Opening of Compton Scattering Beamline

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1.Circularly Polarized 274-keV X-rays

The beamline BL08W[1,2] has been constructed for high energy inelastic scattering experiments, and started its operation on October 10, 1997, and careful experiments have been carride out until Dec. 19 to examine the character of x-rays from an elliptical multipole wiggler, heat load problems on a monochromator [3], reliability of a superconducting magnet system and qualities of detector systems for x-ray spectroscopy. During the period, the initial ring current was 20mA and the magnet gap of the wiggler was 30mm. Thus the observed intensity of the x-ray flux was about 85 times lower than the final capability of the beamline, which can be achieved with a 100-mA ring current and a 20-mm magnet gap. Elliptically polarized 274 keV x-ray were tuned by the asymmetric Si (771) Johann-type monochromator, and found to be successfully focused at the sample position on a spot size of 3 mm high and 1mm wide, which was measured by a x-ray film. The relative energy resolution of the monochromatized x-ray was determined by the energy spectrum of elastically scattered x-rays detected by a Ge SSD, and was found to be 1.48×10^{-3} for a front-end slit width of 30 mm. It should be mentioned that the Darwin width of Si (771) diffraction for 300 keV x-rays is extremely narrow, and the monochromatized photon number significantly reduces. The degree of on-axis circular polarization P_c was 0.78 for 274 keV x-rays emitted from the wiggler with parameters k_x=0.6 and k_y=9.9. The value of Pc was determined by spindependent Compton scattering measurements, and was consistent with a theoretical estimation with a betatron-oscillation coupling ratio of 2%.

2.A 3-tesla Superconducting Magnet

A new superconducting magnet has been used for magnetic Compton-profile measurements. A maximum magnetic field ±3 T could be generated with a current of ±79 A, and the sign of the magnetic field could be altered within 5 s from +3 T to - 3 T, or vice versa. As a result of a reliable recondenser system of liquid He, the magnet was found to be completely free from maintenance of liquid He over one month. A sample is placed at the center of the room-temperature bore of 51mm in diameter penetrating the magnet coil.

3. A 10-Kelvin refrigerator for sample cooling

It is highly required to cool a sample down to low temperatures to detect the temperature dependence of its magnetic properties. A two-stage GM type refrigerator operated with helium-gas circulation was attached to the 3T superconducting magnet: a cold finger of the refrigerator is designed to be inserted in the room-temperature bore of the superconducting magnet. The cold finger is 330mm in length, and is composed of a metal tube so that the x-rays penetrating the sample should not be scattered in the refrigerator. It was found that the lowest temperature at the sample holder was 8 K, even a 3 T magnetic field was quickly switched to - 3 T in 5 s.

4. Magnetic Compton-profile measurements using SSD

Compton profiles have been measured by using a Ge solid-state detector having a crystal size of 11.3 mm in active diameter and 15 mm in thickness (Camberra, Model GLO115). Magnetic Compton profiles of ferromagnetic hcp Co along a-and b-axes have been measured by utilizing the 3T superconducting magnet. The sample was a disk with 10mm in diameter and 2 mm in thickness. The incident x-rays impinged on the side of the disk. The profile are shown in Fig.1. The overall momentum resolution was 0.64 a.u. The experimental profiles are folded at p_z = 0 a.u. The open circles denote theoretical profiles [4] calculated with APW method. The theoretical b-axis profils is in good agreement with the experiment, while the theory does not reproduce the observed dip of the a-axis profile around p_z = 0 a.u.

A trial has been made on measuring a magnetic Compton profile of Fe by switching the helisity of incident x-rays, which could be made by changing the phase of the magnet

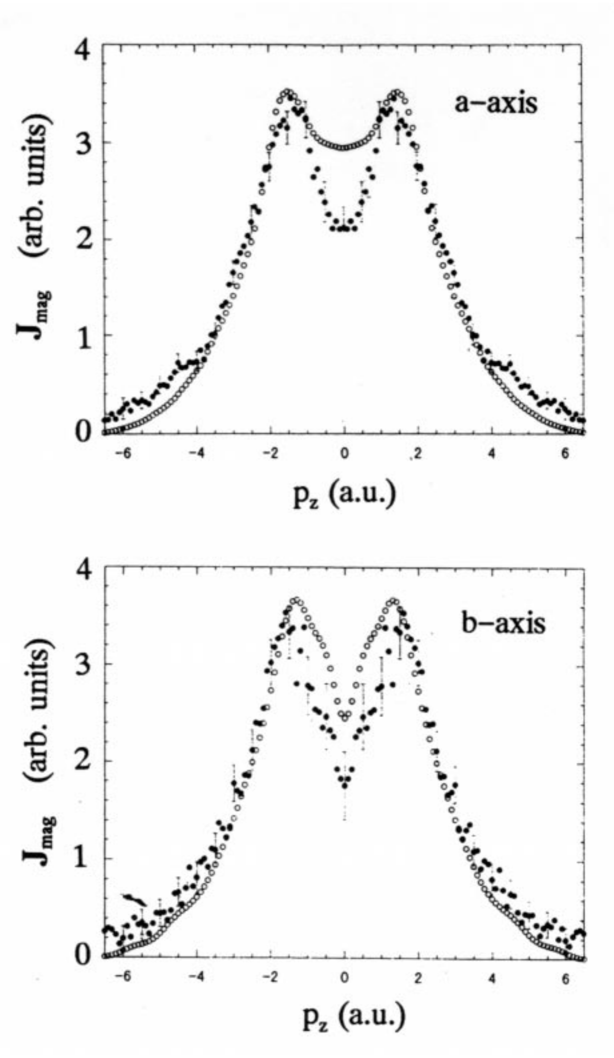

Fig.1. Magnetic Compton profiles of Co along a-axis and b-axis magnetized by using a 3-T superconducting magnet.

array of the wiggler. Two-hour alternating period was adopted to reduce the overall loss time required to change the helisity. After a 60-hour accumulation, a magnetic Compton profile of polycrystalline Fe shown in Fig.2 was obtained. In order to determine systematic errors in the profile, another magnetic Compton profile of Fe was also measured by the ordinary magnetization switching method under the same experimental setup. Although the corrected profile denoted by the open circles is still slightly asymmetric, which indicates the insufficient correction of the gain drift of the detector system, we see a fairly good agreement between them within the statistical accuracy.

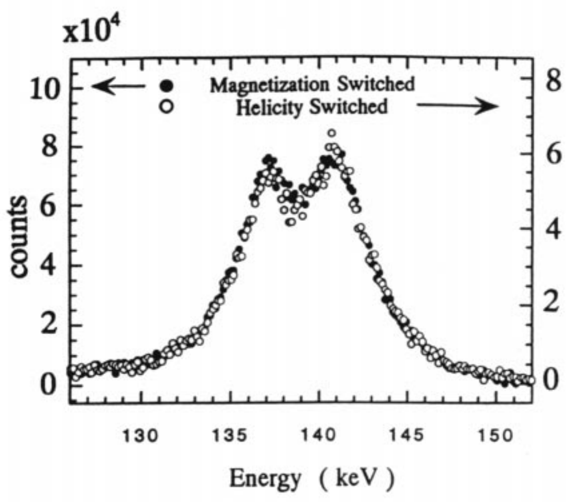

Fig.2. Magnetic Compton profile of polycrystalline Fe measured by switching the helicity of the incident x-rays.

The present success suggests that we will be able to utilize an extremely high field superconducting magnet for magnetic Compton profile measurements.

References

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