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Gamma-ray linear polarization measurement by multi-layer CdTe Compton camera and segmented Ge detector

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Nuclear properties of unstable nuclei, such as masses, half-lives, excited levels, and spin-parities are important to understand the structural evolution in extreme quantum system. About 3000 isotopes of 118 elements have been discovered so far by the continuous effort of developing new accelerators and detection techniques, while the spin-parity of the ground- and excited-states remain to be determined. Linear polarization and angular distribution measurements of gamma-ray are usually applied to determine the electromagnetic multipolarity of gamma-ray. However, the detection techniques have not been applied in the wide range of nuclei due to the limited statistics since the methods usually require the coincidence and intensity distribution measurements of gamma-ray at multiple angles.

To overcome this difficulty, we are developing a new, highly efficient experimental technique for gamma-ray linear polarization measurements by adopting a multi-layer CdTe semiconductor detector array, which has been developed in the X- and gamma-ray observatory field. We conducted a proof-of-principle experiment at the RIKEN Pelletron facility. The first excited state of ^{56}Fe was populated by inelastic scattering of protons. The de-excited gamma-rays of 847 keV were measured by the multi-layer CdTe Compton Camera (CdTe20CC) and the segmented Ge detector (CNS-GRAPE) placed at 90 degrees to the incident proton beam. The linear polarization of gamma-ray was successfully observed by both detector systems. In this presentation, we will show the experimental results and discuss future applications of the detector system for in-beam gamma-ray and decay spectroscopy on rare isotopes.

Experimental study on nuclear physics

Primary author: Dr GO, Shintaro (RIKEN Nishina Center)

Co-authors: Dr TSUZUKI, Yutaka (Department of Physics, the University of Tokyo); Prof. ICHIKAWA, Yuichi (Department of Physics, Kyushu University); Dr IKEDA, Tokihiro (RIKEN Nishina Center); Prof. IMAI, Nobuaki (Center for Nuclear Study, the University of Tokyo); Dr IMAMURA, Kei (RIKEN Nishina Center); Dr NIIKURA, Megumi (RIKEN Nishina Center); Prof. NISHIMURA, Daiki (Department of Physics, Tokyo City University); Ms MIZUNO, Rurie (Department of Physics, the University of Tokyo); Prof. TAKEDA, Shinichiro (3. Kavli Institute for the Physics and Mathematics of the Universe, Institutes for Advanced Study); Dr UENO, Hideki (RIKEN Nishina Center); Prof. WATANABE, Shin (7. Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency); Dr YONEDA, Hiroki (RIKEN Nishina Center); Dr SAITO, Takeshi (Center for Nuclear Study, the University of Tokyo); Prof. SHIMOURA, Susumu (Center for Nuclear Study, the University of Tokyo); Mr SUGAWARA, Sora (Department of Physics, Tokyo City University); Dr TAKAMINE, Aiko (RIKEN Nishina Center); Prof. TAKAHASHI, Tadayuki (Kavli Institute for the Physics and Mathematics of the Universe, Institutes for Advanced Study)

Presenter: Dr GO, Shintaro (RIKEN Nishina Center)

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