ESRF	**Experiment title:** Investigation of the induced magnetic profile in Ce/La/Fe multilayers by XRMS	**Experiment number:** HE526
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Report:

1) Introduction and objectives

In highly correlated Ce/Fe multilayers, cerium adopts an α-like electronic structure within 15Å from the Fe interface. XMCD experiments at the L and M edges, have shown that the hybridization of the Ce 5d and 4f states with the 3d states at the Fe interface induce at room temperature a magnetic order with weak magnetic moments on both the 5d and 4f states of Ce. XMCD results reveal a fundamental difference between the 4f polarisation which is restricted at the Fe interface, and the 5d one which extend over 15Å, though it decreases with Ce thickness. Our previous study on Ce(10-22 Å)/Fe(30Å) multilayer[1] suggest that the Ce 5d polarisation oscillates throughout the Ce layer with a period equal to the (111) interplanar distance in α fcc Ce. Though compatible with the XMCD findings, this oscillating behavior cannot be derived from the dependence of XMCD on the Ce layer thickness since the decrease of the magnetic polarisation prevents from observing changes in the sign of the XMCD amplitude.

2) Experimentals details

In order to get more insight on the complex behavior of the induced 5d states polarisation we have performed a x-ray resonant magnetic scattering (XRMS) experiment at the Ce L_2 edge on $Ce_{15Å}/La_{10Å}/Ce_{15Å}/Fe_{30Å}$ and $La_{15Å}/Ce_{10Å}/La_{15Å}/Fe_{30Å}$ multilayer. The XRMS experiments, which consist in measuring XMCD in scattering condition, have been performed at the ESRF ID12A beamline. The Daresbury two-circle diffractometer, allowing for work under high vacuum, was installed on the beamline. Circularly polarised X-rays were diffracted in the vertical plane and a magnetic field, strong enough to saturate the Fe magnetic moments, was applied parallel to both the diffraction plane and the surface sample. The beam line quality associated with a high efficiency detection device allowed us to extract very low asymmetry (~ 10^{-4}) with a good signal-to-noise ratio.

3) Results

We measured the energy dependence of the asymmetry ratios $R=(I^+-I^-)/(I^++I^-)$, where I^+ and I^- are the diffracted intensities for two opposite directions of the field, collected in the vicinity of the L_2 edge on top of several low angle Bragg peaks. Fig 1. And 2. displays this asymmetry ratio measuredfor the Ce/La/Ce/Fe and the La/Ce/La/Fe multilayer respectivly.

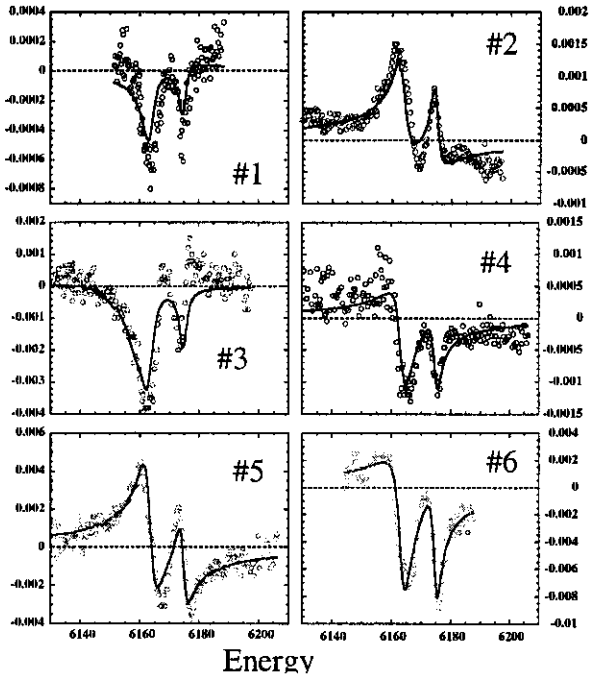

Fig 1: Energy dependance of the asymmetry ratio measured on top of the 6 first order Bragg peaks at the Ce L, edge of the [Ce/La/Ce/Fe] multilayer. Open circles show experimental values and full lines calculation leading to the magnetic profile

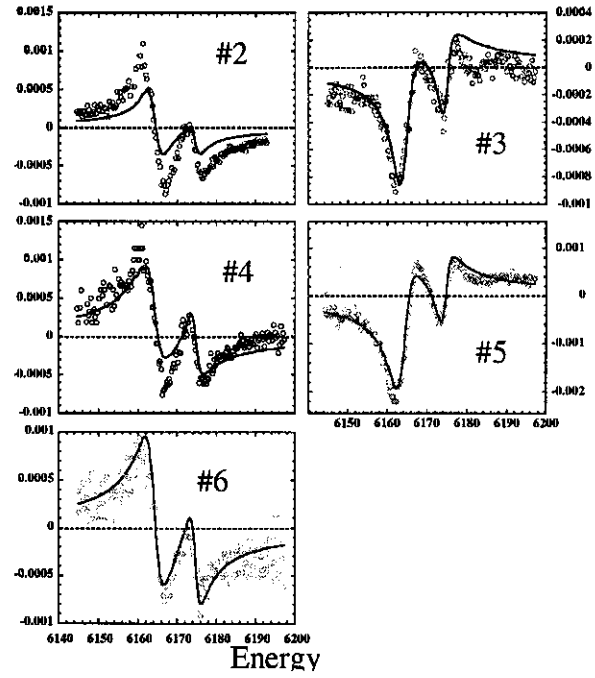

Fig 2: Energy dependance of the asymmetry ratio measured on top of the 6 first order Bragg peaks at the Ce L, edge of the [La/Ce/La/Fe] multilayer. Open circles show experimental values and full lines calculation leading to the magnetic profile

The simultaneous refinement of the asymmetry ratio (fig. 1 and 2) allow us to determine the Ce 5d induced magnetic profile accross the Ce layer for the two systems. As in the case of Ce/Fe multilayer which were investigated previously [1], an oscilalting magnetic profile is found for both the [CeLaCe/Fe] and [LaCeLa/Fe] multilayer. However, while it is sharply decreasing in [CeLaCe/Fe] it is only slowly decreasing in [LaCeLa/Fe] with larger polarization value for Ce atoms at distances far from the Fe interface. Therefore, these different behavior indicate that the magnetic polarization can be described in two main feature : the first is the decay, which as to be related to the 3d-5d hybridization, and the oscilaltion. For this oscillation it is necessary to invoke an other mechanism to explain, first the presence of a magnetic polarisation of Ce atoms in [LaCeLa/Fe] where there is no interface with Fe and second the change of sign from plane to plane. These observation are in line with the suggestion of an intrinsec properties of the ground state of α-like Ce done by Arend *et al.* [3]. The autors stress that strain effects in the Ce ultra-thin layer may be the origin of subtle changes in the electronic configuration of Ce which is still α-like phase but close to the transition into γ-like phase and, hence, very close to a magnetic instability according to the theoritical work of Min et al. [4]. However a clear explanation of the antifferromagnetic coupling from slice to slice in the Ce layer, which is probably not induced by Fe interface, is still missing.

The results have been presented as an oral communication has been accepted to be presented at the SXNS6 conference in Amsterdam, September 1999 [2]. One publication is in print in Physica B. An extend publication is in preparation.

[1] L. Sève *et al.*,Phys. Rev. B **60** (1999) 9662
[2] N. Jaouen *et al,*.Physica Baccepted for publication
[3] M. Arend et al., Phys. Rev. B 57 (1998) 2174