	Experiment title: Study of the Induced Orbital magnetism of Au in UAu_4 ferromagnetic compound using XMCD	**Experiment number**: HE-3448
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Report:

We have probed the magnetism of the 5f shell of U and the induced magnetism of the 5d shell of Au in UAu_4 and related magnetic (UAu_3 and $U_{14}Au_{51}$) compounds by means of x-ray magnetic circular dichroism (XMCD). Only XMCD can provide a element specificity together with an quantitative answer on spin and orbital magnetic moments thanks to the well established sum-rules. It is the most appropriate technique able to separate spin and orbital magnetic moment contributions.

It was proposed i) to check if the violation of third Hund's rule occurs in Au in the magnetic UAu_4 and related uranium-gold based compounds similarly as in VAu_4 alloys using x-ray magnetic circular dichroism and ii) to determine the 5d spin, orbital and total magnetic moment of Au and U 5f spin, orbital and total magnetic moment in UAu_4 and related compounds and compare it with the recent results obtained on VAu_4 and $MnAu_4$ alloys.

The polycrystalline UAu_4, UAu_3, and $U_{14}Au_{51}$ compounds were synthesised by an arc melting method under purified argon atmosphere. Only UAu_4 and UAu_3 were annealed in

high evacuated quartz tubes at 923 K and 1023 K, respectively. The furnace was slowly cooled to room temperature with a cooling rate of 0.6°C/h. All the samples w ere proved to be single phase by x-ray diffraction measurements, with the Ni_4Mo- type tetragonal (for UAu_4), the $PuAg_3$- type hexagonal (for UAu_3), and the $Gd_{14}Ag_{51}$- type hexagonal (for $U_{14}Au_{51}$) crystal structures.

All the measurements have been carried out in the 17T superconducting magnet built by Cryogenic Ltd at the lowest temeprature 2.20K. In Figure 1 is shown the XANES and XMCD recorded at 17T and 2.20K at the U $M_{5,4}$-edges. All samples shows a similar XANES and XMCD signal in shape and in amplitude which means that U carries a similar field induced magnetic moment. The magnetization curve recorded at the U M_4-edge is shown in Figure 2 and is similar than the one obtained from macroscopic measurements (SQUID).

Figure 1

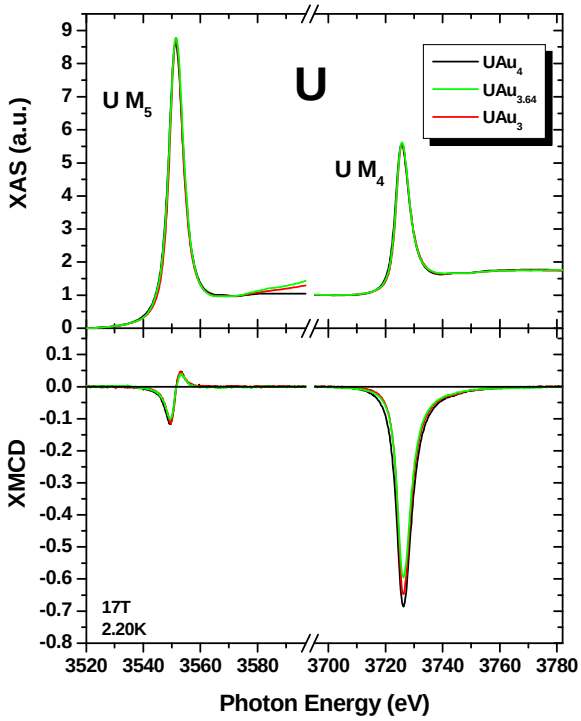
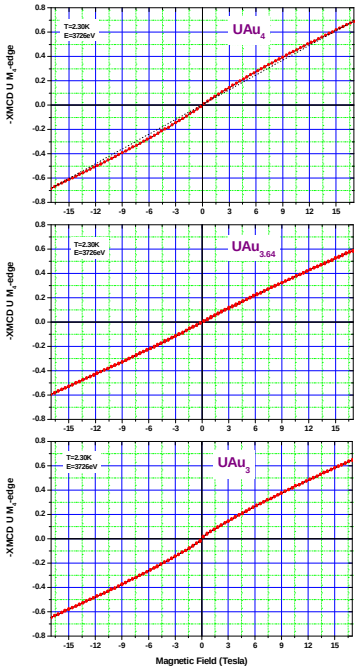


