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Measurement of spatial polarization distributions of inverse Compton scattered gamma rays

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In the UVSOR synchrotron facility, gamma rays with a maximum energy of 6.6 MeV are generated by 90-degree inverse Compton scattering (ICS) between a 750 MeV electron beam and a Ti:Sa laser with a wavelength of 800 nm. The gamma rays are used for atomic-scale defect analysis using gamma-ray-induced positron annihilation spectroscopy [1] and for evaluation of polarized gamma-ray detectors. The generation of polarized gamma rays is one of the key features for ICS. It is well known that polarized gamma rays are generated by using linearly and circularly polarized lasers, but their polarization state varies with the position of the gamma-ray beam cross section. For example, the polarization axis of linearly polarized gamma rays changes with the position of the cross section. Moreover, the degree of circular polarization of circularly polarized gamma rays varies with the scattering angle and changes to linear polarization in the region outside the cross section [2]. On the other hand, ICS using lasers with polarization states different from linear or circular could generate gamma rays with novel polarization states [3]. We have developed a Compton polarimeter capable of measuring the two-dimensional polarization distribution of ICS gamma rays.
In this conference, we will present the measurement results of the spatial polarization distribution of gamma rays generated using linearly, circularly, and axially symmetric polarized lasers. It was clearly observed that the polarization axis of linearly polarized gamma rays changed with the position of the cross section. We also demonstrated that the gamma rays generated by a circularly polarized laser transitioned to linear polarization in the outer region with the polarization axis aligning along the azimuthal direction. Furthermore, the gamma rays generated by an axially symmetric polarized laser were randomly polarized around the central axis and azimuthally polarized in the outer region.
[1] Y. Taira et al., Rev. Sci. Instr., 93 (2022) 113304.
[2] Y. Taira et al., Phys. Rev. A, 107 (2023) 063503.
[3] Y. Taira, Phys. Rev. A, 110 (2024) 043525.

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