Structure of Io plasma torus observed with the Tohoku 60-cm telescope

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Volcanic gases (mainly composed of SO_2, SO and S) originated from jovian satellite Io are ionized by interaction with magnetospheric plasma and then form a donut-shaped region called Io plasma torus. Ion pickup is the most significant energy source on the plasma torus though, distribution of pick-up region and its variability is still unclear. Density profiles of ions along the magnetic field line are determined under condition of diffusive equilibrium. Based on the equilibrium, plasma equator is close to the centrifugal equator though, higher ion anisotropy moves the plasma equator toward the magnetic equator. Measuring ion distribution with enough spatial resolution enables us to derive ion anisotropy which is tightly related to the amount of fresh pickup ion. On this study, we focus on variability of latitudinal structure of Io plasma torus as well as its radial structure using ground-based observation over six month period in 2018. The ground-based observation of sulfur ion emission, [SII] 671.6nm and 673.1nm was made at Haleakala observatory in Hawaii during March through August 2018 using the Tohoku 60-cm telescope (T60). A monochromatic imager with coronagraph attached onto the Cassegrain focus of T60 enables to measure distribution of S^+ with spatial resolution of 0.03 jovian radii (R_J). A digital micro-mirror device DMD was employed to block light from Jupiter disk and Galilean moons. Typical integration time of each frame was 20 minutes and total number of reduced image is 480. We also made observation of neutral sodium cloud extending up to several hundred of R_J as a proxy of supply of neutral particles from Io (Yoneda et al., 2015). Based on observation over the six month, [SII] brightness increases from DOY 80 through 140, then gradually decreases though DOY 230 in 2018. The data reduction of iogenic neutral sodium cloud is still undergoing though, neutral sodium cloud seems to increase from DOY 50 through 135, as [SII] brightness increases. The result suggests that increased volcanic activity from DOY 50-135 caused increase of S+ and brightening of [SII] emission. As for variability of shorter duration, we find [SII] brightening event within a short period (< 2 days) at around 28 through 30 July over a small region (< 30 degrees in longitude). [SII] 671.6 and 673.1 nm emissions are sensitive to cold electron (1-10eV) rather than hot electron (>100eV). Thus, increase of cold electron temperature explains the observed [SII] brightening well as the EUV space telescope Hisaki observed brightening of Io plasma torus associated with injection of hot electron. We also find variation of latitudinal structure of Io plasma torus. Longitudinal peak of S^+ emission at the same system III longitude 279 degree are -0.73, -0.80 and -0.79 R_J on 26, 29 July 7 and August, respectively. The shift of S^+ density peak toward magnetic equator implies higher anisotropy 29 on July and 7 August compared with 26 July. One of the possible explanation of the latitudinal shift of S^+ plasma is an increase of flesh pickup ion which makes higher anisotropy. Further study using Colorado Io Plasma Torus Emission Package (CITEP) will be presented on the presentation to take into account for line-of-sight integration effect of the ground-based observation.

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