Experiment title: Study of the charge and magnetic modulations in CeSb by resonant x-ray scattering at the Ce and Sb absorption edges	Experiment number: HE-1502

Beamline: ID20	Date of experiment: from: 25/06/03 to: 01/07/03	Date of report: 21/03/02
Shifts: 18	Local contact(s): L. Paolasini	*Received at ESRF:*

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Report:

CeSb has a very complex magnetic phase diagram. Schematically, the magnetic structure propagates along the cubic axes, where "spin up" and "spin down" ferromagnetic planes alternate with paramagnetic planes, in different sequences giving different propagation vectors τ_{mag} along the cube axes. The magnetic phases of CeSb are thought to be made of two types of Ce atoms, which leads to different interatomic distances, and therefore to lattice distortions, with a different propagation vector τ_{lat}.

The magnetic properties have been accounted for by the existence of a strong *p-f* mixing due to the electronic structure of the Ce. It has been proposed that the valence *p* electrons hybridize strongly with the Ce 4*f* electrons, leading to a reduction of the crystal field splitting, to an extremely large magnetic anisotropy and to the peculiar sequence of antiferromagnetic phases below T_N. Band calculations indicate that the valence *p* electrons come mainly from the pnictides (Sb and Bi).

In a first experiment (HE-1287), we observed that the skin region of the sample – probed by the X-rays - was frozen in the $|\tau_{mag}|!=!4/7$ phase (with lattice distortion propagation vector $|\tau_{lat}|=2/7$). That first experiment concentrated on the energy dependence of the resonances Ce L_2 and L_3 edges. The analysis shows unambiguously the presence of a resonant (dipole) charge contribution, on top of the known resonant magnetic contribution [1].

The present experiment concentrated on the azimuthal dependence of the resonant intensities, at the Ce L_2 and Sb L_1 edges. We used the same sample, a 4x4x4mm^3 cube cleaved along the cube faces and polished, as in the first experiment. It was mounted in a displex cryostat, on the 4-circle diffractometer of ID20, equipped with azimuthal stage and polarization analysis. We used a vertical scattering plane and different polarization analyzer crystals: LiF (220) at the Ce L_2 edge, and Al (200) at the Sb L edges. CeSb is highly oxidizing and, despite careful handling, we noticed in the course of the experiment that the sample had degraded since the first experiment and was less homogenous, making the normalization of data more delicate.

At the Ce L_2 edge, no effect could be detected in the azimuthal dependence, within the experimental accuracy.

At the Sb L_1 edge, the resonant intensities are very weak, typically 10 counts/s at the maximum of the resonance. We measured energy dependence of the integrated intensity (rocking curves) of the (0 4/7 2) magnetic satellite for two different values of the azimuth: $\psi \approx 0$, where the moments are in the scattering plane, and $\psi \approx 45°$, where the moments make an angle $\approx 45°$ with the scattering plane. The results are shown in the figure below.

The 45° azimuth corresponds to the position studied in the first experiment. The results were reproduced, with better statistics, showing a broad resonance centered around the energy of the absorption edge. Surprisingly, at the 0° azimuth, the measured resonance has a different lineshape. The comparison of the results at both azimuths shows that the resonance has two components, peaking below and above the edge, respectively. This is very different from the observations in UAs and UGa$_3$ where the line-shape of the resonance does not depend on the scattering geometry, and the resonance is interpreted in terms of spin-polarization of the 4p electrons of the non-magnetic ions [2]. Moreover, the fact that the two components have a different azimuthal dependence points to a different origin.

For a magnetic origin, the dipole resonant magnetic intensity is expected to be reduced by a factor ≈ 2 (taking the absorption into account) when changing the azimuth from 45° to 0°. This corresponds to the observation for the resonance above the edge. However, the resonance below the edge increases by a factor 4 when changing the azimuth. This obviously points to a different origin.
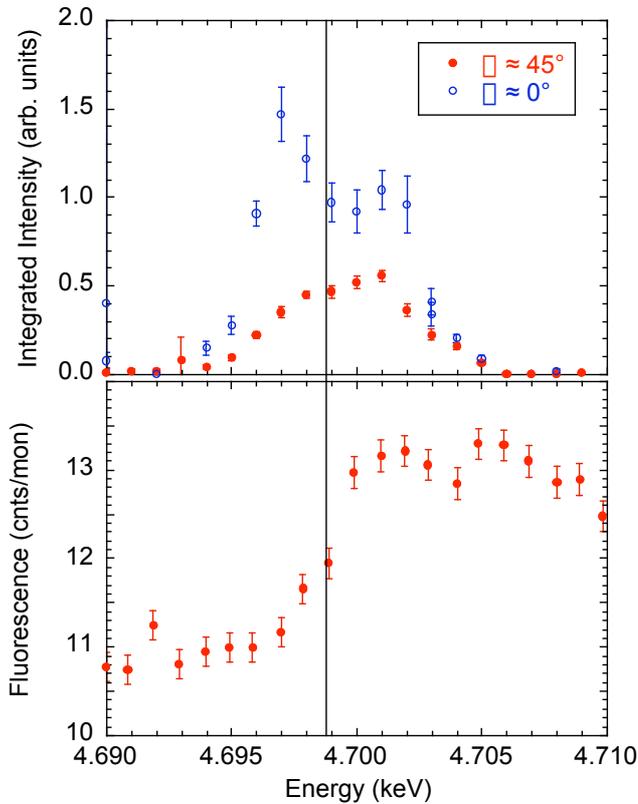

Fig2: Energy dependence of the (0!4/7 2) magnetic intensity around the Sb L_1 edge. The vertical line marks the position of the inflexion point in the fluorescence.

[1] A. Stunault, C. Vettier, L.P. Regnault, F. de Bergevin, L. Paolasini, to appear in Physica B

[2] D. Mannix, A. Stunault, N. Bernhoeft, L. Paolasini, G.H. Lander, C. Vettier, F. de Bergevin and D.!Kaczorowski, Phys. Rev. Lett. 86, 4128-4131(2001)