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Dusty Plasma near the E-ring and the Enceladus in Saturn's magnetosphere

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One of Cassini's most exciting finding is that the moon Enceladus expels water vapour and ice grains from its south pole and forms a plume that becomes the major source for the E ring and the surrounding neutral gas. The Enceladus' plume and dispersed neutral gas produces a large amount of ionized gas, which become a dominant plasma source for Saturn's magnetosphere. Using Cassini Radio and Plasma Wave Science (RPWS) measurements of the cold plasma properties, we show that Enceladus' southern exhaust plume and surrounding plasma disc environment must be associated with a large amount of negatively charged submicron- and micron -sized dust that is strongly coupled by dust-plasma interactions, i.e., a dusty plasma. The conditions in the plasma disk near the equatorial plane are such that $r_d << d_g << L_D$, where r_d, $d_g$and $L_D$are the typical grain radius, the inter-grain distance and the plasma Debye length, respectively. In the case where $d_g < L_D$, the charged dust participates in the screening process and therefore in the collective behaviour of the ensemble, and there were almost no in-situ observations of dust-plasma ensembles in space. Plasma in the Kronian magnetosphere is strongly controlled by the planetary rotation motion through the magnetic field, however, the dust-plasma interactions cause a deceleration of the plasma toward the gravitational bound dust motion. Since the magnetic dipole of Saturn is nearly parallel to the planetary spin axis, one mystery has been to relate the planet's rotation period to the dynamics in the magnetosphere and the associated Saturn Kilometric Radiation (SKR) bursts. We suggest that the dust-plasma interaction further explain the relationship between Saturn's rotation and its periodic magnetospheric dynamics.

Keywords: the Kronian magnetosphere, dusty plasma, E ring