X-ray Magnetic Diffraction of Iron with A Phase Plate on An Undulator Beamline

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X-ray magnetic diffraction is known to be a unique tool by which we can separate magnetic form factor of ferromagnets into the two elementary parts, spin and orbital moment parts. This method utilizes elliptically polarized X-rays. So far, most of the X-ray magnetic diffraction experiments has been made by the white beam method using radiation from bending magnets.

Recently brilliant synchrotron radiation of an insertion device of undulator in 3rd generation facililties such as ESRF, APS and SPring-8 has become available, which is quasi monochromatic and linearly polarized. In this study we tried a monochromatic beam method of X-ray magnetic diffraction using brilliant X-rays from an undulator and a phase plate.

The experiment was made on the beamline BL39XU of Spring-8. X-rays were monochromatized by a Si double crystal with pin-post cooling system. The monochromatized and linearly polarized X-rays were passing through a phase plate of diamond crystal, and were converted to elliptically polarized X-rays. The degrees of linear polarization and circular polarization, P_l and P_c, varied with an offset angle of a phase plate crystal, $\Delta\theta$, from the Bragg condition. The elliptically polarized X-rays were irradiated on a pure iron single crystal plate which was magnetized by an electromagnet. The magnetic effect R of the Fe 220 diffraction was measured at various values of $\Delta\theta$. In this method R is proportional to the polarization factor, $P_c/(1-P_l)$.

The observed curve of R vs. $\Delta\theta$ is shown in the figure. The maximum of the absolute values of R amounts to 1% at $\Delta\theta$=2000sec, which is about twice as large as that measured in 2nd generation SR facilities. A little asymmetry in the observed curve is not yet solved. It is concluded that accurate measurements of magnetic form factors are possible with the phase plate on undulator beamlines.