



	Experiment title: (#1/2) SPIN POLARIZATION OF Rh 4d VALENCE STATES IN Fe ₅₀ Rh ₅₀	Experiment number: HE-333
Beamline: ID 12A	Date of experiment: from: 15 April 1998 to: 21 April	Date of report: 27-8-98
Shifts: 12	Local contact(s): ANDREI ROGALEV	Received at ESRF: 01 SEP. 1998

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Report:

We divided our 24 shifts into two sessions one devoted to the FeRh as planned, the other to RIXS in Ce intermetallics (see separate report). There were two reasons. One was that we encountered some experimental difficulties running the FeRh experiment requiring changes to our experimental set-up (see below). The other was that our previous experiments on Ce intermetallics had been curtailed by 7 shifts as a result of the storage ring breakdown (Nov. 1997). We therefore present two reports.

Our experiments on Co-Rh magnetic alloys performed at ESRF [Gallet et al., Phys. Rev. B 57, 7835 (1998)] have successfully shown the validity of non-resonant x-ray inelastic scattering for identifying the spin-polarization of 4d valence states. We have also shown that the technique is sensitive enough to observe modifications in the spin polarization when 15% Co or Rh is replaced by another element (Ni substituted for Co; Ru or Pd for Rh).

We use the bandpass of the first order peak of Helios II to excite a Rh **2p** core electron to the **continuum states** (i.e., to non-polarized states). The **2p** core hole is polarized due to the use of the highly circularly polarized photons ($\approx 93\%$). Its decay probes the up or down spins in different proportions according to the handedness of the polarization of the photons used in the ionization. The $4d \rightarrow 2p$ x-ray emission dichroism for the two magnetization directions is measured using a UHV-compatible high resolution x-ray spectrometer which we have specially adapted to the white beam section of ID12A. The results allow for a more straightforward interpretation than when dealing with the 3d transition metals [Eisebitt et

al., Solid State Commun. 104, 173 (1997), Gallet et al., cited above].

$\text{Fe}_x\text{Rh}_{1-x}$ at $x=0.5$ has an antiferromagnetic (AF) to ferromagnetic transition at temperature T_{tr} well above room temperature (see Fig. 1). This is accompanied by enhanced thermal expansion. We are particularly interested in observing the x-ray emission dichroism as the temperature crosses T_{tr} and as a function of x . Though we were indeed able to observe dichroism in $\text{Fe}_{50}\text{Rh}_{50}$ (see Fig. 2) we found a very much larger discrepancy than we anticipated between the temperature measured by means of a thermocouple and the true temperature at the point of impact of the beam. In fact we were unable to go down to the AF-phase (that is below T_{tr}) despite the use of liquid nitrogen cooling of the sample holder. From the variation in temperature with and without the beam we estimated the heat load to be approximately 2 w.

Measurements were taken by reversing the magnetic field at each energy step. Checks on the validity of the signal were made by reversing the undulator phase and also using a magnetic field oriented perpendicular to the photon polarization. The measurements, taken well above T_{tr} are compared with an ASW bandstructure calculation for $\text{Fe}_{50}\text{Rh}_{50}$ in the CsCl structure. The magnetic field was approximately 0.1 T. We are planning improvements to the sample cooling and temperature control.

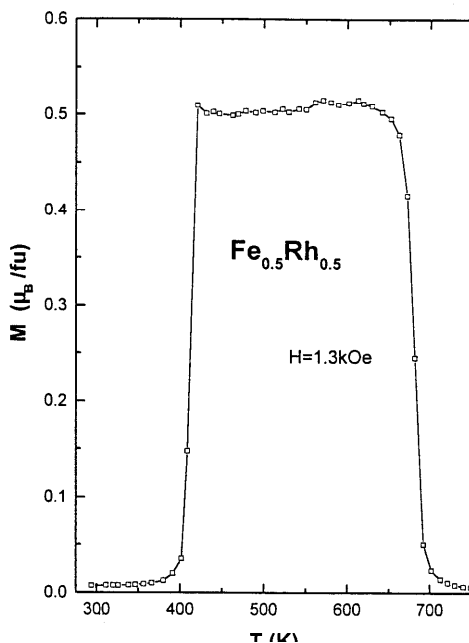


Fig. 1

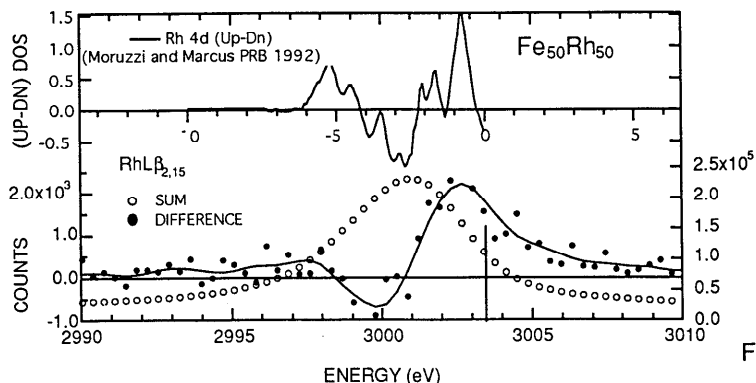
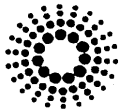


