Azimuthal variation in the Io plasma torus observed by the Hisaki satellite from 2013 to 2016

Fuminori Tsuchiya[1]; Ryo Arakawa[2]; Hiroaki Misawa[3]; Masato Kagitani[4]; Ryoichi Koga[5]; Fumiharu Suzuki[6]; Reina Hikida[7]; Kazuo Yoshioka[8]; Tomoki Kimura[9]; Yasumasa Kasaba[10]; Go Murakami[11]; Ichiro Yoshikawa[12]; Atsushi Yamazaki[13]
[1] Planet. Plasma Atmos. Res. Cent., Tohoku Univ.; [2] Geophysics, Tohoku Univ.; [3] PPARC, Tohoku Univ.; [4] PPARC, Tohoku Univ; [5] Geophysics, Tohoku Univ.; [6] Complexity Science, Univ. of Tokyo; [7] Frontier Sciences, Tokyo Univ.; [8] The Univ. of Tokyo; [9] Tohoku University; [10] Tohoku Univ.; [11] ISAS/JAXA; [12] EPS, Univ. of Tokyo; [13] ISAS/JAXA

http://pparc.gp.tohoku.ac.jp/

The inner area of a planetary magnetosphere generally contains a dense plasma region that corotates with the planet. In the Jovian magnetosphere, sulfur and oxygen ions supplied by the satellite Io are distributed in what is called the Io plasma torus. Various plasma parameters in the plasma torus have significant azimuthal variations that are coupled with the energy flows in the Jovian inner magnetosphere. In this study, 3 years of data obtained by the Hisaki satellite, from December 2013 to August 2016, were used to investigate statistically the azimuthal variations and to find how the variations were influenced by productions of plasma from Io. The azimuthal variation was obtained from a time series of sulfur ion line ratios, S^{3+} 65.7 nm/S^{3+} 140.5 nm and S^{3+} 65.7 nm/S^{+} 76.5 nm, which were sensitive to the electron temperature and the sulfur ion mixing ratio S^{3+}/S^{+}, respectively. Using the two line ratios, we confirmed significant single peaked azimuthal variations in the thermal electron temperature and the S^{3+}/S^{+} mixing ratio in the Io plasma torus. The mean rotation rate of the azimuthal patterns during the 3 years of Hisaki observations was found to be 10.08 h, 1.5% slower than the Jovian rotation period. The azimuthal variation of the S^{3+}/S^{+} mixing ratio is nearly in phase with that of the thermal electron temperature. The peak longitude of the electron temperature tends to precede that of the higher sulfur ion charge state (S^{3+}/S^{+}) by 0 deg-90 deg, which is explained by the competing effect of the sub-corotation of hot electrons and chemical reactions in the plasma torus. These results are consistent with the prediction of the dual hot electron model proposed to explain previous observations (Steffl et al., 2008; Hess et al., 2011). One of new findings from the Hisaki observation is change in the rotation period of the plasma torus associated with Io volcanic activity. The rotation period sometimes decreased from the mean periodicity of 10.08 h. The period fell to 9.93-9.97 h in March April 2015 and to 10.03 h in May June 2016. The decreases in the rotation period in 2015 and 2016 were related to the increase in Io volcanic activity. Both decreases occurred when the thermal electron temperature in the plasma torus increased. On the other hand, the decrease in the rotation period occurred in February 2014 when there was no increase in Io's volcanic activity and no observed increase in the thermal electron temperature. Hisaki also found that a double-peaked azimuthal compoment in the S^{3+}/S^{+} ratio and thermal electron temperature. The S^{3+}/S^{+} ratio was located not only around 0 deg-45 deg, as in previous observations, but also around ˜180 deg. The origin of the double-peaked structure is an open question and further study is needed to resolve it.