EPSC Abstracts
Vol. 5, EPSC2010-311, 2010
European Planetary Science Congress 2010

Equatorial scans of Saturn's dust density

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Abstract

The Cosmic Dust Analyzer (CDA) onboard Cassini measured the apparent dust density in Saturn's E ring during a series of low-inclination orbits in 2009 and 2010. The scans cover radial distances between 7 and 16 Saturn radii with distances to the ring plane between 20.000 and 1000 km. The scans show a gradual decrease of sub-micron dust grains. At a distance of 10 Saturn radii and a distance of 2000 km from the ring plane, the apparent dust density was 0.01/m^3 (for grains bigger than r> 0.3µm).

1. Introduction

The NASA/ESA mission Cassini-Huygens investigates the Saturnian environment since 2004. The orbits have varying inclinations with values between 0° and more than 70°. Furthermore, the observational timeline is fragmented by the distinct requirements of the individual instruments. Cassini is three-axis stabilized and the overall pointing profile changes on an hourly basis. These facts made it extremely difficult for in-situ instruments to achieve global and uninterrupted observations. Recently, the Cosmic Dust Analyzer was able to perform dust density measurements in the outer E-ring using a stable instrument pointing towards the dust RAM direction.

2. Observations

Long duration dust measurements were performed by CDA during the following days: 2009-344, 2009-360, 2010-011, 2010-044, 2010-080. Former long duration scans at higher orbit inclinations were performed earlier around the days 2005-122, 2006-119 and 2006-205. The scan with the lowest inclination was achieved around 2010-080, where the distance to the ring plane varied only by 5000 km over a radial distance of more than 600.000 km. At this measurement, the maximum distance to the ring plane was only 4000 km.

3. Results

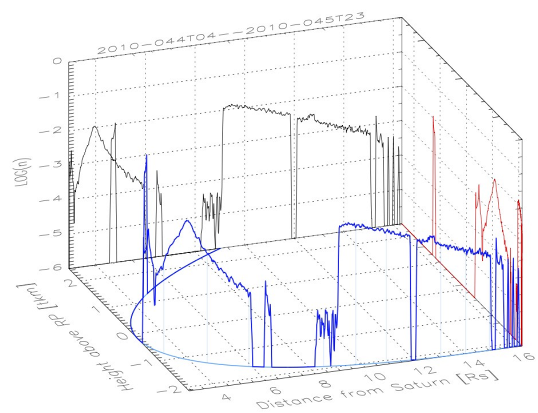

Figure 1: Dust density (side panels in 1/m^3) along the Cassini trajectory around DOY 2010-044. The x and y axis show the radial distance to Saturn (in Saturn radii) and the distance of Cassini to the ring plane (in tkm). Due to Cassini's pointing profile, the periapse scan was interrupted many times.

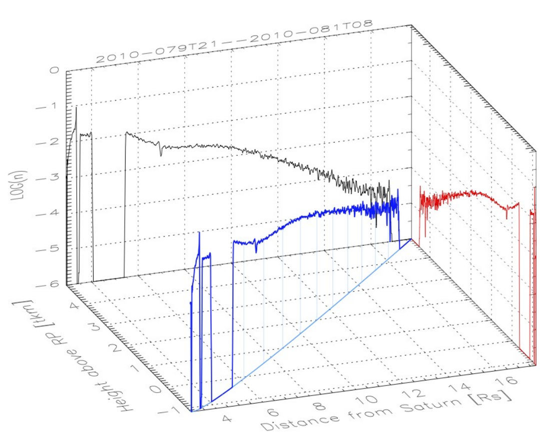

Figure 2: Dust density along the Cassini trajectory around DOY 2010-080. An uninterrupted density scan was achieved between 6 and 16 Saturn radii (Rs). The apparent dust density decreased from 0.008/m^3 at 6 Rs down to 0.00004/m^3 at 16 Rs.

Although the dust impact rate measurements of CDA were corrected for sensitive area (pointing profile) and relative dust impact speed (flux), the calculated density is called an *apparent density*. This is due to the fact that the relative impact speed is not well known (circular orbits have a different relative impact speed than eccentric orbits) and the mass threshold is time variable (due to varying impact speed with time). However, the mass threshold on DOY 2010-045 after 6:00 was given by grains bigger than approximately 0.3 µm. Unfortunately, the instrument triggered also on mass spectra of even smaller grains.

Figure 1 shows the fragmented periapse scan around DOY 2010-044 with a longer uninterrupted scan between 9 and 15 Rs radial distance at the outgoing trajectory. Beyond 15 Rs the spacecraft stopped the fixed pointing and started to perform rolls along one axis. This is indicated the by spikes in the density interleaved by phases of off-RAM dust pointing making it impossible to calculate valid densities.

Figure 2 shows the apparent dust density along the Cassini trajectory for a very low-inclination scan. Cassini remained very close the ring plane for large time segments. Here again, small variations in the density or gaps indicate inadequate pointing of CDA towards the dust RAM direction.

6. Conclusions

These CDA measurements are essential to unfold the vertical from the horizontal dust density profile within Saturn's outer E-ring. Furthermore, the overall gapless extension of this ring is impressive. These in-situ dust observations are able to visualize the distribution of sub-micron sized water ice grains at large radial distances, well beyond the optical detection limit which lies in the range of 9 Saturn radii. Saturn's E-ring is by far the largest planetary dust ring in our Solar System.

Acknowledgements

This work is supported by DLR eV. under the grant 50OH0304.

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