ESRF	**Experiment title:** Magnetic and charge modulation in $CeAl_2$ below T_N	**Experiment number:** HE-307
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Names and affiliations of applicants (* indicates experimentalists):

*J.Schweizer, CENG, DRFMC/SPSMS/MDN, F-38054 Grenoble Cedex 9

*J.X.Boucherle, CENG, DRFMC/SPSMS/MDN, F-38054 Grenoble Cedex 9

*F.Givord, CENG, DRFMC/SPSMS/MDN, F-38054 Grenoble Cedex 9

*A.Stunault, XMaS CRG at ESRF, BP220, F-38043 Grenoble Cedex

Report:

The cubic Laves phase $CeAl_2$ shows antiferromagnetic order below $T_N = 3.8$ K. The complex magnetic structure has already been extensively studied using neutron scattering [1-4]. The magnetic structure is double-**k**, with propagations vectors $\mathbf{k}_1$ and $\mathbf{k}_2$ that are coupled: $\mathbf{k}_1 = (1/2+\delta\ \ 1/2-\delta\ \ 1/2)$ and $\mathbf{k}_2 = (1/2+\delta\ \ 1/2-\delta\ \ -1/2)$, with $\delta = 0.112$. The associated Fourier components of the magnetic moments, $\mathbf{m}^{\mathbf{k}_1}$ and $\mathbf{m}^{\mathbf{k}_2}$, are close to (but deviate slighlty from) the diagonals of the cube, (1 1 1) and (1 1 −1) respectively in the present case. There are 12 magnetic domains, corresponding to all possible $(\mathbf{k}_1, \mathbf{k}_2)$. The Kondo effect is held as responsible for the modulated stucture and for the reduction of the moments. Following upon the onset of the magnetic modulation, one may expect a charge modulation resulting from the interaction between neighboring atoms. The anticipated propagation vectors of the charge modulation are $2\mathbf{k}_1$ and $2\mathbf{k}_2$. The experiment aimed at a study of the charge modulation.

The sample was mounted in a He cryostat, implying the use of horizontal scattering geometry, with the (1 1 −2) axis vertical. We had access to one magnetic domains in the horizontal plane, with propagtion vector $\mathbf{k}_1$. The first (preliminary) part of the experiment concentrated on the study of the resonant x-ray magnetic scattering cross-section close to the cerium L_2 and L_3 edges (6.164 keV and 5.723 keV respectively). To avoid sample heating by the photon beam, we had to attenuate the incoming beam by a factor 16. To reduce the charge and fluorescence background, we used polarization analysis. Magnetic intensities were observed at both edges, in the rotated π-σ polarization channel. The measured intensities were extremely weak at the L_3 egde (less than 0.4 photons/s) and stronger (of the order of a few photons/s) at the L_2 edge, which is in agreement with previous observations in CeSb [5]. Fig.1 shows the observed resonance at the L_2 edge, at the $(3.5+\delta\ \ 3.5-\delta\ \ 3.5)$ magnetic satellite. Other satellites have also been measured. The wave-vector dependence is consistent with a dipolar (2p-5d) origin of the resonance. Whereas the fluorescence line is consistent with the core hole life time deduced from atomic calculations (fwhm $\Gamma \approx 1.9$ eV) as indicated by the fit of the low energy tail of the fluorescence line (fig.2), the energy line-width of the resonance is larger, and must be related to the band character of the excied level.

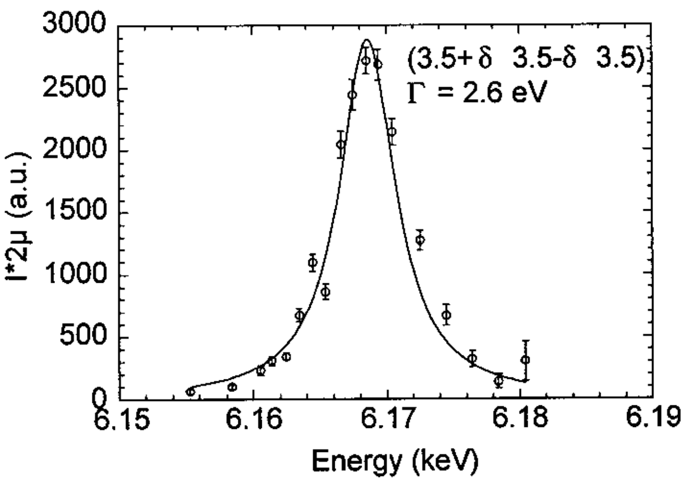

Fig.1: energy dependence of the magnetic intensity around the Ce L_2 egde

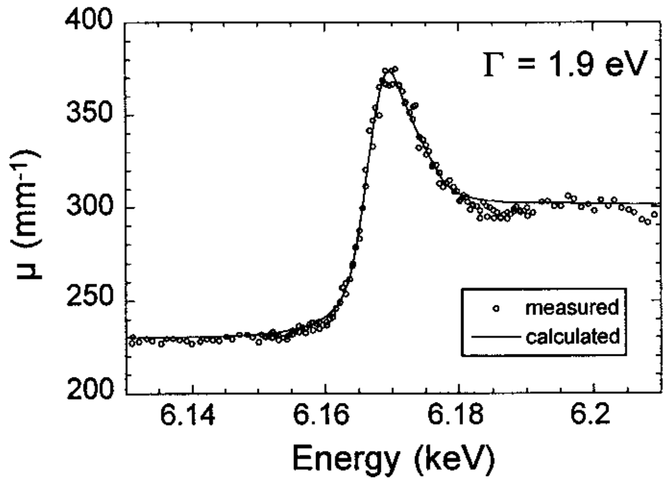

Fig.2: absorption around the Ce L_2 edge

We then concentrated on the charge modulation. Several reflections corresponding to the $\mathbf{2k_1}$ propagation vector were observed, only in the un-rotated π-π polarization channel, as expected from charge scattering. We measured scans in the reciprocal space both at Bragg positions from the crystal lattice and at positions corresponding to the charge modulation. The comparison of the integrated intensities leads to an amplitude of the modulation of the order of $10^{-5}\,a$, *a* being the lattice constant.

References

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