ESRF

Experiment title: **Magnetic Compton profile of UNi_2**

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Beamline: ID15A

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Report:

In recent years, the study of uranium compounds have attracted much interest because of the variety of properties these materials can have at low temperatures. Depending on the strength of the hybridization of the 5f electrons either with the conduction band or with the ligand valence states, the 5f electrons are itinerant or localized [1,2]. Since a number of uranium intermetallics are magnetic one important question is whether the magnetism is best described within a localized or an itinerant picture. Also because the spin-orbit interaction (Δ_{SO}) is of appreciable strength compared to the 5f band width (W), the orbital moment may be substantial in contrast to the ***3d*** metals [3]. Therefore there is much interest to distinguish experimentally the different contributions to the magnetism of uranium compounds. Magnetic Compton diffraction experiments gives the opportunity to measure the spin magnetic moment of each electron shell for each species of a ferromagnet [4,5,6,7].
The first goal of our experiment was to determine the spin densities of unpaired electrons in UNi_2. This moment should be mainly due to the uranium 5f electrons. According to polarized neutrons scattering and theory, it exhibits an almost complete cancellation of orbital and spin magnetism ($\mu_S = -0.47(16)\mu_B$ and $\mu_L = 0.55(17)\mu_B$) [8,9]. UNi_2 crystallises in the hexagonal Laves phase, orders ferromagnetically at T_C = 21 K with the b axis as the easy axis. It has a huge magnetic anisotropy [10]. The experiment was performed at 11 K with a magnetic field of 0.9 T along the easy axis. But, at this temperature, the spin density seems to be too small and can't be detected with our statistic. Our measurement gives no evidence for a magnetic signal at 11 K.
Then, we made experiment on the ferromagnet US which crystallizes in the cubic NaCl structure. It is characterized by a Curie temperature T_C = 177 K and a strongly anisotropic bulk magnetization of 1.55 μ_B directed along the (111) axis. The measurement was made at 160 K with the magnetic field of 0.9 T.
In fig. 1, the experimental and theoretical Compton charge profiles are compared in the range $|p_z| \leq$ 10 **a.u.. We note the** good agreement between the experimental and theoretical profiles for $|p_z| \geq 2$ a.u. reflecting that our systematic corrections, e.g., for absorption, detector efficiency, and multiple scattering, have been properly calculated. In fig. 2, we present the magnetic Compton profile and the best fit to the data. If we normalize our results to the saturation value, we have a total magnetic spin moment $\mu_S = -1.48(2)\mu_B$, a spin moment for the 5f electron, $\mu_S(5f) = -1.09(3)\mu_B$ and a spin contribution of the ***6d*** conduction electrons, $\mu_S(6d) = -0.39(2)\mu_B$.
Combining our results with the total 5f moment determined by neutron diffraction $\mu(5f) = 1.70(3)\mu_B$ [ll], we can estimate all the magnetic moments of US. These moments are in rather good agreement with x-ray magnetic dichroism measurements performed, by our group, at ESRF on ID12A.
These results will be presented in the 17"' General Conference of the Condensed Matter Division of the European Physical Society (August 25,29 - Grenoble, France).

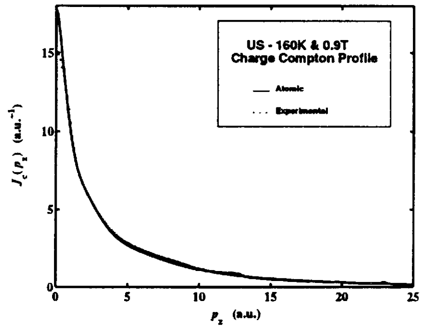

Figure 1: Comparison between the measured and the atomic charge Compton profile of US. The large differences between the two profiles for $p_z < 2.0$ a.u. reflect the solid state effects for the conduction electrons.

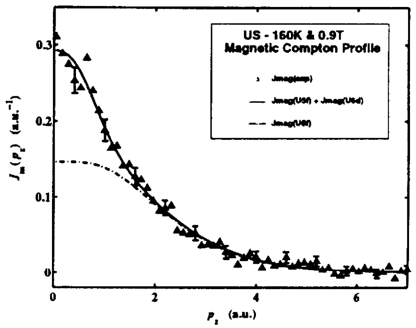

Figure 2: Magnetic Compton profile of US and best fit to the data. The obtained spin moment values are: $\mu_S = -1.48(6)\mu_B; \mu_S(5f) = -1.09(8)\mu_B; \mu_S(6d) = -0.39(6)\mu_B$.

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