Fig. 2



ESRF

	Experiment title: (#2/2) RIXS at the Ce L3 edge in CeF ₃ and highly correlated systems.	Experiment number: HE-333
Beamline: ID 12A	Date of experiment: from: 22 April 1998 to: 27 April	Date of report: 27-8-98
Shifts: 12	Local contact(s): ANDREI ROGALEV	<i>Received at ESRF:</i> 01 SEP. 1998

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Report:

High energy spectroscopies have been at the forefront in the elucidation of cerium's mixed valent behaviour. In particular L_3 x-ray absorption spectra have been extensively analysed to extract an empirical "spectroscopic valence" based on the relative intensities of f^1 and f^0 related features corresponding to a $2p \rightarrow 5d$ excitation where the core hole will either be screened by a localized f electron (plus the $5d$ conduction electron) or less effectively by more delocalized hybridized $5d-4f$ states. There is also the small probability of a quadrupole transition leading to a very well screened $2p^5 4f^2$ final state. Excitation to these three final state configurations in an x-ray absorption process are the intermediate states of resonant inelastic x-ray scattering (RIXS) involving the $3d \rightarrow 2p$ decay channel [see Krisch *et al.*, Phys. Rev. Lett. 74, 4931 (1995)].

Fig. 1 shows the RIXS data for CeF₃ with its nominal configuration of $4f^1$ in the ground state. It is a particularly clear example of the information available from such experiments. A double structure situated in the region of 880 eV energy loss (energy loss is the difference between the incident and scattered photon energy) marks the $3d^9 4f^2$ final state involving a quadrupole

transition in the primary excitation. At 887 eV we observe a very highly localized 5d state identified by a Raman process both below and above threshold excitation. The peak which disperses as the excitation energy is increased from b to g is normal “resonant” fluorescence (the $3d \rightarrow 2p$ transition takes place after ionization). The intensity of the peak is related to the localization of the 5d states in this ionic compound.

In the highly correlated Ce intermetallics the 5d states are less localized because of much stronger hybridization with neighboring atoms. This in turn plays a role in the 4f–5d hybridization. In Fig. 2 we show RIXS data taken at the resonant energy of the quadrupole transition for a number of Ce systems with different effective $4f^1$ occupancy. It illustrates the sensitivity of this second order process.

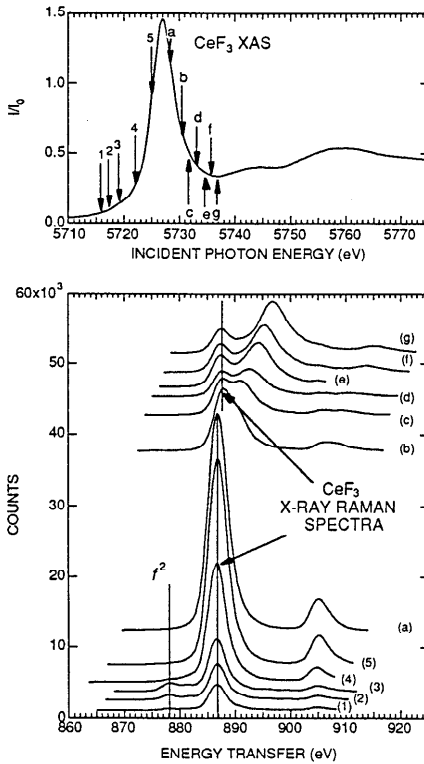


Fig. 1: RLXS at the Ce L_3 edge in CeF_3 (an energy transfer scale is used to clearly separate Raman and normal fluorescence).

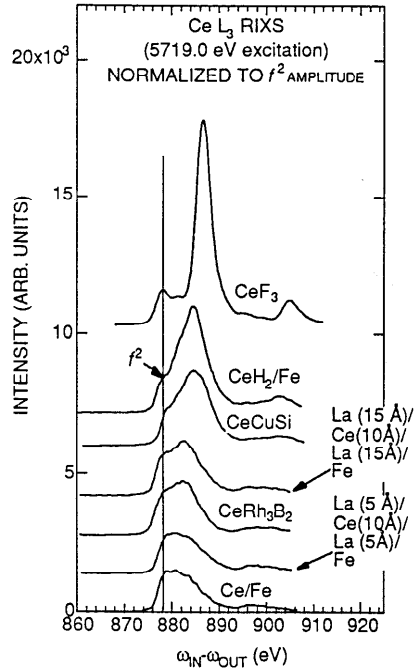


Fig. 2: RIXS at the Ce L_3 edge in various Ce compounds and multilayers (spectra are normalized to the same $3d^9 4f^2$ peak amp.).