ESRF	**Experiment title:** Study of valence in heavy-fermion systems by XAS in pulsed magnetic fields up to 31 T	**Experiment number**: HC1305
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Names and affiliations of applicants (all experimentalists):

KNAFO William, DUC Fabienne, POUX Armelle, FRINGS Paul - LNCMI-Toulouse

AOKI Dai, KNEBEL Georg, LAPERTOT Gérard, BRAITHWAITE Daniel - CEA-Grenoble

HAEN Pierre - Institut Néel, Grenoble

RUEFF Jean-Pascal, BALEDENT Victor - Synchrotron Soleil, Saint Aubin

Report:

The experiment HC1305 was the continuation of experiments HE3934 and HC1040: it consisted in the study of valence by XAS in the heavy-fermion materials $YbRh_2Si_2$ and $YbCu_2Si_2$ in pulsed magnetic fields up to 31T and down to 2 K.

For this final experiment on Yb-based material family, a new method of polishing was used to improve the quality (thickness and homogeneity) of the samples. Samples with less than 20 µm thick and mirror surfaces were then prepared. For both compounds $YbRh_2Si_2$ and $YbCu_2Si_2$, two sets of samples were prepared so that the x-ray beam propagation vector (*BPV*) was applied either parallel to the *a*- or to the *c*-axis of the compound. To check the quality of our samples, we first dedicated one day to perform at room temperature x-ray absorption maps of all the samples. Due to the high acquisition speed, we acquired full XAS spectra in each position of the sample (i.e. each pixel in the maps shown in Figure 1) and could visualize the absorption jump value across the sample. These maps allowed us to identify the region of the sample most suitable to measure (the most homogeneous part, with thickness adjusted to one absorption length,) (cf. *Fig. 1*). Thanks to the very focused beam provided by the ID24 beamline (10*10 μm^2), we could be very accurate avoiding electrical contacts (cf. *Fig.1*, top left) or cracks

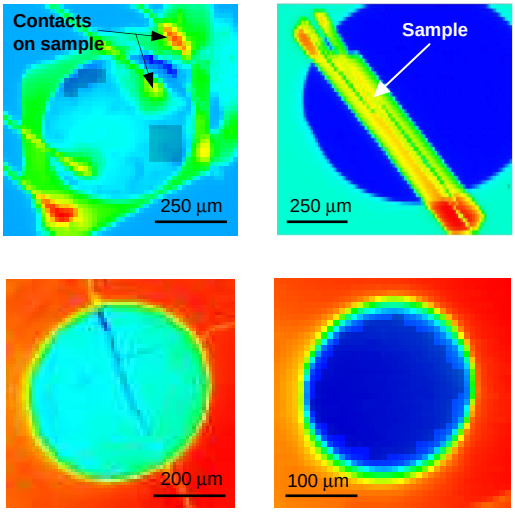

*Fig. 1: (on top left) Maps of $YbRh_2Si_2$ **BPV** || **c**, (on top right) $YbRh_2Si_2$ **BPV** || **a**, (bottom left) $YbCu_2Si_2$ **BPV** || **c**, (bottom right) $YbCu_2Si_2$ **BPV** || **a**. Samples are mounted on silicon supports. Two holes have been drilled on these supports to measure the direct beam and the sample in transmission mode.*

on the sample as we could observe on the $YbCu_2Si_2$ with ***BPV*** || ***c*** (cf. *Fig.1*, bottom left).

The set-up and the parameters for the synchronisation of the beam shutter opening and the triggering of both the detector and the generator were the same as in the previous experiment (see report HC1040).
The temperature of the contacted sample $YbRh_2Si_2$ with ***BPV*** || ***c*** (cf. *Fig. 1*) was checked thanks to the simultaneous resistivity measurements, as performed previously (see reports HE3934 and HC1040). The beam heating of the sample was reduced by selecting a restricted range of incident energies and by adding aluminium foils before the sample in the incident beam path. For $T_{cryostat}$ = 2 K the measured temperature on the sample was T_{sample} = 4 K.

