| ESRF | **Experiment title: Magnetic Compton scattering of the magnetic superconducting system $Ce_{(1-x)}Gd_xRu_2$** | **Experiment number**: HE-1785 |
|---|---|---|
| **Beamline**: ID15a | **Date of experiment**: from: 8/09/04 to: 14/09/04 | **Date of report**: 12/12/04 |
| **Shifts:** 18 | **Local contact(s)**: Thierry D'Almeida | *Received at ESRF:* |


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**Report:**

The C15 Laves phase superconductor $CeRu_2$ displays coexistence of magnetic order and superconductivity on doping with heavy rare earth elements to give $Ce_{1-x}RE_xRu_2$ with RE = Gd, Ho and Tb in concentrations of up to ~14%. This experiment was an investigation of the magnitude and origin of the spin moment in the Gd member of the series using magnetic Compton scattering (MCS). The samples used form the phase diagram shown in figure 1. We hoped to see an induced moment on the Ce and/or Ru site as the samples show a large spin moment for such low Gd concentration. As the C15 Laves phase structure places the Ce in sites with an unusually small Ce-Ce distance there is likely to be delocalisation of the Ce *f* electrons to form large localised moments.

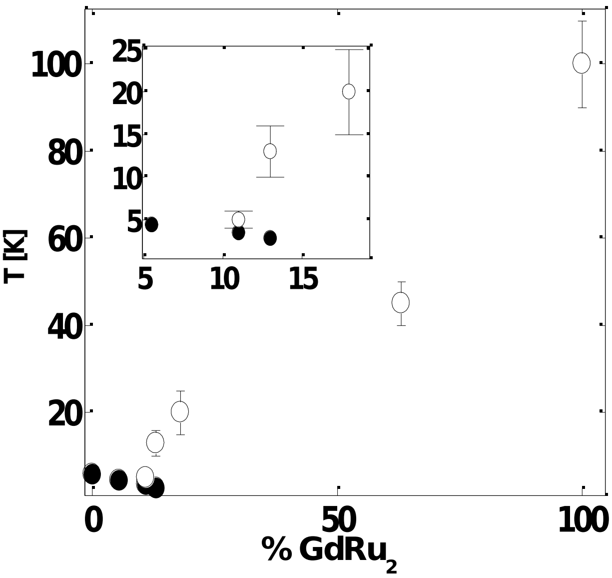


Figure 1. Phase diagram of $Ce_{1-x}Gd_xRu_2$ samples prepared at Warwick University

MCS 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.

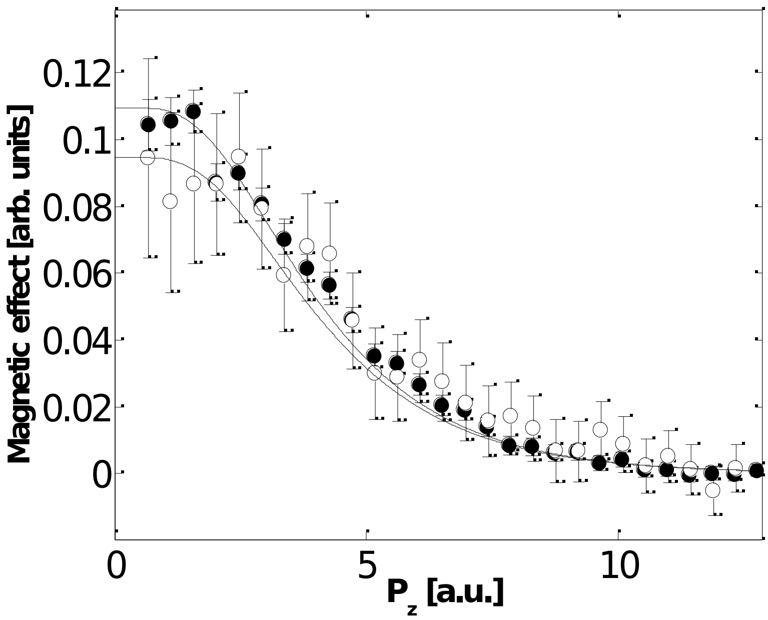

Figure 2. Magnetic Compton profile of GdRu2 ( ) and $Ce_{0.87}Gd_{0.13}Ru_2$ ( ) at 2K, with Hartree Fock relativistic free atom fits for Gd 4f electrons (–) for the GdRu2 data and an example of Gd 4f profile with an oppositely polarised Ce 4f electron contribution (···) for the $Ce_{0.87}Gd_{0.13}Ru_2$

By comparison with Hartree-Fock free atom electron momentum spin denity profiles we can identify the electrons which contribute to the measured spin moment by their width in momentum space. The $GdRu_2$ data can be fitted by a Gd 4*f* profile, but the $Ce_{0.87}Gd_{0.13}Ru_2$ data indicate some Ce 4*f* electron contribution, possibly of opposite polarisation (see figure 2) and we hope to ascertain its magnitude with further quantitative analysis. Our results show that there is no Ru 4*d* electron contribution. From comparison with magnetisation measurements we have found the total moment in the system to be greater than the spin moment measured and, as this orbital contribution cannot be from the Gd atoms, we project there is some orbital moment on the Ce site which decreases with Gd doping. We are planning further investigation to complement these results using magnetic circular dichroism at the Gd and Ce $L_2$ and $L_3$ edges.