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Canting angle of the antiferro-quadrupolar moments in DyB_2C_2

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Introduction

DyB_2C_2 is a typical compound for which the resonant x-ray scattering have been successful to observe the antiferroquadrupolar order, the periodic alignment of aspherical charge distribution of 4f electrons. The ordered state is described by the propagation vectors of (0 0 1/2), (1 0 1/2), (0 0 0) and (1 0 0), among which (1 0 0) is magnetic which appears below T_N. The firsst reports of the observation successfully explained the characters of the (0 0 1/2) reflection, energy, polarization and azimuthal angle dependences[1,2]. However, problems remained with respect to the (1 0 1/2) reflection because it contained large intensities of lattice distortion and the resonant component was hidden.

In the present experiment, the energy dependences and the azimuthal angle dependences of the (1 0 1/2) reflection were carefully examined to detect the resonant components, which involve important information on the antiferroquadrupolar moments.

Experimental Results

Energy dependence

Figure 1 shows the energy dependences of the (3 0 3/2) superlattice reflection for the σ–σ' channel measured at 12 K, $T<T_N$, and at 20 K, $T_N<T<T_Q$. This channel has very strong intensity from the Bragg reflection of the lattice distortion that occurs below T_Q. In spite of this, the resonance structures are beautifully observed both at the pre-edge and main edge, which were not observed in the previous experiment.

Azimuthal angle dependence

Figure 2 shows the azimuthal angle dependences of the (3 0 3/2) reflection for σ–σ' and σ–π' channels at the main edge. Intensities at resonances exhibits clearly the azimuthal angle dependence. The same theoretical model of the antiferroquadrupolar order described in Ref. [2] can explain these variations as indicated by the lines in the figure. For the σ–π' channel below TN, magnetic and quadrupolar contributions are separately shown by the dotted lines.

Missing these results, the previous report concluded that the canting angle was zero above T_N. The present experiment proved not so but has finite canting angle of about 20 degrees, the same order as below T_N.

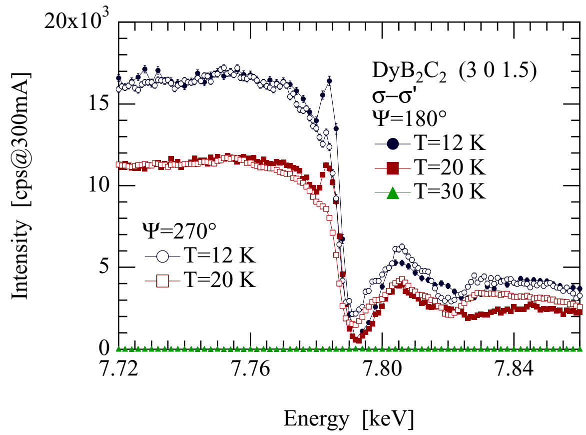

Fig. 1 Energy dependence of the (3 0 3/2) reflection for the σ–σ' channel.

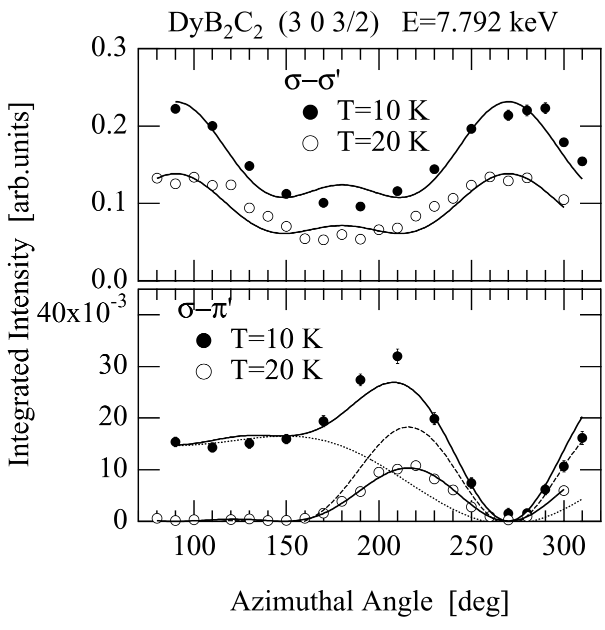

Fig. 2 Azimuthal angle dependence of the (3 0 3/2) reflection at the main edge. Lines are the calculations.

References

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