β-Ce Magnetic Compton Profile Measurement by Helicity Switching Method

N.Hiraoka(1204)[1], A.Koizumi(1345)[1], M.Mizumaki(1171)[2], M.Itou(1458)[2], Y.Kakutani(1344)[1], M.Seigo(1342)[1], M.Fujio(3813)[1], M.Totani(4193)[1], A.Nishinumra(4192)[1], Y.Sakurai(0258)[2], and *N.Sakai(1546)[1]

Fac. of Science, Himeji-Institute of Technology [1], JASRI [2]

In magnetic Compton scattering measurements, it is conventional that the magnetization direction of a sample is frequently reversed whereas a helicity of incident photons is fixed. Although it is also equivalent to reverse the helicity and keep the magnetization direction, such a method (helicity switching method) has been used little. The reason is may be ascribed to (1) the difficulty of quick reversal of the helicity, (2) no guarantee of the same polarization of x-rays after reversing, which is required to compensate the charge scattering component. However this helicity switching method has an advantage of using a high field superconducting magnet. In preliminary experiments we already obtained a satisfactory result by the helicity reversing method comparable to one by the magnetization reversing method for a polycrystalline pure-iron sample [1]. We have this time aimed at applying this method to a more interesting sample.

In the experiment circularly polarized 274 keV x-rays were used and the scattered x-rays were analyzed by a 10-segmented SSD at a scattering angle of 176 °. X-rays from a thin Al foil for reference were simultaneously detected by the SSD at a scattering angle of 15 ° The sample is β-Ce (Double HCP structure) , which has antiferromagnetic ordering below 12K. It was cooled to 10K. Once we planned to use an external magnetic field of 8T to induce the magnetization of Ce, but we were restricted to use the higher field than 2.5T due to a conflict between the high field and the working of a sample refrigerator. The S/N ratios of observed spectra were not satisfactory (~1;10) because of poor shielding against back-ground x-rays.

The magnetic effect is observed (shown in Figure) but very faint because of the large back ground x-rays in addition to the smallness of the induced magnetic moments (0.1 μ_B / Ce ion). The sign of the magnetic effect is positive, which is defined in comparison with the sign of the magnetic effect of iron. If f-electrons conserve their atomic state as other rare-earth metals, the negative magnetic effect should be observed, because the orbital magnetic moment is dominant (**L**=3) and coupled antiparallel with the spin magnetic moment (**S**=1/2) in Ce^{3+} ions. (**L** doesn't contribute to the magnetic Compton scattering.) The positive magnetic effect means that **S** is dominant and **L** is strongly suppressed due to the some situations of a crystal field splitting, a delocalization of f-electrons and so on.

In this study, the discussion is restricted by the low statistical accuracy due to the insufficient field and the poor S/N ratios. When the experimental condition is improved in near future, i.e. a higher field (8T, for example), a more photon flux and the sufficient shielding, statistical accuracy of magnetic Compton profiles increases by about 10 times. At that time, more detailed and precise discussions will be possible and ability of the helicity switching method will be exhibited.

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