	Experiment title: Synchrotron magnetic scattering from actinide materials	**Experiment number**: HE1396
Beamline: ID20	**Date of experiment**: from: 30/06/2004 to: 06/07/2004	**Date of report**: 19/02/2005
Shifts: 18	**Local contact(s)**: Dr. Stuart B. Wilkins	*Received at ESRF:*

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Report:

During June/July 2004 a successful experiment on the actinide 115 compound, $NpCoGa_5$, was undertaken on beamline ID20. $NpCoGa_5$ crystallises into the $HoCoGa_5$ type structure and exists as a member of the $AnCoGa_5$ type compounds of which $PuCoGa_5$ is found to be superconducting below 18.5 K and $UCoGa_5$ exists as a Pauli paramagnet and displays no superconductivity.

A single, encapsulated, crystal of $NpCoGa_5$ was mounted on the closed cycle He refrigerator within the "Super-ϕ" setup on ID20. The sample was cooled to 10 K and a search was undertaken for superlattice reflections corresponding to the anti-ferromagnetic order.

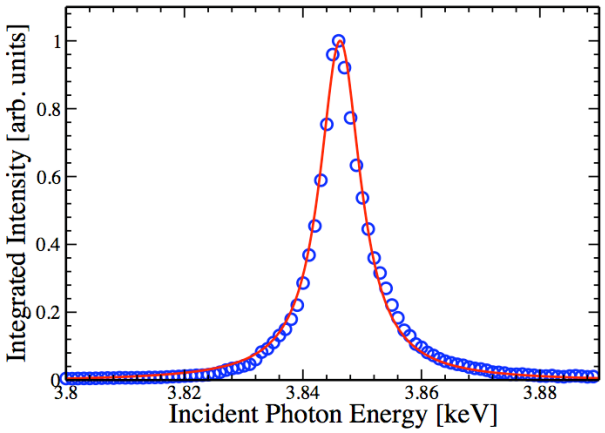
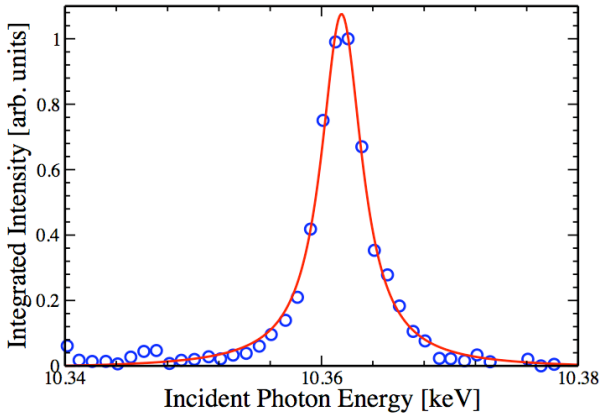


Fig 1: Integrated intensity as a function of incident photon energy in the vicinity of the Np M_4 edge. The solid line is a fit to a Lorentzian function.



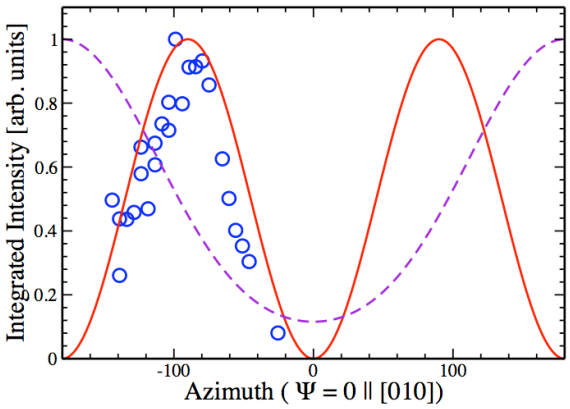


Fig 2 (left) : Integrated intensity as a function of incident photon energy in the vicinity of the Ga K edge. The solid line is a fit to a Lorentzian function.

Fig 3 (right) : Azimuthal dependence of the integrated intensity of the (1 0 5.5) superlattice reflection (open circles). The solid red line is a simulation assuming a "pseudo"-moment direction along [010]. The dashed line is a simulation assuming the moment is along [001] collinear with the moment on the Np sites.

After first orientating the crystal the photon energy was set to within the vicinity of the Np M_4 edge. At a modulation wavevector of (0 0 0.5) around principal Bragg reflections superlattice reflections were measured corresponding to the anti-ferro ordering of the Np magnetic moments. These were found to strongly resonate at both the Np M_4 and M_5 edges, the former of which is shown in Fig. 1. The temperature dependence of the scattering was measured with sufficient accuracy to measure critical exponents.

For the second half of the experiment the incident photon energy was set to within the vicinity of the Ga K-edge. Super lattice reflections were found at the same propagation wavevector as at the Np edge. We studied both the (0 0 5.5) and (1 0 5.5) reflections as a function of energy, temperature and azimuth. Figure 2 displays the resonance at the G *K*-edge observed in the $\sigma \rightarrow \pi$ channel. Contrary to previous findings by Mannix et al.[1] at the Ga edge we found that the temperature dependence of the resonant signal was *identical* to that of the signal at the Np M_4 edge. However, we encountered a significant amount of beam-heating of the sample and believe that the previous results were susceptible to such an effect as we found about the same error in T_N between the edges before adding attenuation to the incident x-ray beam.

The azimuthal dependence of the (1 0 5.5) reflection is shown in Fig. 3. Here we find a surprising result. In previous studies[1] and the uranium analogues $UNiGa_5$ [2] and $UPdGa_5$[3] it has been found that the resonant signal at the Ga *K*-edge, which arises due to a polarization of the *4p* states from hybridization of the actinide *5f* and anion *4p* states, shows the same moment direction as the magnetic ion. Here through the azimuthal dependence it appears like [on the (1 0 5.5) reflection] that the moment direction is within the *a-b* plane, while the Np moments are orientated along the *c*-axis.

At this point, we are unsure of the reason for this but plan further experiments to try to understand these phenomena.

[1] Mannix D, et al. *Phys. Rev. Lett.* **86** 4128 (2001)
[2] Kuzushita, K et al. *Physica B,* to be published.
[3] Ishii K, Unpublished experiment Spring-8 (September 2004)