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Earth-orbiting extreme ultraviolet spectroscopic mission SPRINT-A/EXCEED

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Abstract

The EXCEED (Extreme Ultraviolet Spectroscope for Exospheric Dynamics) mission is an Earth-orbiting extreme ultraviolet (EUV) spectroscopic mission and the first in the SPRINT series being developed by ISAS/JAXA. It will be launched in the summer of 2013. EUV spectroscopy is suitable for observing tenuous gases and plasmas around planets in the solar system (e.g., Mercury, Venus, Mars, Jupiter, and Saturn). Advantage of remote sensing observation is to take a direct picture of the plasma dynamics and distinguish between spatial and temporal variability explicitly.

One of the primary observation targets is an inner magnetosphere of Jupiter, whose plasma dynamics is dominated by planetary rotation. Previous observations have shown a few percents of the hot electron population in the inner magnetosphere whose temperature is 100 times higher than the background thermal electrons. Though the hot electrons have a significant impact on the energy balance in the inner magnetosphere, their generation process has not yet been elucidated. In the EUV range, a number of emission lines originate from plasmas distributed in Jupiter's inner magnetosphere. The EXCEED spectrograph is designed to have a wavelength range of 55–145 nm with minimum spectral resolution of 0.4 nm, enabling the electron temperature and ion composition in the inner magnetosphere to be determined. Another primary objective is to investigate an unresolved problem concerning the escape of the atmosphere to space. Although there have been some in-situ observations by orbiters, our knowledge is still limited. The EXCEED mission plans to make imaging observations of plasmas around Venus and Mars to determine the amounts of escaping atmosphere. The instrument's field of view (FOV) is so wide that we can get an image from the interaction region between the solar wind and planetary plasmas down to the tail region at one time. This will provide us with information about outward-flowing plasmas, e.g., their composition, rate, and dependence on solar activity.

EXCEED has two mission instruments: the EUV spectrograph and a target guide camera that is sensitive to visible light. The EUV spectrograph is designed to have a wavelength range of 55-145 nm with a spectral resolution of 0.4-1.0 nm. The spectrograph slits have a FOV of 400 x 140 arc-seconds (maximum). The optics of the instrument consists of a primary mirror with a diameter of 20cm, a laminar type grating, and a 5-stage micro-channel plate assembly with a resistive anode encoder. To achieve high efficiencies, the surfaces of the primary mirror and the grating are coated with CVD-SiC. Because of the large primary mirror and high efficiencies, good temporal resolution and complete spatial coverage for Io plasma torus observation is expected. Based on a feasibility study using the spectral diagnosis method, it is shown that EXCEED can determine the Io plasma torus parameters, such as the electron density, temperatures, hot electron fraction and so on, using an exposure time of 50 minutes. The target guide camera will be used to capture the target and guide the observation area of interest to the slit. Emissions from outside the slit's FOV will be reflected by the front of the slit and guided to the target guide camera. The guide camera's FOV is 240" x 240". The camera will take an image every 3 seconds and the image is sent to a mission data processor (MDP), which calculates the centroid of the image. During an observation, the bus system controls the attitude to keep the centroid position of the target in the guide camera with an accuracy of ±5 arc-seconds. With the help of the target guide camera, we will take spectral images with a long exposure time of 50 minutes and good spatial resolution of 20 arc-seconds.