Variability of mass loading in the Io plasma torus

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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, though the region of mass loading and its time variability is not clear yet. In order to realize the observation of spatial distribution and time variability of mass loading as well as relationship to clarify between variation of mass loading and characteristics of IPT, Doppler resolved imaging observation of [SII] 671.6 nm emission was carried out at the Haleakala High Altitude Observatory using a Fabry-Perot imager (FPI; R=61,000) coupled to a 35-cm Schmidt-Cassegrain telescope in February 2004 and March 2005, covering 6 and 17 nights, respectively. From the analysis of the Doppler quantities of [SII] 671.6 nm emission in IPT, following results have been obtained. 1) Temperature anisotropy (T_perp/T_parallel) of sulfur ions in the radial range of +/-0.1 RJ centered on the Io's orbit is 2.1, indicating small anisotropy compared to the anisotropy expected 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. This 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) 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+/-1.6x10ˆ3 kg/s and 1.2+/-1.3x10ˆ3 kg/s in 2004 and 2005, respectively. 3) Change of corotation deviation with respect to Io digression angle (IDA) is not seen for the range of IDA = 45 - 315 degrees. This suggests that mass loading is almost uniform in the longitudinal range away from Io. 4) Based on the observational results 2. and 3., to conform with the generally accepted total mass loading rate all over the IPT, about 1000 kg/s, it is suggested that the mass loading region is almost uniformly distributed along Io's orbit far from Io. 5) 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 from about 2700 /cmˆ3 in 2004 to about 2400 /cmˆ3 in 2005 at the ribbon 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 2. 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.