# "Forbidden" Reflections of Hematite ($Fe_2O_3$) near the Fe K-Absorption Edge

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## Introduction

Finkelstein et al. [1] observed an evidence of electronic quadrupole transitions at a resonant peak near the iron K-absorption edge of hematite, $\alpha$-$Fe_2O_3$, which has a corundum structure. Below the Neel temperature ($T_N$ = 950K) hematite is a canted antiferromagnet with the spins nearly perpendicular to the [001]. At the Morin temperature ($T_M$ = 250K) it changes into an uniaxial antiferromagnet with spins lying along the [001]. Brunel and Bergevin [2] observed the change of spin alignment by measurements of the intensity and azimuthal dependence of the magnetic superlattice reflections at temperatures above and below the $T_M$. In the present report, in order to investigate anisotropy of electronic and magnetic scattering from hematite, we measured the forbidden reflections at room temperature.

## Experimental

Synchrotron X-ray measurements were performed at BL3A and 4C. The incident X-rays were polarized horizontally, i.e. $\sigma$-polarized. A natural hematite crystal with (001) surface was mounted on a four-circle diffractometer. Energy spectra and azimuthal dependence of (003) and (009) reflections were measured near the iron K-edge.

## Results and Discussion

The (003) and (009) reflections have similar energy spectra which show only one peak (about 7.105 [keV]) in the pre-edge region and a continuous (non-resonant) tail below the edge. We did not observe any peaks above the edge but the non-resonant tail might continue above the edge, since absorption was so strong that the tail was not observed clearly.

The azimuthal dependences of the intensities measured at the peak position (7.105 keV) and the 20 eV lower than the peak (7.085 keV) are shown in Figs. 1 and 2, respectively. In Fig. 1, the threefold pattern was observed for the (003) reflection. Finkelstein et al. observed a similar azimuthal symmetry which showed not threefold but sixfold. On the other hand, the azimuthal dependence of the (009) reflection at 7.105 keV scarcely showed threefold, rather non-periodic. We suppose that the resonant peak consists of two components, electric and magnetic scattering, and they intricately interplay.

In Fig. 2, the azimuthal dependence of the (003) reflection measured at 7.085 keV shows twofold pattern. The site symmetry of iron atoms in hematite is 3, therefore this profile should be caused by non-resonant magnetic scattering, which was observed by Brunel and Bergevin. Measurement at low temperature is now in progress.

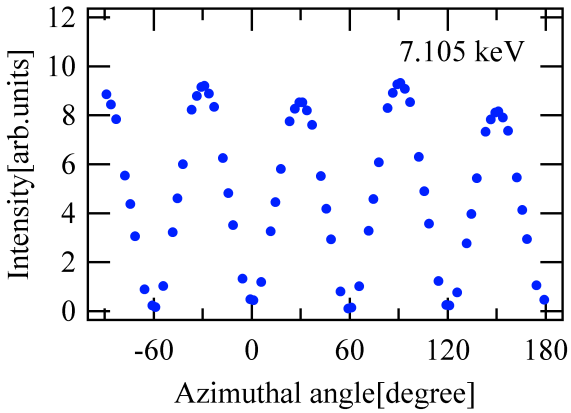


Fig. 1 Azimuthal dependence of the (003) reflection at 7.105 [keV].

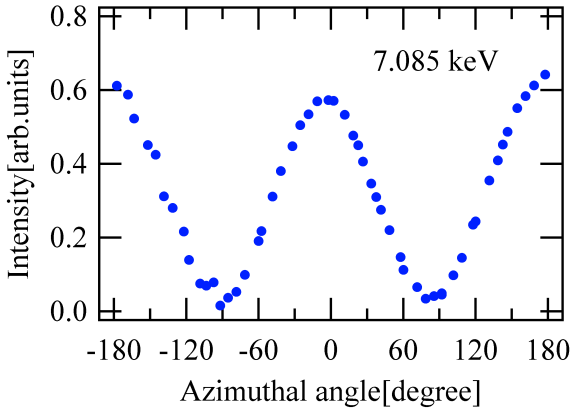


Fig. 2 Azimuthal dependence of the (003) reflection at 7.085 [keV].

## References

[1] K. D. Finkelstein , Qun Shen and S. Shastri: Phys. Rev. Lett. **69** (1992) 1612.
[2] F. de Bergevin and M. Brunel: Acta Crystallogr. Sect A **37** (1981) 324.

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