XAS measurements at the L_3 edge of Yb have been first performed on the $YbCu_2Si_2$ samples.
Selected XAS spectra and differences obtained as a function of temperature and magnetic field are reported on Fig. 2.
These data clearly show a change of valence depending on the temperature. This variation is of the same order of magnitude for both crystallographic directions.
On the other hand, no change of valence is observed upon the application of magnetic field when the latter is applied along the hard magnetic axis ***H*** || ***a*** whereas a tiny change is detected for ***H*** || ***c*** (easy magnetic axis).

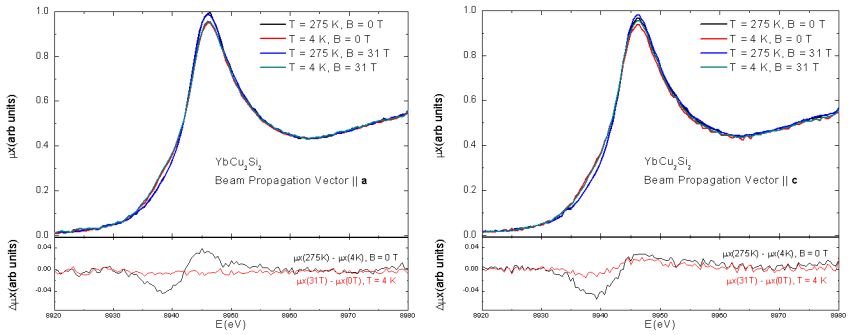

*Fig.2: (left) XAS spectra and differences depending on the temperature and magnetic field for $YbCu_2Si_2$ || **a** (right) XAS spectra and differences depending on the temperature and magnetic field for $YbCu_2Si_2$ || **c***

Fig.3 reports the XAS spectra and difference obtained on $YbRh_2Si_2$ with ***BPV*** || ***c***. Here also, a change of valence is clearly visible as a function of temperature.
However, when we applied the magnetic field along its hard magnetic axis ***c***, no field-induced change of the valence is detected, within our experimental error, as shown by the flat red curve in the bottom part of Fig. 3.
The measurements on $YbRh_2Si_2$ with ***BPV*** || ***a*** were more difficult. As a matter of fact, the $YbRh_2Si_2$ samples are platelet-like crystals with the largest cross-section perpendicular to ***c***-axis (L x l x h = 1 x 1 x 0.05 mm^3). They are therefore more difficult to polish, leading to smaller and thicker samples than the one prepared with cross sections perpendicular to the ***c***-axis (see Fig.1). Besides, they are more inhomogeneous (different colours in maps are characteristic of inhomogeneities). These inhomogeneities correspond to indium used to grow the crystals. This led to noisy spectra with a reduced white line.

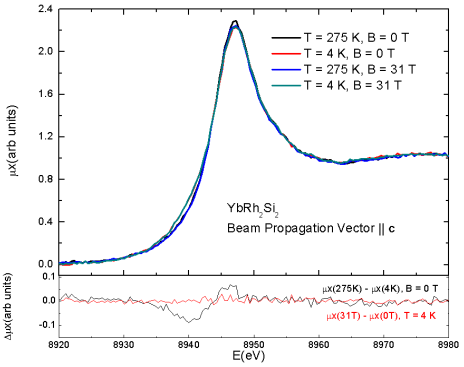

*Fig.3: (left) XAS spectra and differences depending on the temperature and magnetic field for $YbRh_2Si_2$ || **c***

In summary, these measurements confirm the results obtained previously (experiment HE3934) on $YbCu_2Si_2$ and $YbRh_2Si_2$ when the magnetic field is applied parallel to the ***c***-axis. In addition, this experiment allowed to complete the study of $YbCu_2Si_2$ samples by applying the magnetic field parallel to the ***a***-axis. A change of valence intimately connected to the magnetic anisotropy was thus observed in this compound.
For $YbRh_2Si_2$ with **BPV** // ***a***, samples were not large and thin enough to measure good quality XAS spectra in transmission mode. To go further on this compound, we discussed the possibility to perform static high magnetic field (up to 17 T) XAS and XMCD measurements in fluorescence mode on the ID12 beamline.