SHORT ELECTRIC-FIELD ANTENNAE AS DIAGNOSTIC TOOLS FOR SPACE PLASMAS

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A technique, used in geophysical prospection to measure the ground permittivity, has been successfully transposed to space plasmas. The basic principle is to measure the self impedance of a single electric antenna or the mutual impedance between two sets of Hertz dipoles. Since the impedance of the probe depends on the dielectric properties of the medium in which the probe is immersed, some characteristics of this medium can be determined. Space plasma parameters such as the density and temperature of thermal electrons may thus be reliably and accurately deduced. As a bonus, natural waves are also investigated in a large frequency range including, in particular, the lower- and upper-oblique resonances, the electron gyrofrequency and its harmonics, the plasma frequency,and the upper hybrid frequency.
As any electrode immersed in a plasma acquires a charge, it perturbs the plasma in its immediate neighbourhood: an ion sheath is created and insulates the electrode partially from the unperturbed plasma. The way to get around this difficulty is to use four electrodes, two for transmitting and two for receiving. Transmitting electrodes are excited from a signal generator, in series with a current meter if necessary, while the receiving electrodes are connected to a voltmeter with a very high input impedance. The transmitted current I and the received voltage V being known, the mutual impedance Z is by definition Z = V/I. Both the imaginary and the real parts of Z may then be interpreted to deduce plasma properties.
The quadripole probe technique have been used for many years on sounding rockets and spacecraft (GEOS-1, GEOS-2, VIKING, ARCAD/AUREOL-3, MARS-96). It allowed the ground permittivity of Titan to be measured aboard CASSINI/HUYGENS. Electric-field impedance measurements will also be made on ROSETTA and BepiColombo. They have finally been proposed for RESONANCE, a project of the Space Research Institute of Moscow, to investigate the wave-particles interaction in the inner magnosphere and auroral regions.

Electric Field Antennae, Impedance measurements, Plasma Diagnostic

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