Geophysical Research Abstracts, Vol. 9, 07518, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-07518

Dynamics of Enceladus' plume particles

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Since July 1st 2004, the Cassini spacecraft has been exploring the Saturnian system, which is distinguished by a pronounced ring system. In particular, Saturn's diffuse E ring is the largest planetary ring of the solar system ranging from 3(Saturn's radius $= 60\,330$ km) to approximately Titan's orbit. The vertical ring thickness is 8 000 km at Enceladus orbit and 15 000 km at the outer rim of the ring. The ring is not only remarkable for its extend but also for its narrow size distribution. As the particle size distribution is due to grain dynamics, knowledge of the dynamical properties of the ring particles is essential for understanding the ring formation.

The Cosmic Dust Analyser (CDA) on Cassini measures the mass, speed, charge, and elemental composition of individual dust particles hitting the detector. The purpose of the High Rate Detector (HRD) sub-unit is to record the dust flux within the densest regions of the E ring.

On July 14th 2005, Cassini performed a close encounter at the icy moon Enceladus - the dominant E ring dust source. The shortest distance to the moon's surface was 175 km what is well inside the moon's sphere of gravitational influence. The CDA data obtained during this flyby can only be explained by a collimated dust source at the south pole area of the moon. This finding finally led to the discovery of a strong cryo-volcanism in this region replenishing the ring with fresh dust.

Here, we present model calculations for dust grains ejected at Enceladus' south pole into the ring. We show that only grains $14\mathrm{ms}^{-1}$ faster than the moon's three-body escape speed do not re-collide with Enceladus during their first orbit and thus be able to populate the ring. Our numerical results match the CDA data reasonably well. In particular, our findings explain the vertical extent of the ring as derived from the in-situ observations.