Figure 2

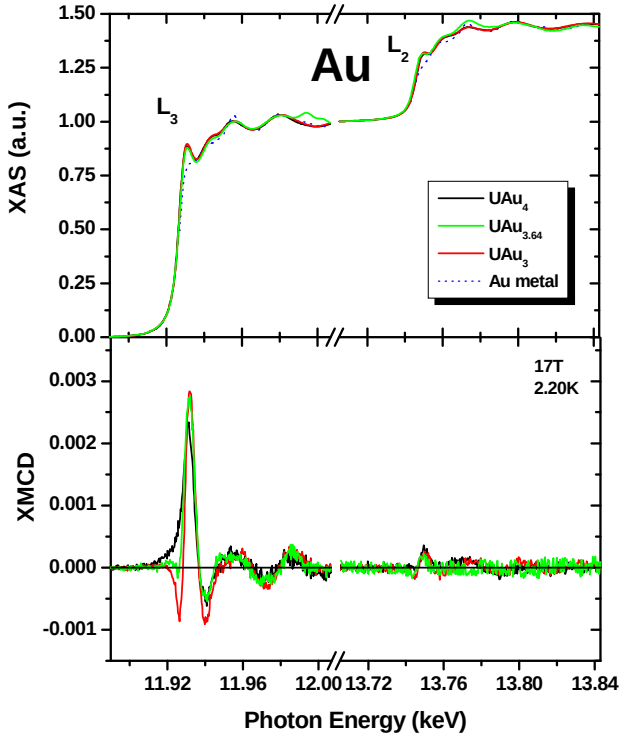


From the isotropic XANES spectra we have obtained an expectation of the 5f spin-orbit interaction per holes similar to pure U metal and that most likely U is U^{3+}. We found out using the sum-rules assuming an intermediate coupling scheme for the T_z that the total magnetization of U 5f under 17Tesla and at 2.20K is about $0.37\mu_B$/atom which is agrees fairly well with SQUID.

Next we have recorded the Au $L_{2,3}$-edges XANES and XMCD under 17T and 2.20K. For all samples, a relatively large positive and a weak positive XMCD signals have been observed at the Au L_3 and L_2 edges respectively as seen in Figure 3. It means according the sum-rules that Au 5d carries a large orbital moment aligned parallel to its spin and both are coupled anti-parallel to the U magnetization. There is then no violation of the third Hund's rule but we found that the induced Au 5d orbital moment can be as large as the spin moment

(independantly of the applied field). The magnetization curve recorded at the Au L_3-edge is identical to the one recorded at the U M_4-edge (not shown).

Figure 3



From the sum-rules analysis at the Au L-edges, we have obtained an 5d induced magnetization at 17T and 2.20K which is about -0.003μ_B/atom with an orbital-to-spin ratio that changes from ~0.5 up ~1 for UAu_3 and UAu_4. When looking more in details, we found that the induced Au 5d magnetization does not scale with the U magnetization and that the the induced Au 5d orbital-to-spin ratio varies within the series. This is also reflected by the fact the XMCD signal shape at the L_3-edge changes as a function of U content. The Au 5d states are strongly affected by the 5f U spin-orbit coupling and therfore an enhanced Au orbital moment with respect to 3d-Au systems is found.

As a conclusion, we have successfully carried out XMCD experiments on UAu_4, UAu_3, and $U_{14}Au_{51}$ intermetallic compounds as a function of low temperature and high magnetic field both with ground-state properties such as magnetization. A sizeable magnetic moment was evidenced by XMCD signals at the Au -$L_{2,3}$ edges. We believe that XMCD provide unequivocal information not readily obtained by the other technique like SQUID.