Geophysical Research Abstracts
Vol. 16, EGU2014-14237, 2014
EGU General Assembly 2014

Deriving large electron temperatures and small electron densities with the Cassini Langmuir probe at Saturn

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The Langmuir Probes (LPs) are commonly used to investigate the cold plasma characteristics in planetary ionospheres/magnetospheres. The LPs performances are limited to low temperatures (i.e. below 5-10 eV at Saturn) and large densities (above several particles/cm3). A strong sensitivity of the Cassini LP measurements to energetic electrons (hundreds eV) may however be observed at Saturn in the L Shell range L=6-10 RS. These electrons impact the surface of the probe and generate a detectable current of secondary electrons.
We investigate the influence of such electrons on the current-voltage (I-V) characteristics (for negative potentials), and manage to reproduce the observations with a reasonable precision through empirical and theoretical methods. Conversely, the modelling allows us to derive useful information about the energetic electrons from the LP observations : some information about their pitch angle anisotropy (if combined with the data from a single CAPS ELS anode), as well as an estimate of the electron temperature (in the range 100-300 eV) and of the electron density (above 0.1 particles/cm3). This enlarges the LP measurements capabilities when the influence of the energetic electrons is large (essentially near L=6-10 RS at Saturn).
We finally show that a significant influence of the energetic electrons (larger than the contribution of thermal ions) is also expected in various plasma environments of the Solar System, such as at Jupiter (i.e near Ganymede, Europa, Callisto and Io), or even at Earth (in the plasmasheet, the magnetosheath or in plasma cavities). Large electron temperatures and small electron densities could potentially be derived in these environments, which may be of interest for Langmuir Probes in the Earth magnetosphere or onboard the future JUICE mission at Jupiter.