

R006-P47

ポスター 1 : 11/25 AM1/AM2 (9:15-12:35)

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Observation of the Earth's Plasmasphere in Extreme Ultraviolet by PHOENIX onboard EQUULEUS

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The Plasmaspheric Helium ion Observation by Enhanced New Imager in eXtreme ultraviolet (PHOENIX) onboard the 6U CubeSat EQUULEUS is a compact extreme ultraviolet telescope optimized for the He II 30.4 nm emission line, which originates from resonant scattering of solar radiation by plasmaspheric He ion. The Earth's plasmasphere is a torus-shaped region of cold plasma surrounding the Earth, whose dynamics are strongly influenced by geomagnetic disturbances. Imaging the plasmasphere in EUV provides a direct method to study its global structure and temporal evolution.

PHOENIX, despite its small size, consists of a multilayer-coated mirror, a metallic thin filter, and a photon-counting detector, achieving an angular resolution better than 0.19 degree and a temporal resolution shorter than 1.5 hr. In May 2023, during EQUULEUS's cruise to the Earth – Moon Lagrange point 2, PHOENIX successfully obtained global meridian-view images of the plasmasphere. The results clearly revealed plasma density structures aligned with dipole-shaped geomagnetic field lines and captured the shrinkage of the plasmasphere associated with a geomagnetic disturbance on May 6. These achievements represent the first global imaging of the plasmasphere using an ultra-small instrument, highlighting the potential of nano-spacecraft to perform advanced space plasma observations.

In addition to these imaging results, ongoing work applies the Minimum L Algorithm to map the plasmopause position onto the geomagnetic equatorial plane based on line-of-sight brightness profiles. Preliminary analysis also indicates an inward motion of the plasmopause during the same disturbance event, demonstrating that the mapping technique can reproduce and quantify the plasmaspheric erosion observed in the images. This presentation will show both the established imaging results and the ongoing efforts toward quantitative plasmopause mapping, highlighting the expanding scientific potential of PHOENIX for future planetary and magnetospheric exploration.