Dust and Spacecraft Charging at the Vicinity of Enceladus' Plume

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One of the most remarkable discoveries of the Cassini-Huegens mission is the detection of a plume of gas icy dust emanating from the south polar region of Enceladus. The water vapor plume is found to be the major source of the Enceladus neutral torus and the magnetospheric plasma, while icy dust grains emitted as collimated jets replenish the diffuse E ring that extends from Enceladus to the orbit of Titan. Since the discovery of Enceladus' plume, several close flybys are planed to understand the plume properties as well as the dust-moon-magnetosphere interactions. In addition to the Cosmic Dust Analyser (CDA), under certain conditions Cassini plasma / radio wave instruments (e.g., RPWS, CAPS, and INMS) are capable to detect charged dust particles. The in-situ plasma/dust measurements collectively provide important informations of this dust-rich plasma environment.

A significant electron deficiency at the vicinity of Enceladus has been reported based on the Cassini Langmuir probe measurements and has been interpreted as an indication of the "dusty plasma" condition. In this work we consider the dust influence to the Langmuir probe measurement by taking the "dust currents" into account. Apart from the ion and electron collection currents, in a dust-rich environment charges carried by the ambient dust grains are convectively delivered as an additional current to the spacecraft. On top of that, due to the fast flyby speed, a significant amount of impact plasma generated by hyper-velocity dust-spacecraft impacts may dominate the charging of the spacecraft. The intensity of the "dust currents" depends on the dust grain size distribution and the dust-spacecraft relative speed. Adopting CDA measurements and considering the possibility of the dusty plasma condition, our calculations indicate that the "dust currents" contribute greatly to the spacecraft charging during the Cassini-Enceladus flybys and may have an impact on the plasma data interpretation.