ESRF	**Experiment title:** ***Spin density in $Sr_3Ru_2O_7$***	**Experiment number**: HE-2727
Beamline: ID15a	**Date of experiment**: from: 30/10/08 ***to:*** **04/11/08**	**Date of report**: 10/08/09
Shifts: 18	**Local contact(s)**: Veijo Honkimaki	*Received at ESRF:*

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Report:

The objective of the experiment was to investigate the two-dimensional spin density in the a-b plane in the high field metamagnetic phase of the quantum critical system $Sr_3Ru_2O_7$. Of particular interest and importance to our understanding of this system is the distribution of the Ru 4*d* moment, and the existence, or otherwise, of any oxygen moment. During the experiment, we measured the 1-dimensional spin density resolved along the [100] and [110] crystallographic directions using spin-polarised Compton scattering. The is excellent agreement with LMTO band structure calculations: determination of the orbitals involved in the magnetisation is in progress.

$Sr_3Ru_2O_7$ is an itinerant metamagnet, thought to exhibit a new kind of quantum critical point and also of interest because of its relationship to the unconventional superconductor Sr_2RuO_4: indeed, it has been postulated that it should also exhibit superconductivity, although this has never been observed. A measurement of the spin density is of great value, since it reflects the electronic orbitals from which the moment derives. $Sr_3Ru_2O_7$ itself has largely two-dimensional electronic properties, and the procedure proposed here will be ideal for this study. Some of the present team performed an analogous experiment using polarised neutron diffraction (using spectrometer D3 at the ILL [5]). However, because Compton scattering does not rely on being able to measure Bragg peaks, it is more sensitive to itinerant and relatively diffuse moments, such as would be expected if there is any induced oxygen 2p moment. For $Sr_3Ru_2O_7$ (and

Sr_2RuO_4) there may be strong hybridization between the Ru d_{xz}/d_{xy} and the oxygen p_z and p_y orbitals leading to π-bonding, in contrast to the superconducting cuprates.

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 E_I=200-250keV. The energy dispersion of the scattered beam is directly related to the electron momentum distribution. In this case, an energy of ~219keV was used, with a scattering angle of 174 degrees, which gives the optimal resolution and countrate. The 13 element Ge detector was employed, of which 12 elements were usable. 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 [1], and recent publication [2]).

The experiment was first performed in May 2008, but failed because of a technical problem with the detector electronics. Once this had been fixed, the experiment was repeated in October. The data obtained for the [100] and [110] directions are presented in figure 1. The data were taken at T = 1.5K and B = 7T. The spin moment was $0.8\mu_B$ per formula unit. Although the moment is of reasonable size, the large number of electrons per formula unit (Z = 258) means the magnetic effect (given by M/Z) was small, and great care and effort was required to obtain acceptable normalisation. Also plotted in figure 1 are LMTO band structure calculations. These agree remarkable well with the experimental data: in the region p_z < 1 a.u. such agreement is unusual . Further analysis and interpretation is currently underway in order to determine which orbitals are responsible for the magnetism and whether there is significant hybridisation with the oxygen sites. A paper will be written for publication over the next ~6 months.

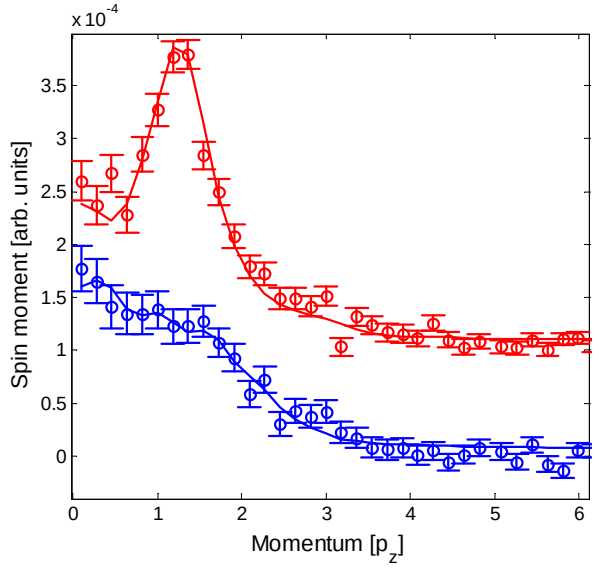

Figure 1. Experimental MCPs for $Sr_3Ru_2O_7$ measured in a field of 7T at 1.5K. Resolved along [100]: red (upper) data; resolved along [110]: blue (lower) data. Also shown are the LMTO calculations.

References:

[1] Experimental report HE1675.
[2] C. Shenton-Taylor et al.,
J. Phys.: Condens. Matter **9** 186208 (2007).