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土星プラズマディスク中におけるダスト-プラズマ相互作用
Dust-plasma interaction in Saturn's plasma disk

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Plasma in Saturn's magnetosphere is co-rotating due to the rapid rotation of the planet. The co-rotation speed can slow down due to, for instance, mass loading. Past observations by the particle detectors for few hundred eV ions showed that the plasma speeds are close to the ideal co-rotation speed around 5 Rs and gradually slow down to 20–30% of the ideal co-rotation at 7 Rs.

On the other hand, the Cassini observation using the Langmuir Probe (LP) showed that the ion bulk speeds are close to Keplerian in the E ring. The E ring of Saturn consists of small (micron- and nano- meter sized) dust grains. These dusts are negatively charged inside 7 Rs and expected to contribute to the electro dynamics in the plasma disk. Also 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 in a large region. Recently the Cassini Plasma Spectrometer (CAPS) onboard Cassini also observed that the sub-co-rotation of the ions can be slow down to 40–50% of the ideal co-rotation.

We statistically investigated the ion bulk speeds in the equatorial region of the inner magnetosphere using the Langmuir Probe (LP) onboard the Cassini spacecraft. The LP observation showed that the ion speeds are about 50% of the ideal co-rotation speed at 4 Rs and has a clear increasing trend with the distance from Saturn. Beyond 7 Rs the ion speed values are spread toward the ideal co-rotation speed. This can be due to that the sub-micron sized negatively charged the E ring dust contribute to the plasma dynamics in the plasma disk.

We have also calculated the ion speeds using the three components MHD equations including dust to investigate the effect of the ion-dust coulomb collision to the ion speed. Our models show that the ion-dust collision can reduce the ion acceleration by the co-rotation electric field when the ion-dust collision frequency is comparable to the ion cyclotron frequency. We indicate that magnetospheric electric field may be also important for the dust-plasma interaction in Saturn's plasma disk.

In this presentation, we compare results of our model with the Cassini/LP observation and discuss the dust-plasma interaction in the plasma disk of Saturn. We also discuss based on our results that future exploration to Saturn plays very important roles in planetary sciences.

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