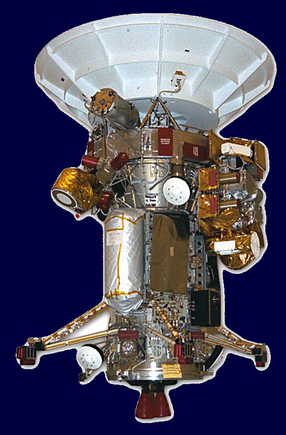
Cosmic Dust Group

Saturnian stream particles: Origin and Dynamics inside Saturn's magnetosphere

Uwe Beckmann, Sascha Kempf, Ralf Srama, Georg Moragas-Klostermeyer, Eberhard Grün
Max-Planck-Institut für Kernphysik, Heidelberg, Germany

Messengers from the Saturnian system

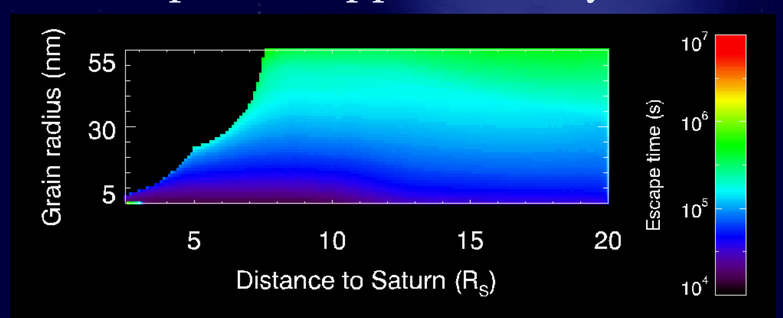
In 2004 during the approach to Saturn the Cassini Spacecraft detects nanometer – sized dust particles 1 AU (Astronomical Unit $\approx 1.5 \cdot 10^{11}$m) away from Saturn. Backtracking of their path showed that these particles have their origin inside Saturn's magnetosphere. The speed of the particles at the magnetopause is about 100km/s. First estimates indicate that only positively charged particles at the edge of the A ring reached this velocities. However, new data of Saturn's plasma environment and potential of big grains required a new consideration.

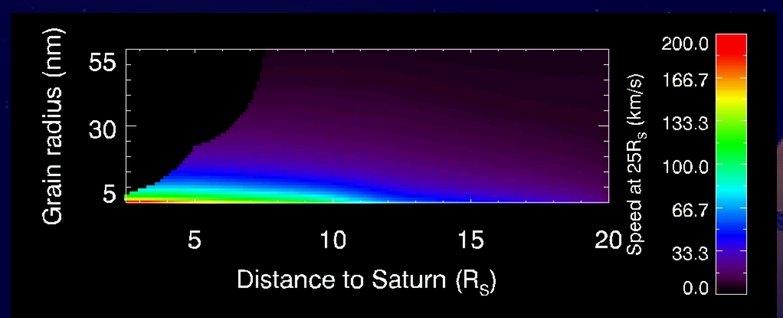


The Spacecraft Cassini and a detailed view of the Cosmic Dust Analyzer

Forces on tiny particles inside Saturn's magnetosphere

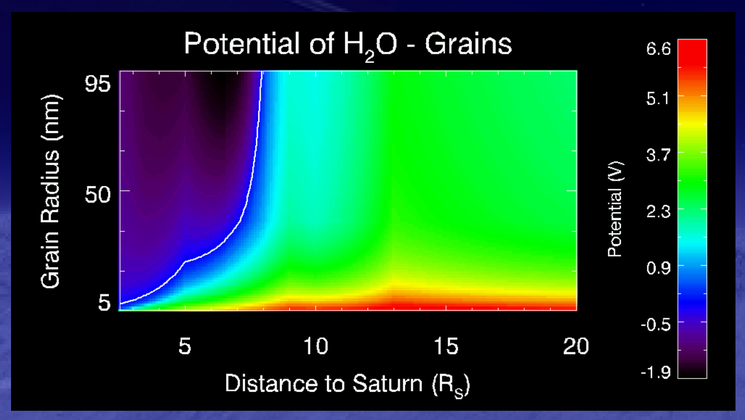
The main forces to the dust grain is the gravitation of Saturn and the electro-magnetic force due to Saturn's rotating magnetic field. In order to the short time tiny particles stay in the Saturnian system other forces like radiation pressure, moon gravitation and plasma drag are neglected. The equation of motion is numerically solved for different dust grains starting inside Saturn's magnetosphere. Due to the CDA measurements possible stream particles must have a speed of approximately 100km/s at 25RS.

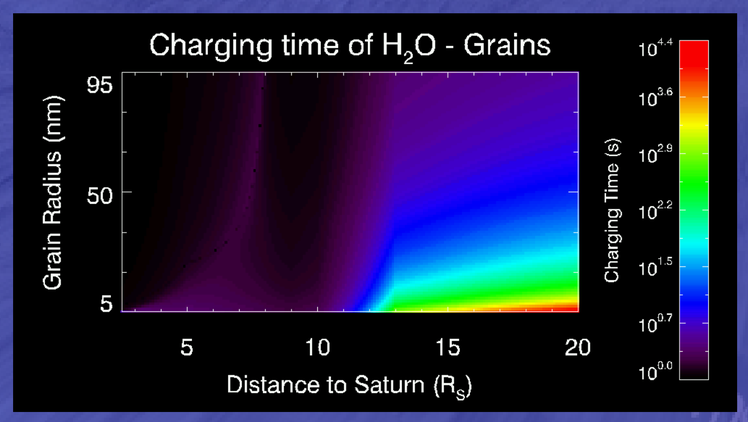




Potential of dust grains

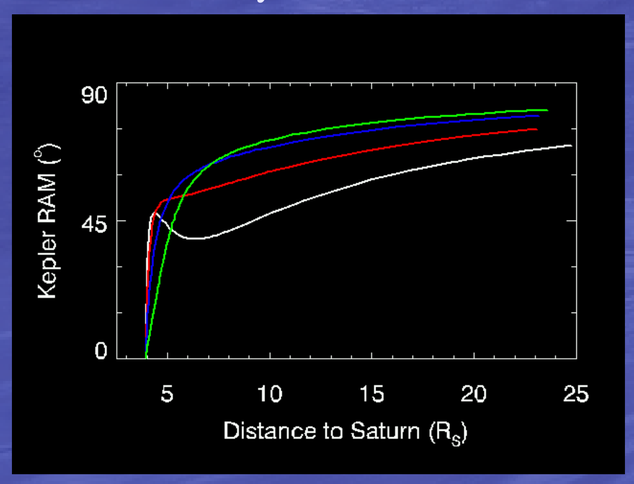
A dust grain inside a plasma is charged up by collecting ions and electrons, and by emission of electrons due to secondary electron emission and photo ionization This could be described by electric currents on the particle. All of these currents depend on the potential of the grain itself. Due to the fact, that smaller dust grains emits electrons better than larger ones, the surface potential of small particles is higher then of large ones.





Dynamics of Enceladian plume particles

The detected geysers on Enceladus seemed to be the main source of the huge dusty E ring. Possibly, it is also the source of the stream particles. In order to detect stream particles inside Saturn's magnetosphere with the CDA and separates them from the ring particles their mean direction must be known. Also the speed of the particles are necessary in order to know if the particle could be detected by the CDA.



The angle between plume particles and Kepler RAM is shown left and their speed is shown right. The color represent different grain sizes. White is a grain radius of 5nm, red 7nm, blue 10nm and green 13nm. Larger particles couldn't leave the system.