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X-ray Magnetic Scattering in the antiferromagnetic order in GdAs

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Introduction

GdAs is considered to be a simple antiferromagnet, which orders below T_N=18.7 K, since the Gd^{3+} ion has only spin magnetic moment with S=7/2 and has no orbital moment (L=0). The crystal structure is of NaCl type and the ordering propagation vector is considered to be type <1/2 1/2 1/2>, but has not been observed directly by diffraction methods. Neutron scattering experiment has not been performed because of the huge absorption of neutrons by Gd.

In such a situation x-ray magnetic scattering becomes a powerful tool to investigate the magnetic order. In the present experiment we tried to observe x-ray magnetic scattering both at resonance and at off resonance. The purpose also involves to investigate the mechanism of the resonant magnetic scattering by using a simple antiferromagnet such as GdAs[1,2].

Experimental Results

Experimentals

Since the x-ray magnetic scattering is extremely weaker than the charge scattering, stronger beam intensity is preferable. However, we have performed the experiment at BL-4C , where the intensity is weaker than BL-16A2, to utilize more flexible energy tunability of the bending magnet.

Energy dependence

Figure 1 shows the energy dependences of the (3/2 3/2 3/2) reflection at 7 K, below TN, and at 25 K, above TN. The energy spectrum exhibits the interference structure between nonresonant and resonant magnetic scatterings; it is asymmetric around the absorption edge at 7.724 keV. This structure can be fit by the atomic scattering amplitude,

$$f=iA+iB/(E-\Delta+i\Gamma/2),$$

as demonstrated by the solid line in the figure. The first term represents the nonresonant magneticscattering and the second term the resonant scatttering.

An important result of the fit is that the atomic parameters A , proportional to the magnetic moment, and B, proportional to the atomic parameter introduced in Ref. [3], have the same sign if we assume the in-plane magnetic structure. If we assume the magnetic moments to be perpendicular to the (1 1 1) plane, we obtain A and B with opposite signs.

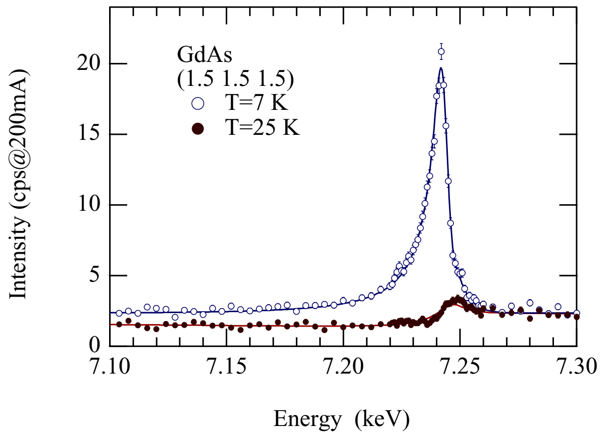

Fig. 1 The energy dependence of the (3/2 3/2 3/2) reflection at 7 K and at 25 K.

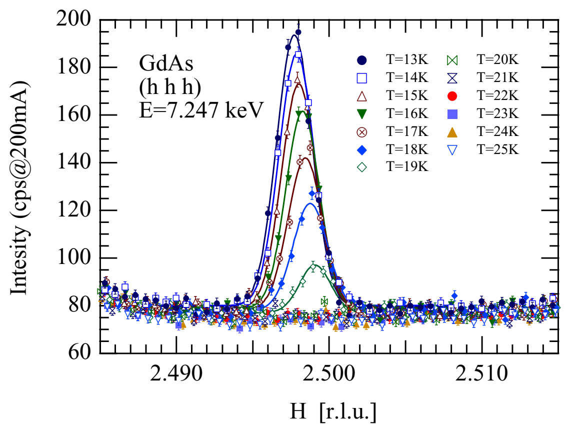

Fig. 2 Temperature dependence of the peak profiles of the (5/2 5/2 5/2) reflection.

Temperature dependence

Figure 2 shows the temperature dependence of the peak profiles. From the temperature dependence of the integrated intensities, we obtained the critical exponent β to be 0.31. This is a typical value for the three dimensional Heisenberg magnet.

References

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