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First In-Situ Determination of the Ionospheric Structure of Saturn by Cassini/RPWS

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Abstract

During the first close flyby of the planet Saturn by the Cassini spacecraft in its Grande Finale, the Radio & Plasma Wave Science (RPWS) sensors (including a Langmuir probe) determined the ionospheric structure of Saturn. We present the plasma density and electron temperature data from several Cassini flybys and discuss the results in light of possible theories for the interaction with the Saturn ring system and space environment.

1. Introduction

The Cassini spacecraft project is coming close to its end after many highly fruitful years in the service of planetary science. However, the end-performance will be as spectacular as the beginning with several close flybys of the majestic rings, even crossing the ring-plane inside the innermost visible ring (the D-ring), and a last tour right into the upper atmosphere and ionosphere of Saturn (Figure 1).

The Radio & Plasma Wave Science (RPWS) instrument package on board Cassini includes a Langmuir probe (LP) that is providing the first ever detailed in-situ measurements of the ionosphere of a giant gas planet (Saturn). The Cassini spacecraft will do 22 close flybys of Saturn, and during each of these the intent is to investigate its ionosphere in detail by RPWS.

In particular, the RPWS Langmuir probe will characterize the ionosphere of Saturn and how the rings affect the latitudinal structure of Saturn's upper atmosphere. It will study how the rings interact with the ionosphere close to the equatorial plane. Is there a "water rain" from the rings? RPWS will also investigate if a dense organic rich ionosphere exists at the lowest encountered altitudes.

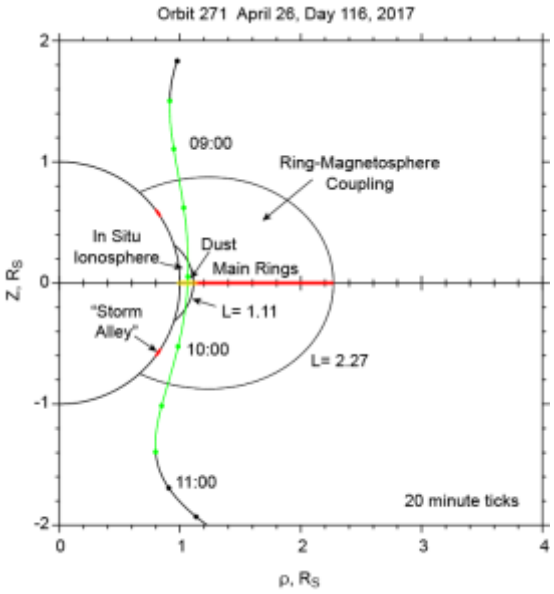

Figure 1: One Proximal orbit example with expected encountered regions (right).

The strong dipole magnetic field of Saturn is believed to facilitate a possible coupling between the rings and the atmosphere/ionosphere of Saturn [*Northrop and Hill*, 1982, 1983], serving as a ring mass pathway. The structure of the rings can therefore, along magnetic flux tubes, be reflected in the latitudinal structure of the ionosphere where the ring material, predominately water (ice), is deposited at particular latitudes and affect the local atmosphere through photochemical reactions. Cassini in the Proximal orbit phase, with its high-inclination polar orbits, will traverse through these magnetic flux tubes, and can investigate these relationships in detail.

2. Initial results

We present in this abstract the results from the first encounter (Figure 2), and when this abstract is written data from the next flyby (out of 22 flybys) is being analysed. We hope to present the full data set

at EPSC, including the last final orbit where we hope to see the ionosphere structure below the ionospheric peak of Saturn.

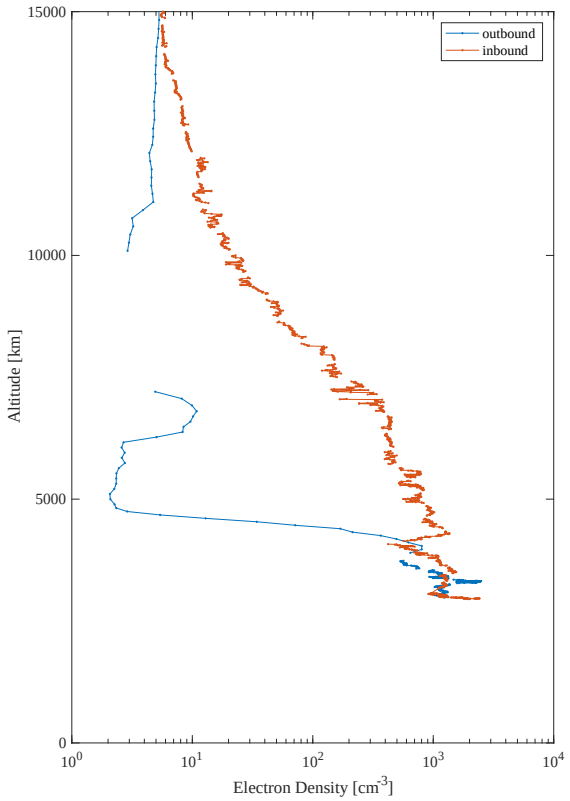

Figure 1: RPWS/Langmuir probe electron density with 20 samples/s resolution from the first flyby of Saturn, April 26, 2017.