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Slowing ion by a dust-plasma interaction and ionospheric conductivities in Saturn's plasma disk

Slowing ion by a dust-plasma interaction and ionospheric conductivities in Saturn's plasma disk

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Past observations using the particle detectors on Voyager and Cassini showed that the plasma speeds in the Saturn's inner magnetosphere are close to the ideal co-rotation speed around 5 Rs and gradually become 70?80% of the ideal co-rotation speed at 7 Rs [Bridge et al., 1981, 1982; Richardson, 1986, 1998; Wilson et al., 2008, 2009]. On the other hand, observations using the Langmuir Probe (LP) on board the Cassini spacecraft showed that the ion bulk speeds are close to Keplerian speed in the E ring [Wahlund et al., 2009]. The E ring of Saturn consists of small (micron- and nano- meter sized) dust particles. These dusts are negatively charged inside 7 Rs and expected to contribute to the electro dynamics in the plasma disk [Horanyi et al., 2004; Kempf et al., 2008]. Near Enceladus, which is a major source of the E ring dusts, the electron densities are significantly smaller than the ion densities and the ion speeds are near Keplerian [Morooka et al., 2011]. According to the latest ion modeling, the ions are slowed down due to the interaction with dust through the magetosphere-ionosphere coupling and the ion speeds from the modeling are consistent with LP observations when the thickness of dust distribution is larger than 3 Rs. Moreover, the ion speeds are Keplerian in high density region such as the neighborhood of Enceladus. However, this model is only solved in one dimension, which is the radial component.

We have calculated the ion speeds in the two-dimension expanded in the latitudinal component to investigate the effect of the distributions of density and temperature in latitude on the ion speeds. We have also investigated the effect of the ionospheric conductivities. The ionospheric conductivities are considered a few mho [Cowley and Bunce, 2003; Cowley et al., 2004, 2008; Moore et al., 2009]. Cowley and Bunce [2003] calculated the co-rotation lag due to the ionospheric current in the Saturn's inner magnetosphere. Moore et al. [2009] estimated the latitudinal variations of Pedersen conductivity. However, variations of ion speeds due to the changes of the ionospheric conductivities are not estimated. We have estimated the variations of ion speeds with our model that the effect of dusts is included and extended in two-dimension.

In this presentation, we discuss importance of role to inner magnetosphere played by dusts and the ionosphere through monitoring the ion speeds. We also discuss based on our results that future exploration to Saturn plays very important roles in planetary sciences.

キーワード: Saturn, inner magnetosphere, ionosphere, plasma disk, dust-plasma interaction, dusty plasma
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