ESRF	Experiment title: Radiative cascade relaxation of core-holes excited with cicularly polarized photons	Experiment number: HE-122
Beamline: ID12A	**Date of experiment:** from: Feb 27 to:Mar 12	**Date of report:** Aug 28,1997
Shifts: *30*	**Local contact(s):** José Goulon	***Received at ESRF:***

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ESRF

Report:

These resonant inelastic x-ray scattering (RIXS) experiments, the first to ***be performed on beamline ID12A***, had three main objectives:

1) Assess the possibilities of performing RIXS experiments using the KoHzu monochromator in the important 3-6 keV energy range. For x-ray analysis we use a compact custom-built bent-crystal spectrometer. It is completely UHV compatible and the radiation path is continuously under vacuum. It is designed to operate in various detection modes. As predicted by structure factor calculations a beryl crystal operating in fifth order proved to be highly efficient in the 5 keV range. A variety of other crystals are also available.

2) Investigate the possibility of detecting radiative cascade relaxation. Such transitions, only studied, so far, in the hard x-ray to y-ray region, are of intrinsic interest. They would also be a way of extending the lower energy limit of the beamline. To test this possibility we examined the Gd $L_3 \rightarrow 5d^1$ excitation: $|G> \rightarrow 2p^5 3d^{10} 5p^6 5d^{n+1} 4f^m \rightarrow 2p^6 3d^9 5p^6 5d^{n+1} 4f^m$, followed by $\rightarrow 2p^6 3d^{10} 5p^6 5d^{n+1} 4f^{m-1}$ or $\rightarrow 2p^6 3d^{10} 5p^5 5d^{n+1} 4f^m$.

3) Perform RIXS experiments at a rare earth L_3 edge. Two scanning modes were used: ω_2 at constant ω_1 and ω_1 at constant ω_2 (ω_1 and ω_2 are the incoming and outgoing photon energies). Here too the experiments were primarily performed with the purpose of preparing forth-coming experiments, in particular on the Ce-Fe layered systems. Relatively very few experiments of this type have been reported. Notable exceptions are work by Hämäläinen et al. [I], Krisch et al. [2], and, from a theoretical view point, Can-a et al. [3].

We chose to put the emphasis on the $2p \rightarrow 4f$ E2 transition in Sm which has the nominal $4f^6$ ground state.

Results

We were unable to detect significant signal strength from the cascade transitions we were looking for. Renormalising to the $2p^53d^{10}5d^{n+1} \rightarrow 2p^63d^95d^{n+1}$ signal observed in fifth order, enabled us to ascertain that the cross section for the cascade process was more than one order of magnitude smaller than expected. The origin of this finding is still under examination.

The RIXS experiments were performed to plan. Here it should be pointed out that the mutichannel-plate detector used for the experiment was optimised for the low energy transitions. Its very low efficiency above = 2 keV was an advantage in the cascade experiments (the tail of the high energy emissions in higher order did not mask the spectral region of interest), but an obvious handicap for these studies. A specific detector system for future high energy studies will make it possible to improve resolving power. Spectra taken in the two modes are shown Figs. 1 and 2. In Fig. 1 the E2 transition is well identified as ω_2 is scanned at fixed values of $\omega_1 < L_3$. Fig. 2 shows ω_1 scanned as a function of various values of ω_2 selected by means of an "electronic window" set on the position-sensitive detector. The E2 transition was picked out by suitably choosing ω_2. We are presently working on an analysis of the data the objective being a quantitative assessment of the E2/El ratio.

[I] K. Hämäläinen et al.. Phys. Rev. Lett. 67, 2850 (1991)

[2] M. H. Krisch et al., Phys.. Rev. Lett. 74, 4931 (1995)

[3] P. Carra et al., Phys. Rev. Lett. 74, 3700 (1995)

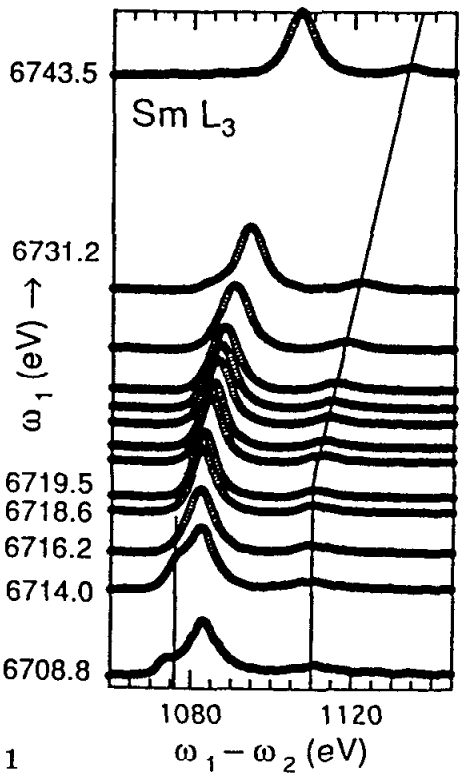

Fig. 1

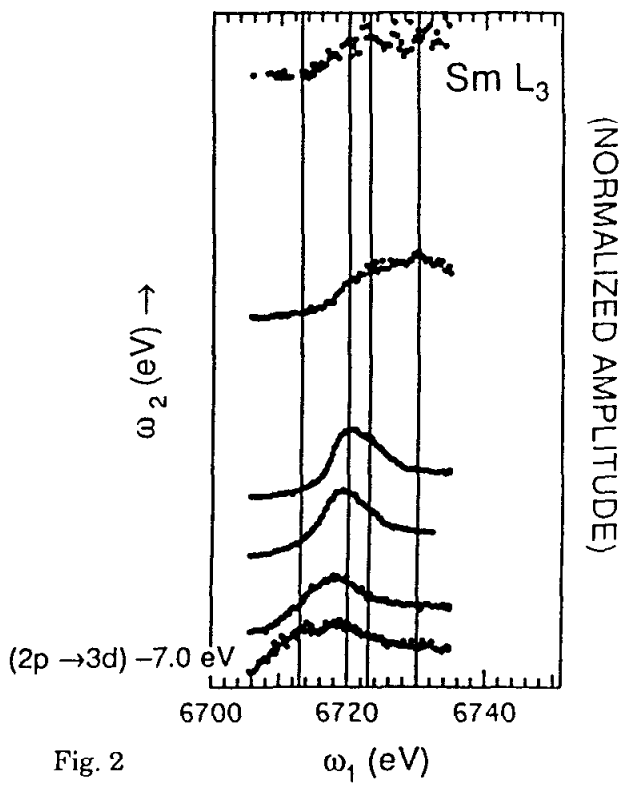

Fig. 2