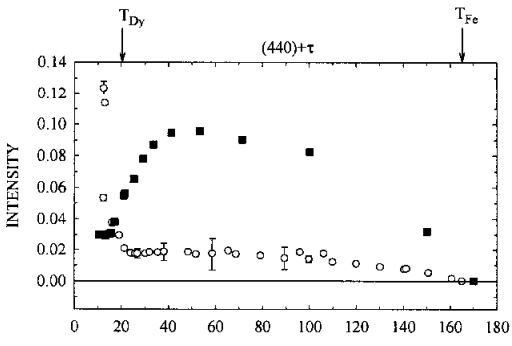

Figure 1: The temperature dependence of the energy integrated intensity of the (440)+q satellite as measured at the L_2 (8.581keV, open points) and L_3 (7.789keV, closed points) resonant edges of Dysprosium

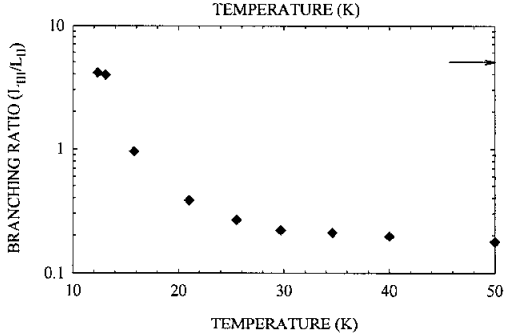

Figure 2: The temperature dependence of the ratio of the L_3 edge integrated intensity to the L_2 edge integrated intensity. The arrow indicates the ratio for $DyFe_2$ as determined by dicroism measurements [2].

References:

[1] J. .A. Paixão *et al.* to be published
[2] D. Watson *et al.* Phys. Rev. **B. 53**, 726 (1996)
[3] M. van Veenendal *et al.* Phys. Rev. Lett. **78**, 1162 (1997)