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The dust E ring of Saturn as seen from the HF radio antennas on Cassini over the past ten years

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Abstract

We have analyzed a collection of about 750000 radio spectra acquired between 2004 and 2014 with the HF-RPWS receiver (covering the band 3.5-318 kHz [4]), previously used by Schippers et al. to provide the electron density and core temperature in the inner magnetosphere of Saturn [1], but from an other point of view: We have exploited the monopole and the dipole antennas voltage power collected in the lowest band of the HF-RPWS receiver, where the plasma shot noise and the dust impact noise are fully dominant, by using the fact that the monopole is much more sensitive to the dust impacts than the dipole [2].

This allowed us to get a reliable diagnosis on the dust grains impacting the spacecraft, namely an *observable* which is only depending on the dust grain density, the grains size distribution and their impact velocities. We obtained this observable along the Cassini's orbits, mainly around the periapsis, and we exploited it first as a function of the distance from Saturn, between 2 and 13 Saturn radii (Rs), and then as a function of the latitude (until about 1Rs altitude from the equatorial plane).

The main advantage of our method is to be almost immune to the spacecraft floating potential and practically uncorrelated to the ambient plasma variations, in addition to having a large impact detection area and a high cadence of measurements. The main inconvenience is to supply only one observable which is a mixing between a minimal dust flux (with a threshold of sensitivity) and the mass/size of grains within assumptions about the impact velocities. It may be useful as complementary measurement of the dust analyzers.

Over a long period of observations on many Cassini's orbits, it reveals the long-term and large-scale structure of the dust distribution in the innermost part of the visited Saturn's magnetosphere, in a very reliable way from about 3.5 to 13 Rs, that is within the dust E-ring and the plasma torus (both originating from Enceladus cryovolcanic activity). Since this technique reveals the dust concentration together with the electron density and temperature, with the same instrument, it is particularly suitable to study dust-plasma interactions.

In summary, we obtained, over the past ten years of Cassini's radio in situ observations, the quasi-equatorial dust density E-ring profile for the typical dust size populations (between 1 and 0.1 μm), which clearly exhibits both the plasma drag effect and the erosion of the grains from the Enceladus orbit to 13 Rs. We have also identified an excess of confined dust grains between Tethys and Dione's orbits and some specific plasma-dust interaction processes inside the Enceladus' plumes, as the electron depletion occurring in the Enceladus' volcanic plumes[3], when the high dust density traps most of the plasma electrons.

We plan to show and compare these new results to some previous observations, simulations or theories.

References

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