ESRF	**Experiment title:** Investigation of the magnetic structure of $GdCu_2$	**Experiment number:** HE-1062
Beamline: BM28	**Date of experiment:** from: 2001/05/03 to: 2001/05/09	**Date of report:** 2001/08/22
Shifts: 18	**Local contact(s):** D. Mannix	*Received at ESRF:*

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Report:

The experiment is a continuation of HE-943 where magnetic reflections of a $GdCu_2$ single crystal had been observed at temperatures $T \leq 10$ K $\leq T_{\mathrm{N}} = 42$ K.

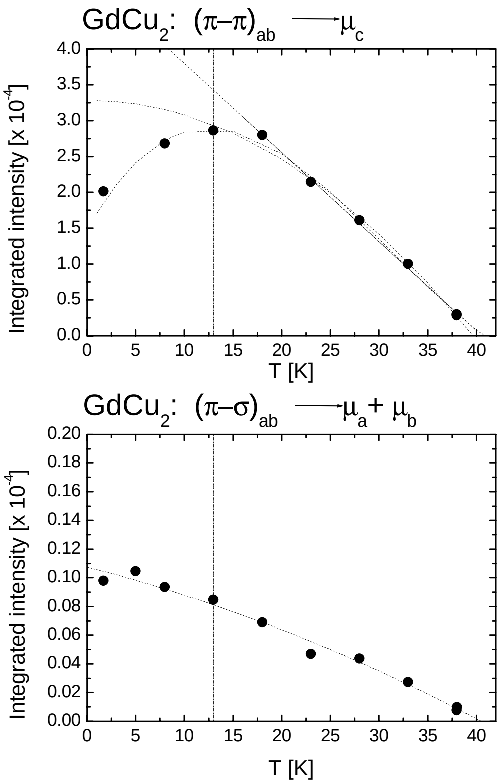
Currently $GdCu_2$ is believed to exhibit a magnetic structure with a noncollinear, cycloidal propagation of $\tau \sim (1/3\ 0\ 0)$ within the ac-plane and an antiferromagnetic propagation along the b-direction [1], [2]. The moments are expected to be confined to the ac-plane of the orthorhombic structure. Note that the ac-plane can be viewed as a distorted hexagonal plane. Magnetization measurements in a magnetic field $\mu_0 H = 0.5$ T showed that the temperature dependence of the magnetization along the c-axis changes below $T = 10$ K whereas the temperature dependence along the a-axis is unchanged. Specific heat and thermal extension measurements do not indicate any first order phase transition. The aim of the experiment was to refine the magnetic structure and to investigate the properties of the magnetic structure around $T = 10$ K to get knolegde about the occurence of a spin-reorientation phase transition in zero field. Resonant magnetic scattering was performed at the Gd-L_2-edge with the use of a Graphite (006) single crystal for polarization analysis of the diffracted beam.

Positions of the magnetic reflections

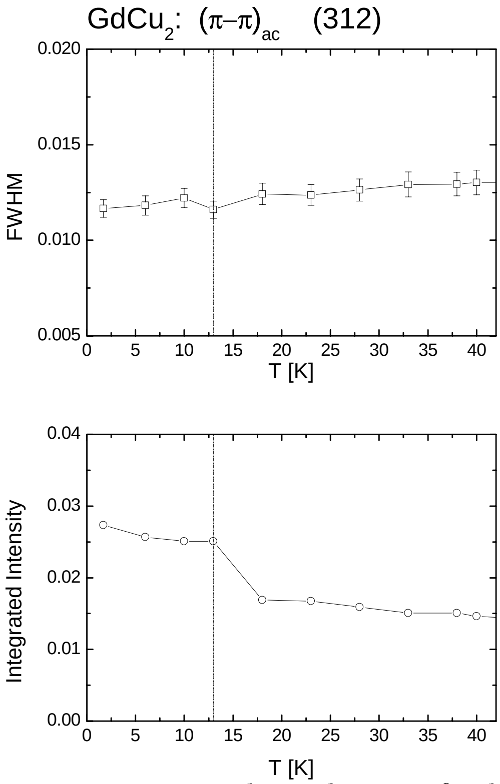
The magnetic reflections were measured temperature dependent in ac- and ab-scattering plane. Their positions have been corrected using the positions of five charge peaks at each temperature. Scans on magnetic reflections along the reciprocal k- and l-direction show no splitting. Therefore the b- and c-components of the wave vector $\tau \sim (1/3\ 0\ 0)$ were confirmed to be zero. The τ_a values have been found to be different from 1/3 for all magnetic reflections. Although the comparatively large error of these data makes it difficult to determine the component τ_a unambigously the magnetic structure seems to be incommensurate down to low temperatures. This can be understood well because the influence of the crystal electric field on the magnetism is neglectible in $GdCu_2$.

Magnetic moment direction

The resonant experiment was performed in horizontal scattering geometry to get the information about the moment directions along b (ac scattering plane) and along c (ab scattering plane) in the π-π polarization, respectively. The intensity corresponding to μ_b is found to be zero whithin the experimental error which is due to the finite polarization ratio. Using this fact the left part of the figure shows the dependence of the integrated intensities corresponding to μ_c and μ_a on the temperature. Whereas there is no change in the temperature dependence of the intensity belonging to μ_a, the intensity belonging to μ_c has a maximum at $T \simeq 13$ K. At this temperature the in-plane magnetization along a- and c-direction for $\mu_0 H = 0.5$ T starts to become different. Obviously there is a reorientation of magnetic moments which leads to a decreasing c-component also in zero field. The data can be interpreted as a distortion of the magnetic structure from a circular to an ellipsoidal cycloid. Because no 3^{rd} harmonics of τ could be identified at any temperature one cannot conclude only from the measured data at which temperature the cycloid is circular.



Temperature dependence of the integrated intensity of the magnetic reflection (4 -1 1)-τ. Because the component μ_b of the magnetic moment has shown to be zero the lower diagram corresponds to μ_a only. The lines are guides for the eyes.



Temperature dependence of the line width (FWHM) (top) and the integrated intensity at the charge reflection (312). The data were measured in π-π-polarization.

Magneto-elastic coupling

The right part of the figure shows the temperature dependence of the line width (FWHM) and integrated intensities of the (312) charge reflection. The intensity increases at the same temperature where the spin reorientation is observed. The structure factor of (312) depends only on the deviation of the orthorhombic structure of our compound ($Imma$) to the related hexagonal structure ($P6/mmm$). From thermal expansion, temperature dependent x-ray diffraction and specific heat data it can be excluded that there is a structural phase transition at this temperature. Thus the increase of the intensity can be assumed to result from small changes in the parameters of the atom positions.

References

[1] M. Rotter, A. Schneidewind, M. Loewenhaupt, M. Doerr, A. Stunault, A. Hiess, A. Lindbaum, E. Gratz, G. Hilscher, H. Sassik, ,Physica **B 284-288**, 1329 (2000).

[2] M. Rotter, A. Lindbaum, E. Gratz, G. Hilscher, H. Sassik, H. E. Fischer, M. T. Fernandes-Diaz, R. Arons, E. Seidl, J. Mag. Magn. Mat. **214** 281 (2000).