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Spin and orbital magnetic form factor of $CeRh_3B_2$ observed by X-ray magnetic diffraction

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Introduction

A rare earth compound of $CeRh_3B_2$ has peculiar ferromagnetism. Though the Curie temperature (115K) is the highest among the Ce compounds with non-magnetic elements, the magnetic moment per Ce atom is rather small ($0.4\mu_B$). It is important to research magnetic structure to clarify the magnetic property of $CeRh_3B_2$.

We have applied X-ray magnetic diffraction (XMD) to a single crystal of $CeRh_3B_2$. This method enables us to measure independently the spin and the orbital magnetic form factor. The aim of this study is to reveal the magnetic property of this compound through the spin and orbital moment distribution in real space obtained by the XMD.

Experiments

White beam of elliptically polarized synchrotron radiation from the bending magnet of BL3C was irradiated on the sample crystal and the diffraction intensity of *hk*0 reciprocal lattice points with 90 degree scattering angle was measured by a pure-Ge SSD. The magnetic field 2.15T was applied to the sample crystal. The angle between the directions of sample magnetization and incident X-rays (α) was set to 0 or 135 degree. The orbital magnetic from factor $\mu_L(\mathbf{k})$ and the spin magnetic form factor $\mu_S(\mathbf{k})$ were measured under the condition of α= 0 and 135 degree, respectively.

Results and discussion

The observed $\mu_L(\mathbf{k})$ and $\mu_S(\mathbf{k})$ are shown in Fig. 1 and Fig. 2, respectively, for *kh*0 points of even *h* and *k*. We tried to fit atomic-model theoretical curves of $\mu_L(\mathbf{k})$ and $\mu_S(\mathbf{k})$ under the dipole approximation to the observed data. Theoretical curves are expressed as, $\mu_S(k)=\mu_{S0}\langle j_0(k)\rangle$ and $\mu_L(k)=\mu_{L0}\{\langle j_0(k)\rangle + \langle j_2(k)\rangle\}$. Here $\langle j_n\rangle$ is the radial integral of the wavefunction multiplied by the n-th spherical Bessel function. We used $\langle j_0(k)\rangle$ and $\langle j_2(k)\rangle$ of 4f electrons of Ce^{+3} tabulate in the literature.[1)] The values of μ_{S0} and μ_{L0} are the spin and orbital moment.

Results of the fitting are shown in Fig. 1 and Fig. 2 as solid lines. The values of $\mu_{L0}=1.3\mu_B$ and $\mu_{S0}=-0.9\mu_B$ are obtained. In Fig. 1 the observed $\mu_L(\mathbf{k})$ is represented well by the theoretical curve, but in Fig. 2 the observed $\mu_S(\mathbf{k})$ is not. The observed data points of $\mu_S(\mathbf{k})$ are aligned along the line which decays more slowly than the dipole approximation curve in the k space. This fact infers that the spin moments might be distributed more concentratedly in the real space than those of the dipole approximation is.

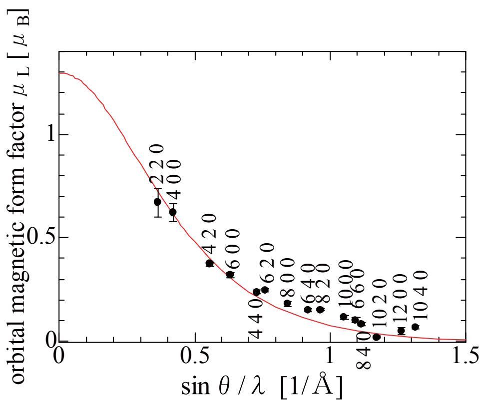

Fig. 1. Orbital magnetic form factor

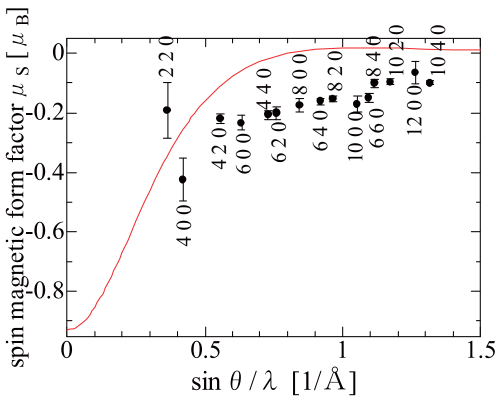

Fig. 2. Spin magnetic form factor

References

1) International Tables For X-ray Crystallography Vol. IV (eds. J. A. Ibers and W. C. Hamilton, Kynoch Press, Birmingham, 1974).