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木星磁気圏におけるプラズマの加速、加熱、輸送
Acceleration, heating, and transport of space plasmas in Jupiter’s magnetosphere

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本　文

The planet Jupiter is a magnetic rotator that has the largest intrinsic magnetic moment and the fastest rotation velocity in the solar system planets. The huge magnetosphere induced by its magnetic field is filled with the heavy oxygen and sulfur ions originating volcanoes at the moon Io. The heavy magnetosphere corotate with Jupiter at its rotation period of ~10 hr, which centrifugally drives the radial plasma transport and electromagnetic acceleration in the magnetosphere. Basics and recent results for the dynamics of Jupiter’s magnetosphere are introduced in this talk with a focus on the observations with JAXA’s planetary space telescope ‘Hisaki’, which the authors have been developing and operating.

The extreme ultraviolet (EUV) space telescope Hisaki is the first small scientific satellite mission of the Japan Aerospace Exploration Agency. The scientific scope of the mission is to investigate the dynamics of space and the atmospheric environments of planets in our solar system. Since its launch on 14 September, 2013 to the present day, Hisaki has observed Jupiter's aurora and Io plasma torus for more than 1200 days, which is an average of 200 observation days per year. The continuous long-term monitoring unveiled the dynamics in the aurora and the Io plasma torus, which are closely associated with the plasma circulation in the inner magnetosphere and electromagnetic particle acceleration.

The plasma circulation from the inner to middle magnetosphere was found to be enhanced during large volcanic eruptions at Io in 2015 (Yoshikawa, 2017; Tsuchiya et al., 2018a; Kimura et al., 2018). Accompanying enhancement of neutral atom escape from Io's atmosphere (Koga et al., 2018a, b, and 19), radially outward mass and energy transports in the torus drastically changed during the Io volcanic eruptions, which are successfully quantified based on the Hisaki EUV spectroscopy (Yoshioka et al., 2018; Hikida et al., 2019). Radial profile of plasma and our analytic model of plasma mass loading process suggested that the outward transport is likely driven by the interchange instability (Tsuchiya et al., 2018a; Kimura et al., 2018). A hot plasma sector embedded in the torus was found in the Hisaki long-term monitoring data, and subcorotation speed of the hot plasma sector is dependent on the volcanic activities (Tsuchiya et al., 2018b). Correlations of the torus brightness structure with the dawn-dusk electric field structure and radiation belts are also discussed based on the GMRT radio arrays and Hisaki observations (Murakami et al., 2016; Kita et al., 2019).

Synergies with the Hubble Space Telescope and Juno spacecraft also provide new insights into the plasma precipitation in the inner and middle magnetosphere. Based on the HST-Hisaki coordinated observation, Kimura et al. (2015, 17) found simultaneous occurrence of the large-scale hot plasma injection in the inner magnetosphere with the middle magnetospheric disturbance based on imaging and monitoring of the short-lived auroral brightenings (Fig. 1). They were recurring with a period of 2-3 days during the solar wind quiet period (Tao et al., 2021). Juno in-situ plasma measurements by Yao et al. (2019) suggested that the short-lived auroral brightening is triggered by the global reconfiguration of magnetosphere, which is likely associated with the centrifugally-driven magnetotail reconnection (Fig. 2).

The solar wind response of Jupiter's UV aurora monitored with Hisaki and Juno discovered a mysterious 10-hour time lag of the short-lived auroral brightening with respect to the solar wind shock arrival at Jupiter's polar region (Kita et al., 2016, 2019). This cannot be explained by a simple propagation process of the MHD waves in the magnetosphere, which implies an unknown energy transport and temporal evolution process in the magnetosphere that is relatively slow compared to the simple MHD wave propargation process. The hot plasma injection at the central torus in the deep inner magnetosphere follows the short-lived auroral intensification (Suzuki et al., 2018), which implies a global energy and/or mass transport from the middle/outer to the inner magnetosphere (Kimura et al., 2017; Yoshikawa et al., 2017; Tsuchiya et al., 2018a).

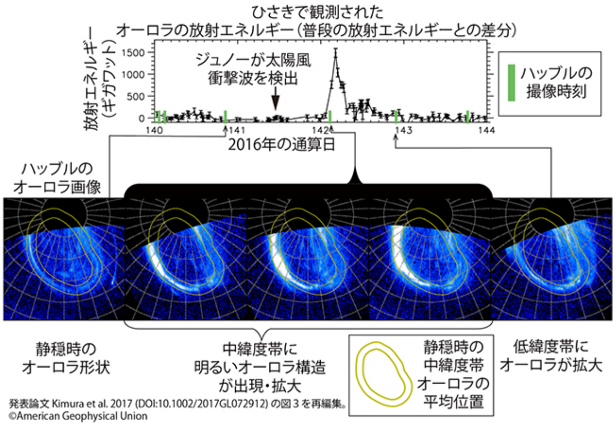

Fig. 1: Time series of power emitted from Jupiter's aurora and its morphology
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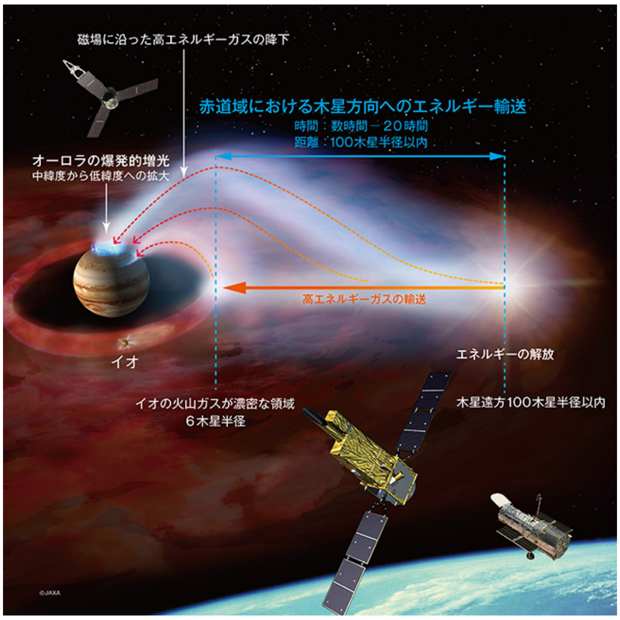

Fig 2.: Illustration of Jupiter's energy release andtransport process inferred from the auroral observation with Hisaki and Hubble Space Telescope
https://www.riken.jp/press/2017/20170523_1/

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