Experiment title:

Resonance Exchange Scattering from GdS

Experiment number:

HC-379

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Report: During this experiment we studied:

1. the temperature dependence of the magnetic order and of the lattice
2. the lattice distortion due to magneto-elastic coupling
3. the energy-dependence of the $Gd\,L_{II}$ and L_{III} resonances
4. the polarization dependence of the resonant scattering at the L_{II} *edge*
5. and finally and most important the angular dependence (form factor and polarization dependence) of the resonance

The temperature dependence of two magnetic super-lattice peaks ($\frac{1}{2}\frac{1}{2}\frac{5}{2}$ and $\frac{1}{2}\frac{1}{2}\frac{11}{2}$) has been measured. In the temperature range from 35 to 45 K a splitting into two peaks has been observed, caused by a distortion of the crystal lattice. Figure 1 shows the temperature dependence of the sub-lattice magnetization obtained as the square root of the integral intensity.

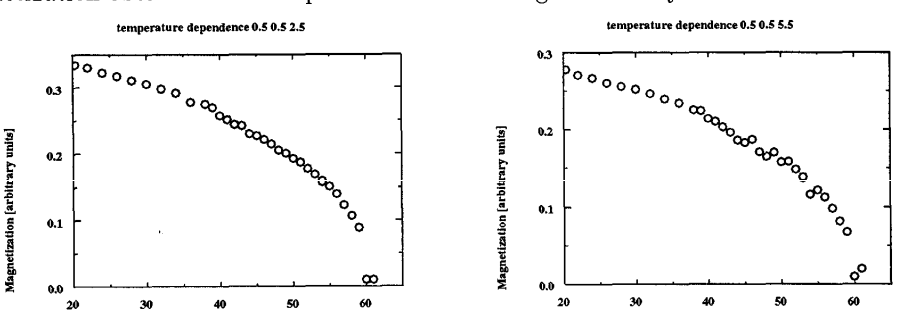

Figure 1: *Temperature dependence of the* ($\frac{1}{2}\frac{1}{2}\frac{5}{2}$) *and* ($\frac{1}{2}\frac{1}{2}\frac{11}{2}$) *magnetization at resonance (7930* eV)

Figure 2 shows the energy dependence at the L_{II} and L_{III} edges as measured without polarization analysis on the $\frac{1}{2}\frac{1}{2}\frac{5}{2}$ Bragg peak. The shape of the curve is very similar at both edges.

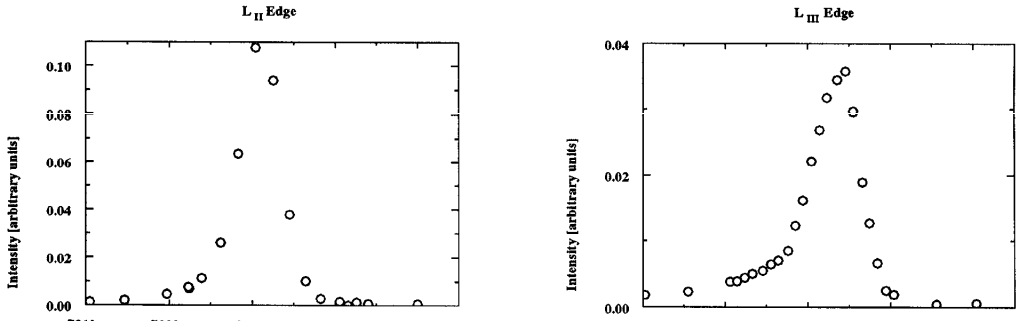

Figure 2: Energy dependence *of the* $(\frac{1}{2}\frac{1}{2}\frac{5}{2})$ peak *at the* L_{II} and L_{III} *edge.*

A polarization analysis has been performed on the L_{II} edge employing a PG-006 analyzer crystal. The aim was to identify dipolar and quadrupolar contributions and to determine the spin direction from the angular dependence.

Because the crystal phase plate was not yet available the measurements had to be done in vertical geometry for $\sigma \rightarrow \sigma$ and $\sigma \rightarrow \pi$ polarization and in horizontal geometry for $\pi \rightarrow$ CT and $\pi \rightarrow \pi$ polarization.

In Figure 3 the dependence of the integral intensity on the polarization and the Bragg angle is shown for a a–polarized incident beam. The integral intensity in the $\sigma \rightarrow \sigma$ polarization measurement is about 100 times smaller than for $\sigma \rightarrow \pi$ polarization. This indicates that the resonance exchange scattering from GdS is dominated by electric dipole transitions to the conduction band. Electric quadruple transitions into the $Gd\,4f$ states are negligible.

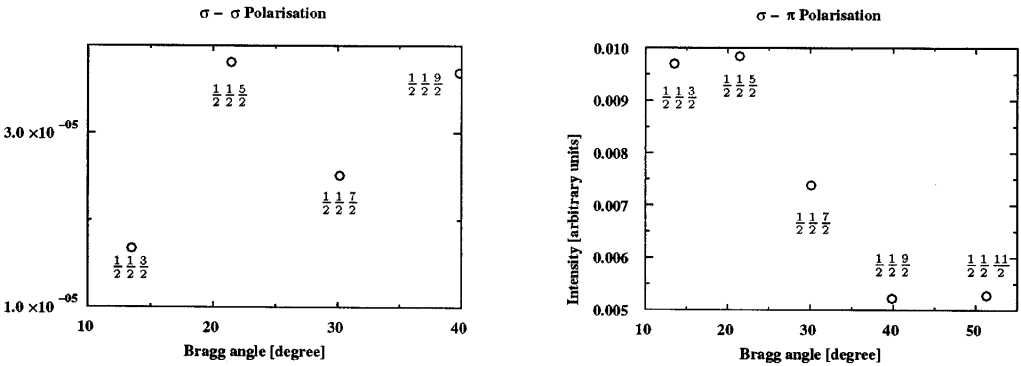

Figure 3: *Integral Intensity for* $\sigma \rightarrow \sigma$ and $\sigma \rightarrow \pi$ polarization in dependence *of the Bragg angle.*

our original intention was to determine the spin direction from such data. Unfortunately due to experimental problems we did not succeeded in measuring with incident π–polarization. Therefor our refinement of the spin direction did not converge due to a lack of data points. The determination of the spin direction is the last step in the magnetic structure determination for GdS from resonant x-ray diffraction data. Further experiments are planned.