Synchrotron X-ray Studies on Magnetic Order

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I will give a talk about following two topics.

1. Investigation of long-wavelength magnetic order Long-wavelength magnetic order in a frustrated magnet often induces ferroelectric polarization, resulting in giant magnetoelectric effects. Such long-wavelength magnetic order with a propagation vector Q_m often causes lattice modulation with a wave vector of Q_m or $2Q_m$ [1]. The intensities and positions of synchrotron x-ray superlattice reflections can therefore provide useful pieces of information about the magnetic order [2].

Magnetic x-ray scattering is another powerful technique to investigate such long-wavelength magnetic order. In a spiral magnet, especially, the intensity of magnetic diffraction should be different between left- and right-handed circularly polarized x-ray beams [3].

2. Investigation of magnetic structure and wave function in a 5d transition metal oxide In 3d transition-metal compounds, each magnetic moment is almost identical to $-g\mu_B S$, because of the quenching of orbital moment L in a ligand field. In contrast, the magnetic moment at a lanthanide ion is generally determined by the total angular momentum $J = L + S$. For the magnetic moment of a 5d transition element, the competition between the spin-orbit interaction and the ligand field effect is not as clear as in the case of 3d and 4f transition elements. Resonant x-ray magnetic diffraction in Sr_2IrO_4 has revealed not only the magnetic structure but also the wave function of Ir^{4+}. The resonant enhancement of magnetic reflections is extremely large at the L3 edge but almost absent at the L2 edge, implying that the orbital momentum is not quenched at each Ir^{4+} ion. Such a unique state in 5d transition-metal compounds would cause extraordinary electro-magnetic and magneto-optical responses.

[1] T. Arima et al., J. Phys. Soc. Jpn. **76**, 023602 (2007).
[2] T. Arima et al., Phys. Rev. B **72**, 100102R (2005).
[3] M. Blume and D. Gibbs, Phys. Rev. B **37**, 1779 (1988).