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Cassini charging at Saturn insertion orbit

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We present detailed calculations of the electric potential structures around Cassini spacecraft during the Saturn orbit insertion period. Three-dimensional particle-in-cell self-consistent code has been applied to find the potential distributions in a complicated and variable plasma environment of Saturn's magnetosphere in a wide range of distances (for the dipole shell in the range L$\sim$ 4-10). As input data we use the plasma parameters derived from the Cassini plasma spectrometer measurements during Saturn insertion orbit on June 30, 2004 [1,2]. Modeling of orbiter charging includes photoemission due to solar UV radiation, interactions with inhomogeneous plasmas, and different types of plasma ions, plasma flows and flyby geometry. Numerical simulations show that at large distances from Saturn (outside of Rhea's dipole shell L$\sim$ 8.7) a spacecraft potential changes its sign from a positive value to a negative one, mainly due to a local increase in ambient plasma density. The dependence of the average spacecraft potential on the distance to Saturn is qualitatively similar to that deduced from the Cassini plasma spectrometer data [1]. We analyze also the spatial distribution of three main plasma constituents in the electric field of the orbiter (electrons, water group ions and protons) and find that the presence of the two ion species produces a new kind of plasma wake with a self-consistent charge separation between the different plasma components. The ion focusing occurs only for the protons, while the potential structure of the spacecraft prevents the heavier component - water group ions - from ion focusing downstream. Finally, we discuss the relevance of this study to interpretations of Cassini plasma measurements as well as to charging of small dust particles in the planetary magnetosphere.

[1] E.C. Sittler Jr. et al. Planet. Space Sci., 54, 1197. (2006).
[2] E.C. Sittler Jr. et al. Planet. Space Sci., 56, 3. (2008)