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Atoms and molecules originated from volcanic eruption on jovian satellite Io are ionized around Io and, in turn, they are picked up by jovian magnetic field. This process defines the term “mass loading”. Mass loading supplies energy of about a few tera watts to the Io plasma torus, IPT, through the region of mass loading and its time variability is not clear yet. In the present study, in order to realize the observation of spatial distribution and time variability of mass loading as well as relationship between variation of mass loading and characteristics of IPT, Doppler resolved imaging observation of [SII] 671.6 nm emission was carried out using a Fabry-Perot imager (FPI; $\lambda/\delta\lambda \sim 61{,}000$) coupled to a 35-cm Schmidt-Cassegrain telescope at the Haleakala High Altitude Observatory in February 2004 and March 2005, covering 6 and 17 nights, respectively.

In addition, in order to have an insight of the plasma environment in close proximity of Io, high spatially resolved observation of Iogenic neutral sodium cloud was made at Haleakala using the FPI coupled to the AEOS 3.7-m telescope equipped with an Adaptive Optics (AO) system in March 21, 2005.

From the analysis of the Doppler quantities of [SII] 671.6 nm emission in IPT, following results have been obtained for characteristics of IPT.

1. Temperature anisotropy ($T_{\perp}/T_{||}$) of sulfur ions in the radial range of ±0.1 R_J centered on Io's orbit is 2.09, indicating small anisotropy relative to the anisotropy estimated from the kinetic energy of a sulfur ion picked up by corotating magnetic field. In addition, this anisotropy is maintained for regions both radially and longitudinally away from Io's orbit. The fact implies that the time scale for relaxation of ion temperature anisotropy by coulomb collisions is sufficiently short compared to the time scale of torus plasma replenishment (order of 10 days).

2. Regarding the emission intensity, System III dependence is clearly seen; the emission intensity for λ_{III} = 157.5±22.5° is about twice of that for λ_{III} =

22.5±22.5° at ribbon. Time variation exceeding measurement errors are also seen.

3. Estimated electron density at the ribbon changes from ~2700 /cm^3 in 2004 to ~2400 /cm^3 in 2005, giving a reduction of ~10%.
4. From the displacement of the IPT center from Jupiter center, dawn-dusk electric field with strength ratio relative to corotation electric field is estimated to be 0.021±0.011 and 0.020±0.011 in 2004 and 2005, respectively. Observed displacement sometimes exceeds the expectation from the offset tilted dipole.
5. Deviation of latitudinal center position of the ribbon from the centrifugal equator exceeds 1° while ion temperature anisotropy is less than 10 for all System III longitudes. Therefore, observed deviation of latitudinal center position of the ribbon from the centrifugal equator should be caused not by ion temperature anisotropy but by another unknown reason.

Following results have also been obtained for the corotation deviation in IPT.

6. Observed corotation deviation has clear System III longitude dependence. This may be caused by the deviation of real magnetic field from dipole field.
7. Corotation deviation is not dependent only on System III longitude.
8. Radially averaged corotation deviation is –3.2±2.5 km/s and –1.9±2.0 km/s and the total mass loading rate is estimated to be 2.0±1.6×10^3 kg/s and 1.2±1.3×10^3 kg/s in 2004 and 2005, respectively.
9. Corotation deviation against Io digression angle (IDA) is not seen for the range of IDA = 45 – 315°. This suggests that mass loading is almost uniform in the longitudinal range away from Io.
10. Based on the observational results 8. and 9., to conform with the generally accepted total mass loading rate all over the IPT, ~1000 kg/s, it is suggested that the mass loading region is almost uniformly distributed along Io's orbit far from Io.
11. Decreasing trend from 2004 to 2005 is confirmed for both observed total mass loading rate and estimated electron density at the ribbon position. Change of

plasma density at the ribbon, given in result 3. above, is thought to correspond with more averaged trend of mass loading. On the other hand, rather large decrease of mass loading rate from 2004 to 2005, result 8. above, can be understood as caused by a short time scale change of mass loading. It is suggested that observed large decrease of mass loading rate is due to limited short observation period in each year; 6 night in 2004 and 17 nights in 2005.

From the high spatially resolved observation of Iogenic neutral sodium cloud, following results have been obtained.

12. Although distribution of sodium corona is almost spherically symmetric, there is an asymmetry with respect to Io flux tube: column density at a radial distance of 6 R_{Io} in the sub-Jupiter side is 1.30(+0.36/–0.32) times greater than that at the same radial distance in the opposite side. The result indicates that hotter electron temperature in the anti-Jupiter side in a source region of sputtering causes ~1.3 times less source rate in the anti-Jupiter side.
13. Distribution of sodium atoms with slow LOS component which is though to be produced by sputtering is expressed by $N(r)=(1.2\pm0.6)\times10^{12}\ r^{-1.6\pm0.3}\ cm^{-2}$. Lower limit for distribution of sodium atoms produced by pickup ion neutralization is estimated to be $N(r)=(6.7\pm0.9)\times10^{10} r^{-1.2\pm0.20}\ cm^{-2}$.