ESRF	**Experiment title:** Magnetic Critical Scattering from GdS: An Antiferromagnet with Heisenberg and Biquadratic Exchange Interaction	**Experiment number:** HE193
Beamline: Bl12 / ID20	**Date of Experiment:** from: 28-Oct-97 to: 03-Nov-97	**Date of Report:** August 12, 1998
Shifts: 18	**Local contact(s):** Anne Stunnault	Received at ESRF: 18 AOUT 1998

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Report:

In the metallic antiferromagnet GdS the Gd^{3+} ions occupy the sites of a fcc lattice. Due to the $^8S_7$ ground state of Gd^{3+}, GdS is expected to behave as an isotropic Heisenberg system. However, magnetisation measurements reveal a significant amount of biquadratic exchange interaction [l]. It was the aim of this experiment to study the critical behaviour close to the Néel temperature and to search for deviations from the Heisenberg critical exponents caused by the biquadratic exchange interaction.

During our measurements we encountered serious experimental problems, namely temperature instabilities of the sample during injections. Since the storage ring was running in single bunch mode with an injection every eight hours, we were forced to measure a complete temperature dependence in eight hours as shown in Figure 1.

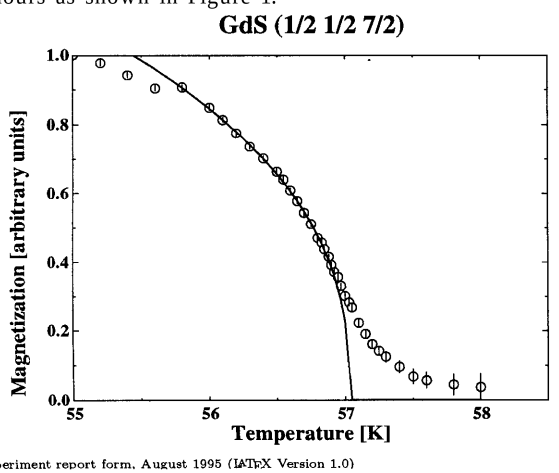

Figure 1: Temperature dependence of the $(\frac{1}{2}\frac{1}{2}\frac{7}{2})$ magnetisation at resonance (7930 eV) measured during one run. The solid line shows the fit with a potential law with exponent β = 0.384 ± 0.005. The Néel temperature is T_N = 57.03 ± 0.01. The "rounding" above T_N arises from critical fluctuations.

As planned we performed measurements with high momentum space resolution close to the Neel temperature using a Ge (111) analyser crystal. The aim of this experiment was to determine the critical exponents γ and ν of GdS from the magnetic critical scattering. We expected the crossover within a few tenth of a degree Kelvin from T_N where the width of the diffuse component becomes comparable to the instrumental resolution.

Figure 1 shows the temperature dependence of the square root of the integrated intensity of the $(\frac{1}{2}\frac{1}{2}\frac{7}{2})$ Bragg peak. The fit to the intensity gives $T_N = 57.03 \pm 0.01$ and $\beta = 0.384 \pm 0.005$. The value of β is close to 0.367, the value for a three-dimensional Heisenberg model. Close to the Neel temperature we observed a broadening of the signal. This was caused by magnetic diffuse scattering and an independent non magnetic phenomena. For this reason we measured the Bragg scattering 50 eV away from the resonance energy as shown in figure 2. Below the Neel temperature the weak non-resonant magnetic scattering is observed, above a non-magnetic non-resonant peak remains. The origin of this signal is not yet understood.

As a first step in the data analysis this non-magnetic non-resonant peak was subtracted. After this correction a sharp and a broad component is observable above the Neel temperature as shown in figure 3. Similar observations were reported from other magnetic systems [2,3,4]. Because of the bad statistics, caused by the above mentioned technical problems, and the small difference between the two components, the separation failed. Also the attempt to describe the broad component with an Heisenberg model to reduce the number of parameters for the separation failed.

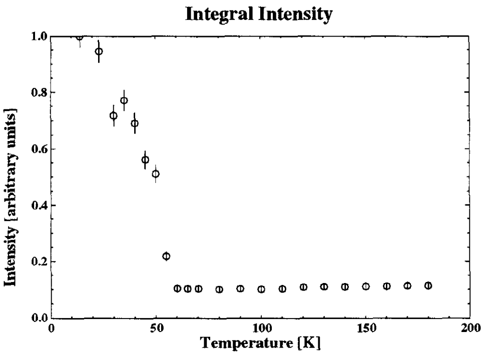

Figure 2: Temperature dependence of the $(\frac{1}{2}\frac{1}{2}\frac{7}{2})$ non resonant intensity. Below the *Néel* temperature weak non-resonant magnetic scattering is observable. Above, a non-magnetic peak is remaining, which does not show any temperature dependence.

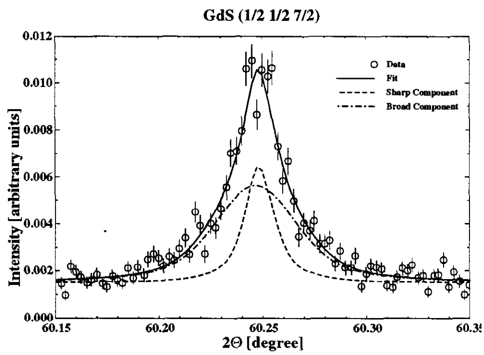

Figure 3: Theta-two-theta scan around the $(\frac{1}{2}\frac{1}{2}\frac{7}{2})$ position at *57.3K*. The *solid line* represents the fit, combined from a sharp component and a broad component (dashed lines).

In conclusion we were able to measure critical fluctuations close to the Néel temperature. We observed a sharp and a broad component but a separation and therefore an evaluation of the critical exponents was not possible. We observed a non-resonant non-magnetic signal at the same position as the magnetic peak over a wide temperature range.

[l] Kobler et al, private communication
[2] Thurston et al, Phys. Rev. B 49 1994, 15730
[3] Landrige et al, Phys. Rev. B 49 1994, 12022
[4] Watson et al, Phys. Rev. B 53 1996, 686