Research on source and escape processes of Io's atmosphere based on the Hisaki observations

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Abstract

We present the time variation of atomic oxygen emission around Io and spatial distribution of Io's oxygen neutral cloud observed by Hisaki. Io's atmosphere is mainly dominated by sulfur oxides (and several percent is NaCl and KCl) that originated from volcanoes. They are dissociated and some of oxygen and sulfur atoms escape from Io's gravity by atmospheric sputtering, and create Io's neutral cloud around Io's orbit. The spatial distribution of Io's oxygen and sulfur neutral cloud was not observed because their emissions are faint (several Rayleighs (R)). Thanks to the continuous observations of Io plasma torus by Hisaki, we succeed to derive the spatial distribution of atomic oxygen emissions at 130.4 nm around Io's orbit.

We observed the enhancement of atomic oxygen emissions around Io in 2015. In the same periods, the enhancement of infrared emission from Io's volcano and extended sodium nebula emission were observed in the same period. This shows the volcanic activity increases gases originated from Io. The decreasing time scales from peak to nominal phase are different between sodium and atomic oxygen emissions. This may show the source regions of SO_2 are wider than those of NaCl.

We also analyzed the Io phase angle dependence and radial distribution of atomic oxygen emission during a volcanic quiet period (from November to December, 2014). The results show Io's oxygen neutral cloud consists of two components, a leading cloud that spreads inside Io's orbit (often called "banana cloud") and a longitudinally uniform, diffuse region distributed along Io's orbit. It is possible that oxygen atoms whose initial speed is near 2.6 km/s (around escape speed from Io's gravity) and that are ejected on the trailing side, may mainly create the banana cloud, and oxygen atoms whose initial speed is much larger than 2.6 km/s or those that are ejected on the leading side may mainly create the diffuse region. If we can compare the model with the observations of Io's neutral oxygen cloud, it is expected to constrain the velocity distribution of escaping neutrals from Io.