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A measurement of atmospheric circular polarization with POLARBEAR

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Although the cosmic microwave background (CMB) is assumed to be only linearly polarized due to the Thomson scattering, some exotic theories predict the generation of circular polarization in the CMB during its propagation. E.g., Faraday conversion due to the supernovae remnants of first stars[1], the scattering by cosmic neutrino background[2], and Lorentz violation[3]. Thus, the circular polarization of the CMB could be the new search tool of the universe.

Since most current CMB experiments aim to detect the primordial B-mode linear polarization, it is fine to introduce the optical device to convert circular polarization to linear polarization for the quick observation of the circular polarization. We focused on the leakage between linear and circular polarization due to the frequency dependence of the half-wave plate (HWP). We used the observed data of the POLARBEAR experiment with a continuously-rotating HWP, and confirmed the observation method by detecting the atmospheric circular polarization whose intensity is much stronger than the noise level of the experiment[4]. In this presentation, we will show the analysis method and results of this observation. This is the first result of the circular polarization detection using a continuously rotating HWP.

[1] S. De and H. Tashiro, Phys. Rev. D 92, 123506 (2015)

[2] R. Mohammadi, Eur. Phys. J. C 74, 3102 (2014)

[3] L. Caloni et al, JCAP 03, 018 (2023)

[4] T. Fujino et al, ApJ 981, 15 (2025)

Auteur: FUJINO, Takuro (High energy accelerator research organization)

Co-auteur: Dr TAKAKURA, Satoru (UTokyo)

Orateur: FUJINO, Takuro (High energy accelerator research organization)

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