Three-year of observations of Jupiter’s aurora and Io plasma torus variabilities by extreme-ultraviolet spectroscope HISAKI and future directions

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Extreme Ultraviolet spectrograph, EXCEED, on-board the HISAKI satellite is designed for observing tenuous gas and plasma around planets in the solar system. It enables us to obtain fully continuous data set and find time variability in the planetary magnetosphere and ionosphere with time scales of several hours to months. Here, we introduce findings of Jupiter’s UV aurora and plasma emissions from the Io plasma torus (IPT) obtained from the HISAKI observation since Dec. 2013. Jupiter is known to have a huge magnetosphere in which the plasma convection is mainly driven by the planet spin motion. This is caused by the strong intrinsic planetary magnetic field, fast spin motion, and presence of a primary plasma source inside the inner magnetosphere. The plasma source from the satellite Io with a typical rate of 1 ton/sec causes slowly outward transport of plasma from inner to middle magnetosphere. The HISAKI observation found decrease in hot electron density as decreasing radial distance, which is an evidence of steady hot plasma transport into the inner magnetosphere due to interchange instability. HISAKI also found brightening in IPT associated with transient enhancement of Jupiter’s aurora, showing an evidence of transient and rapid inward transport of energy from the outer/middle to inner magnetosphere. The transient enhancement of Jupiter’s aurora is also one of discoveries from HISAKI. It was observed during solar wind quiet period, suggesting that the transient energy release can be drive by the internal plasma circulation process. Wide spectral observation enables us to estimate aurora electron energy and total emission power and showed that enhancements of auroral intensity accompany increases of the electron number flux rather than the electron energy variations. The HISAKI-HST campaign in Jan. 2014 provided unique data set to study time variability in Jupiter’s auroral structure. During this period, Jupiter’s main auroral oval decreased its emitted power by 70% and shifted equatorward by about 1 degree. The decrease in emitted power is attributed to a decrease in auroral current density rather than electron energy, consistent with the HISAKI observation. HST also captured variations in auroral structure during a short-lived transient brightening observed by HISAKI and showed hot plasma inflows from tail reconnection region. Observations of Jupiter’s magnetosphere by HISAKI and HST show us a new picture of the Jovian magnetosphere: significant energy is released in the magnetosphere due to internally driven process and is rapidly re-distributed from outer/middle to inner magnetosphere. HISAKI also reveals new insights about responses of the magnetosphere to the solar wind. Intensification of the aurora brightness is well correlated with enhancement of dynamic pressure of the solar wind. The amplitude is controlled by the duration of a quiescent interval of the solar wind. The response of IPT to the solar wind dynamic pressure is also discovered from the HISAKI observation and is interpreted by the modification of large scale electric field in the magnetosphere. Satellite-magnetosphere interaction is also a unique topic for outer planet magnetosphere. HISAKI found hot plasma heating around the satellite Io and it is responsible for 10% of total energy input to IPT. The HISAKI mission will extend until the spring of 2020 and provide us an opportunity to make simultaneous observation of Jupiter’s magnetosphere with

NASA’s JUNO spacecraft.

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