ESRF	**Experiment title:** ***Origin of the induced ferromagnetism in EuB6***	**Experiment number**: HE-1358
Beamline: ID15a	**Date of experiment**: from: ***16/07/03*** ***to:*** ***22/07/03***	**Date of report**: 13/08/05
Shifts: 18	**Local contact(s)**: Nozumi Hiraoka	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Jonathan A. Duffy (University of Warwick)*

Sonya Crowe (University of Warwick)*

Jonathan W. Taylor (Rutherford Appleton Laboratory)*

Zoe. F. Banfield (University of Warwick)

Malcolm J. Cooper (University of Warwick)

Report:

The spin density of EuB_6 was measured using spin-polarised Compton scattering. The data show little evidence of any induced non-4*f* spin moment in addition to the 4*f* contribution.

Despite extensive experimental and theoretical work the electronic properties and magnetic ordering coupling of EuB_6 are still not fully understood. EuB_6 is of the same simple cubic structure as CeB_6 with a Eu atom at the body centre position surrounded by B_6 octahedra. EuB_6 has a ferromagnetic ground state reached by two consecutive phase transitions. Neutron diffraction results reported the increase of the magnetic moment in the [100] direction on cooling, from its onset at 16 K to 6.9±0.2 μ_B [f.u.]$^{-1}$ at 1.5 K, in zero field. The magnitude of this moment is smaller than the Eu^{2+} value of 7.94 μ_B [f.u.]$^{-1}$ but in agreement with that of 7.02 μ_B [f.u.]$^{-1}$ predicted by band structure calculations. This moment implies an electronic state of Eu^{2+}, giving a half filled 4*f* band. Semimetallic behaviour has been observed by Shubnikov-de Haas and de Hass-van Alphen measurements. Electrical Resistivity measurements at high pressure suggest that the exchange interaction is also metallic in nature, similar to the RKKY interaction. No measurement has been made of the delocalised moment in EuB_6 which is important to the understanding of the exchange interaction and therefore its electronic and magnetic properties. Spin-polarised Compton scattering measurements of EuB_6 were made in the [100] and [111] directions to identify any

delocalised moment which could help identify the nature of the magnetic exchange interaction.

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 ~205keV was used, with a scattering angle of ~172 degrees, which gives the optimal resolution and countrate. The 13 element Ge detector was used, giving a total countrate of ~100kcps. 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. The magnetic field was applied using the 1.0T electromagnet installed on ID15a, and an "orange" cryostat was used, with kapton windows to minimise background scattering.

The spin polarised profiles of EuB_6 measured in the [100] and [111] directions were the same within experimental error, showing no anisotropy. The data for the [100] crystallographic direction are shown in figure 1. The summed data are in agreement with a Eu 4*f* electron moment within experimental error. A delocalised moment contribution would be expected to be apparent from ~2 a.u., and so is clearly not apparent in these data. This indicates that there can only be a small induced net moment in addition to the 4f contribution.

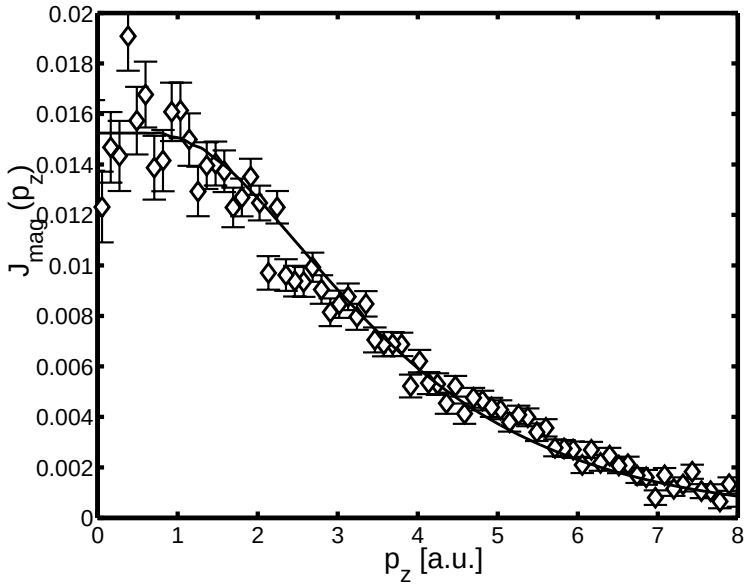

Figure 1 Positive momentum, low energy, side of the MCP of the summed [100] data, normalised to 1 and with a momentu scale bin width of 0.1. A RHF free atom fit of a Eu 4*f* electron spin moment is also plotted.