ESRF	**Experiment title:** Soft XMCD study of the Spin Reorientation transition in $R_2Fe_{14}B$ compounds	**Experiment number:** HE-143
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Report:

$Nd_2Fe_{14}B$ exhibits a Spin Reorientation Transition (SRT) at around 135 K in which the easy magnetization direction continuously rotates from the (001) axis (high temperature phase) towards the (110) axis (low temperature phase). Although the bulk magnetization behavior had been well determined, the evolution of the magnetic moments on the microscopic scale was poorly understood. Specifically, the evolution of the relative orientation of the Fe and Nd magnetic moments, as well as the change of their relative magnitude during the SRT, were not known.

In this experiment we have used Fe $L_{2,3}$ and Nd $M_{4,5}$ X-ray Magnetic Circular Dichroism (XMCD) to follow the Fe- and Nd-sublattice magnetizations through the SRT of a single crystal. We have applied the sum rules to determine the temperature dependence of the projected magnetic moments, to be compared with available Mössbauer spectroscopic measurements. We have been able to determine the angular distribution of both Fe- and Nd-sublattice moments as a function of temperature. The present study gives experimental evidence for the existence of non-collinear arrangements of both sublattices in the low temperature magnetic phase. In Figure 1, the temperature dependence of $\theta_{Fe}(T)$ and $\theta_{Nd}(T)$ determined from our XMCD experiment is shown, with θ the angle between the magnetic moments and the c-axis (tetragonal structure). An important new result is the observed delay in the reorientation of the Fe sublattice SRT with respect to that of the Nd sublattice by 10 K (Fig.1).

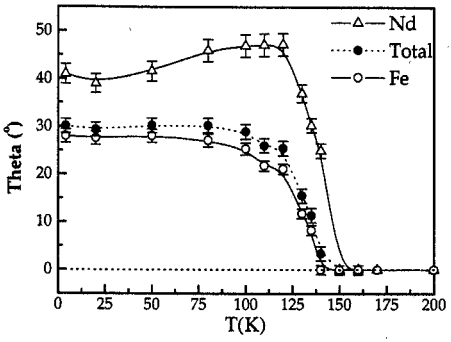

Figure 1

Application of XMCD sum rules to the Fe $L_{2,3}$ edges yields a behavior of $\langle S_z \rangle$ and $\langle L_z \rangle$ as a function of temperature. The obtained values are compatible with neutron diffraction data and band structure calculations respectively. Concerning the orbital Fe magnetism, we have found two new results of critical importance:

- we have observed a direct correlation between the orbital magnetic moment of Fe, the macroscopic anisotropy of the Fe sublattice and the tetragonal crystallographic distortion (c/a)
- we have observed (see Figure 2) a sharp peak (up to 70% in magnitude) in the temperature dependence of $\langle L_z \rangle$ just below the SRT, while no anomaly is detected for $\langle S_z \rangle$, an effect that cannot be correlated with the loss of symmetry in the low-T phase.

However, this effect seems to be correlated with $d\theta_{Fe}/dT$ (Figure 2), in such a way that the orbital instability seems to be associated with the phase transition.

This last effect is the first experimental evidence of an orbital instability through a phase transition and it opens a new subject of research. These results were presented as an invited talk by Luis Miguel García Vinuesa at the XMCD'99 workshop (ESRF, 12-13 February 1999) and a letter is in preparation to be published.

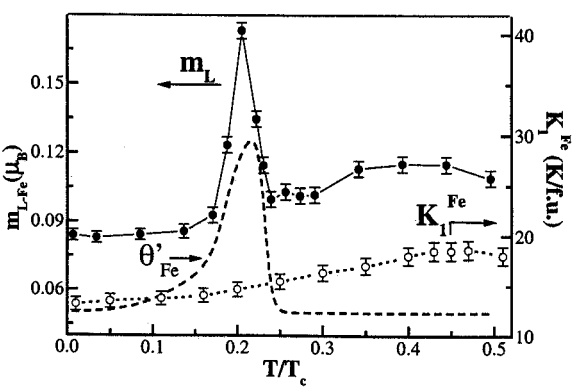

Figure 2