ESRF	**Experiment title:** An investigation of the antiferromagnetic phase transition in UPd_2Si_2	**Experiment number:** HE-76
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Names and affiliations of applicants (* indicates experimentalists):

*Didier Wermeille, ESRF
*Anne Stunault, ESRF
*Christian Vettier, ESRF
*Erik Lidstrom, JRC and ESRF
Nick Bernhoeft, ILL
Pascal Lejay, CNRS
Jacques Flouquet, CENG

Report:

Resonant magnetic x-ray scattering has been used to investigate magnetic properties of uranium compounds. This technique takes advantage of the enhancement of the scattering cross section when the incident photon energy is tuned near the absorption edges of magnetically polarised atoms in materials. The purpose of the reported work is to study the nature of the antiferromagnetic phase transition in UPd_2Si_2. The experiments have been performed at the uranium M_{IV} edge (E=3.728keV) on ID20. Preliminary data have also been taken at the uranium L_{III} edge (E=17.166keV). The sample was mounted on the four-circle diffractometer in a closed cycle helium refrigerator, with the **a*** and c* axis in the vertical scattering plane.

At the M_{IV} edge, we have evidenced two successive phase transitions. Below T=136K, an incommensurate magnetic phase appears, whose wavevector is clearly temperature dependent. In the interval 125K-105K, this magnetic structure coexists with a second incommensurate phase with a wave vector q_z=0.715r.l.u. and between 108K and 95K with a simple antiferromagnetic phase. The incommensurate phase changes to a temperature independent commensurate q_z=2/3r.l.u. phase below 95K. Finally, below 85K only the simple antiferromagnetic structure remains.

At the L_{III} edge, the incommensurate phase can hardly be detected. Furthermore, the temperature dependence of the resonant commensurate magnetic peak is different from what observed at the M_{IV} edge. In Fig. 1 are plotted the normalised integrated intensity for commensurate peak at the two edges as a function of temperature. The two sets of data have been taken with the same experimental setup (cryogenics and thermal sensors). If we assume that in both cases the main transition is electric dipolar in character (further data analysis is needed to confirm this assumption) it would imply that the polarised 5f electrons will move from the commensurate position around 85K to the incommensurate phase, whereas the 6d electrons are essentially unaffected by the onset of the incommensurate phase and remain polarised up to 110K. This picture is consistent with neutron experiments where the magnetic interaction is due to the average electronic polarisation density.

A second surprising discovery is the difference in the energy response of the magnetic scattering at the commensurate and incommensurate positions in the reciprocal space at the M_{IV} edge. At the incommensurate position, q_Z=0.715, the response shows a single, well defined peak, centred at 3.729keV corresponding to the uranium M_{IV} edge;with a full width at half maximum of about 6eV, for the whole range of temperature where this phase exists. At the commensurate position, the response is a single peak centred at the same position but with a width larger by 2eV for the temperatures below 90K. Above this temperature, at both the commensurate and the temperature dependent wave vector incommensurate positions, where the two phases coexist, there is a broadening followed by a clear splitting of the peak, showing a minimum at 3.729keV and two components separated by about 8eV (Fig. 2). This is not fully understood at the moment and further analysis and experiments are foreseen in order to determine if a competition between near surface and bulk magnetism could explain these results.

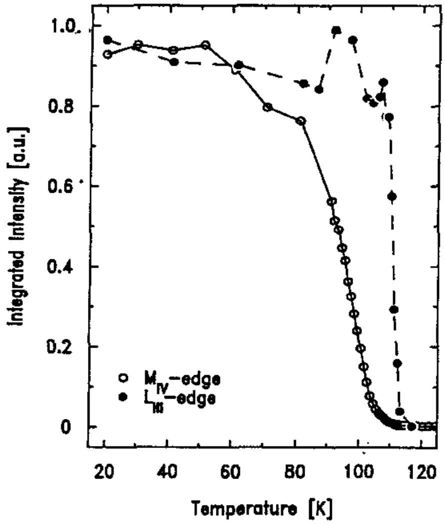

Fig. 1. Temperature dependance of the resonant magnetic integrated intensity in the commensurate phase at the uranium M_{IV} (o) and L_{III} (•) edges.

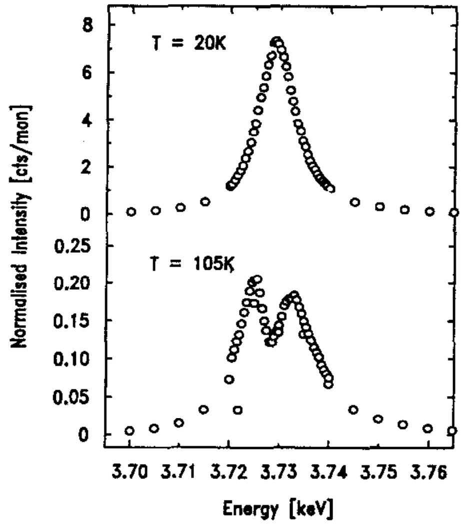

Fig. 2. Energy scans at the commensurate position for the low temperature phase (T=20K) and the one where the two phases coexist (T=105K).