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ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Spin density in UCoGe	**Experiment number**: HE-3029
Beamline: ID15A	**Date of experiment**: from: 15/09/09 to: 22/09/09	**Date of report**: 20/01/10
Shifts: 18	**Local contact(s)**: Thomas Buslaps, Veijo Honkimäki	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

*J. A. Duffy: University of Warwick

*M. W. Butchers: University of Warwick

*J. W. Taylor: ISIS, RAL

Report:

The purpose of this experiment was to measure the spin density of UCoGe using spin polarised Compton scattering. The issue of the spin and orbital magnetic moments in the U*TX* series (*T* = transition metal, and *X* is a *p*-electron systesm) has been under great scrutinity recently. Experimentally the total moment is shown to be small [1] (m_0 = 0.03 μ_B), although theoretical work [2-4] predicts the moment to be far higher. The published calculations suggest two large opposing spin and orbital moments on the U site and a moderate spin moment on the Co site.

Spin polarised Compton scattering samples the spin-dependent electron momentum density through the use of circularly polarised synchrotron radiation. The technique involves high-energy inelastic scattering of a monochromatic beam of circularly polarised photons. The energy dispersion of the scattered beam is directly related to the electron momentum distribution. In this case, an energy of ~90keV was used, just below the uranium K-edge, with a scattering angle of 174 degrees. The 13 element Ge detector was employed. In order to extract the spin polarised signal two measurements are made with parallel and antiparallel applied field directions with respect to the scattering vector. This experiment used the new 9T cryomagnet that has been installed by the Warwick group (long term proposal HE1675 [5], and recent publication [6]).

The data obtained in September 2009 are shown in Figure 1, together with our own LSDA+U calculations, performed using the KKR method. The profile was measured at T = 1.5 K (within the FM regime) and B = 5 T. We found a spin moment of (-0.35 ± 0.05) μ_B per formula unit, aligned antiparallel to the total

magnetisation. By comparison with our bulk magnetometry we calculated the orbital moment to be (0.52 ± 0.05) μ_B. The small moment along with the large number of electrons (Z = 151) meant our magnetic effect was small, requiring a long counting time. The individual contributions of the U 5*f* and Co 3*d* net spin moments were not derived explicitly from the profiles, as can be done in some cases because the momentum distribution of Co 3*d* and U 5*f* electrons is very similar. However, with reference to published theoretical work and our own KKR calculations, the Co spin moment can be estimated to be around 0.1 μ_B, resulting in a spin moment on the uranium site of -0.25 μ_B. We are now attempting to refine our approach to obtain a more rigorous estimation of the contributions to the spin moment. Note that the orbital contribution will be dominated by the U 5f electrons.

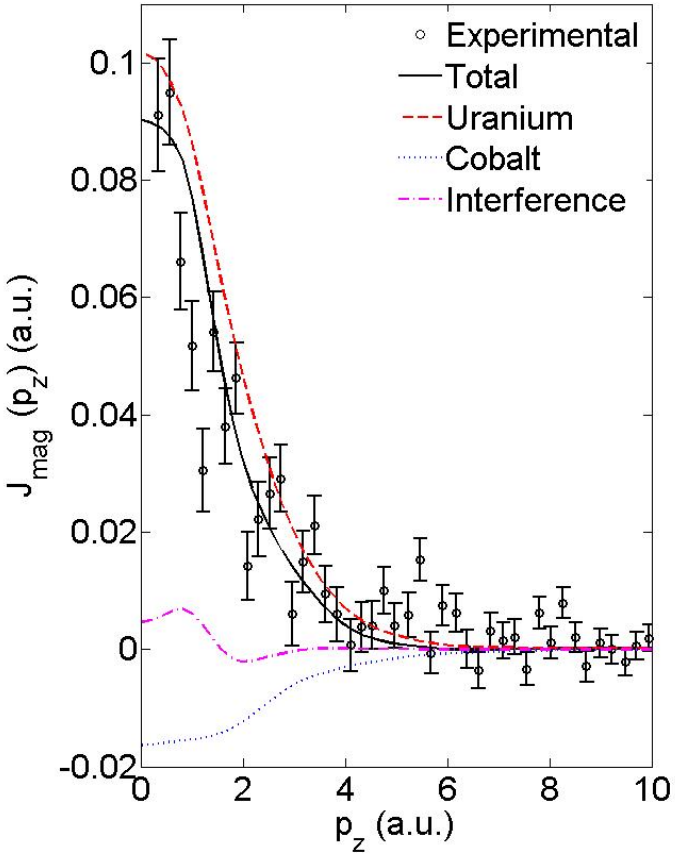

Fig. 1: Experimental MCP for UCoGe, plotted with theortical site specific distribution as predicted by KKR calculations.

Our data show that the current theoretical predictions are inadequate for describing this system, and perhaps other related systems. This experiment is now being prepared for publication within the next 6 months.

References:

[1] N.T. Huy *et al*., *Phys. Rev. Lett.*, **99** 067006 (2007).

[2] P. de la Mora and O Navarro, *J. Phys.: Condens. Matter*, **20** 285221 (2008).

[3] M. Divis, *Physica B*, **403** 2505 (2008).

[4] M. Samsel-Czekala, et al, J. Phys: Condens. Matter. **22**, 015503 (2010)

[5] Experimental report HE1675.

[6] C. Shenton-Taylor et al., J. Phys.: Condens. Matter **9** 186208 (2007).