Geophysical Research Abstracts
Vol. 17, EGU2015-11290, 2015
EGU General Assembly 2015

Mutual Impedance Probes on board Rosetta, Bepi-Colombo and JUICE

Pierre Henri (1), Jean-Pierre Lebreton (1), Jean-Louis Rauch (1), Christian Béghin (1), Pierrette Décréau (1), Anders Eriksson (2), Réjean Grard (3), Michel Hamelin (4), Christian Mazelle (5), Orélien Randriamboarison (1), Walter Schmidt (6), Jean-Gabriel Trotignon (1), Gaétan Wattieaux (7), Daniel Winterhalter (8), Youcef Aouad (1), Fabrice Colin (1), Dominique Lagoutte (1), Olivier Le Duff (1), and Xavier Vallières (1)

(1) LPC2E, CNRS, Université d'Orléans, Orléans, France, (2) IRF, Swedish Institute of Space Physics Uppsala, Uppsala, Sweden, (3) European Space Research and Technology Centre, Noordwijk, The Netherlands, (4) LATMOS, Université Pierre et Marie Curie, Paris, France, (5) IRAP, Université Paul Sabatier Toulouse III, Toulouse, France, (6) Finnish Meteorological Institute, Helsinki, Finland, (7) LAPLACE, Université Paul Sabatier Toulouse III, Toulouse, France, (8) NASA Jet Propulsion Laboratory, Pasadena, USA

The mutual impedance probe is an active radio frequency probe, designed to measure in situ the bulk plasma properties. An ideal configuration consists of both a transmitting and a receiving dipole, whose baseline is at least a few Debye Lengths. Due to various accommodation constraints on the spacecraft, the transmitter may only be a monopole. In that case, the image of the transmitter charge is distributed over the whole spacecraft surface. The operating principle consists in injecting a frequency-variable current through the transmitter, in a frequency range that encompasses the plasma frequency (or upper hybrid frequency in a magnetised plasma), and measuring the induced voltage at the receiver. Assuming a transmitted current I(f) of constant amplitude that induces a potential difference V(f) at the receiver dipole, the mutual impedance probe provides the coupling complex impedance Z(f) = V(f)/I(f) between the transmitter and the receiver as a function of frequency. The impedance depends on the plasma properties, in particular the bulk density and temperature (in case of a Maxwellian distribution) of the electron population.

The measurement principle is illustrated with in situ observations from the Mutual Impedance Probe (RPC-MIP), one of the five sensors of the Rosetta Plasma Consortium (RPC) on the ESA Rosetta mission. RPC-MIP has been providing regular measurements of the comet plasma environment since early August 2014 when Rosetta was within 100 km from the nucleus of its target comet 67P/Churyumov-Gerasimenko. RPC-MIP operates in the frequency range from 7 kHz to 3.5 MHz that allows covering the plasma density range expected during the mission from solar wind to deep coma densities. RPC-MIP operates in two geometrical configurations. In the baseline configuration, the transmitter and receiver dipoles are aligned on a 1m-beam. The transmitter-receiver distance, of the order of 50 cm, allows probing plasmas with Debye lengths up to 20-25 cm. For longer Debye lengths, MIP uses as the transmitter, one of the two Langmuir Probes of the RPC-LAP instrument located at about 4 m from the MIP receiving dipole, which allows probing plasma with Debye lengths up to about 2 m.

Based on the same principle the Permittivity Probe (SESAME-PP), attached to the Rosetta Lander Philae, measures the electrical properties of the cometary surface material in the frequency range 20 Hz to 10 kHz.

Regarding future space missions, AM2P (Active Measurement of Mercury's Plasma) is the mutual impedance experiment of the PWI (Plasma Wave Investigation) consortium, on board the MMO spacecraft of the Bepi-Colombo ESA-JAXA mission scheduled for a mid-2016 launch and arrival at Mercury in 2024. MIME (Mutual Impedance MEasurements) is the mutual impedance experiment of the RPWI (Radio and Plasma Waves Investigation) on board the ESA mission JUICE, scheduled for launch in 2022 and arrival at Jupiter in 2030.