The Cosmic Dust Analyser (CDA) of the Cassini Spacecraft

Frank Spahn (Co-I), Nicole Albers, Alexander Krivov, Miodrag Sremcevic, Nikolai Brilliantov, Martin Makuch, Martin Seiss, Marcel Hörning – and Cassini CDA Team

The Cassini Mission

Cassini is an international space mission to Saturn organized by NASA, ESA and the Italian Space Agency. The spacecraft contains two major components: Cassini Orbiter & Huygens Probe:

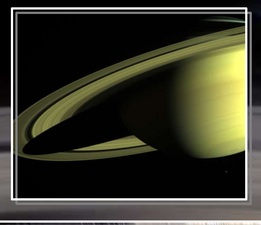
Experiments - Orbiter:
- Ultra-Violet Imaging (UVIS)
- Cosmic Dust Analyser (CDA)
- Imaging Subsystem (ISS)
- Radio-Plasma Wave (RPWS)
- Infrared-Mapping (VIMS)
- Plasma Spectrometer (CAPS)
- Magnetometer (MAG)
- Magneto Imaging (MIMI)
- RADAR
- Radio Sciences (RSS)
- Ion-NeutralMass Spec.(INMS)
- Composite Infrared (CIRS)

Huygens-Probe Experiments
- Atmosphere prop. (HASI)
- Doppler Wind (DWI)
- Descent Imager/ Spectral Radiometer (DISR)
- Aerosol Collector (ACP)
- Surface Science (SSP)
- Gas Ghromatograph (GCMS)

Cosmic Dust Analyzer (CDA)
The cosmic dust analyzer is an in situ dust impact experiment. The high velocity impact causes a plasma cloud whose properties provide information about the mass, composition, velocity and direction of the dust grain. It is the only European contribution on the orbiter.

The main goals of the experiments are: in situ registration of dust populations at lowest optical depths Faint rings, Dust clouds around satellites Composition and Origin of those complexes
Principal Investigator: Prof. Dr. E. Grün/Dr. R. Srama

Scientific Goals



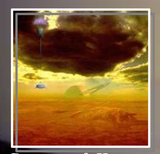
Saturn:
- Atmosphere
- Internal Structure
- Magnetosphere
- Plasma-Environment
- Dust Environment

Saturns Rings:
- Origin and Composition
- Size Distribution
- Structure Formation
- Dust „Halo“
- Age and Lifetime

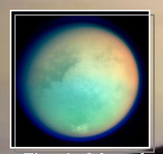
Satellite Phoebe taken by Cassini at June 13, 2004

Icy Satellites:
- Surfaces & Cratering
- Dust „Clouds“
- Detection of new Moons
- Why are surfaces that different?
- Fate of retrograde Moons

Titan:
- Atmosphere
- Surface Features
- Geological Activities
- Oceans & Lakes?

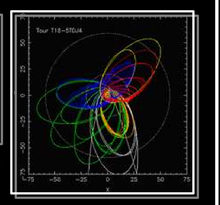


Descent of Huygens artistic impression



Titan in false color taken 500,000km dist.

The Journey:
- Launch 10/13/1997
- 12/2000 Jupiter
- Arrival 7/1/2004 SOI - Saturn
- Nominal Mission – until 12/2008

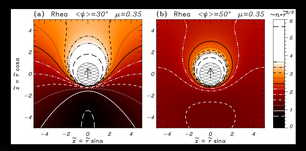


Launch Oct. 1997 (above) The 4 year tour of the orbiter:

74 orbits =nominal mission

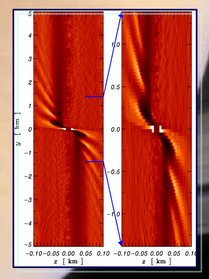
Contributions in Potsdam

Team Member – CDA Exp./Orbiter (Co-I => F.S.)
- Dynamical Modeling:
  - Dust „Clouds“ around satellites & rings (see Fig.)
  - E ring of Saturn
  - Impactor-Ejecta processes, erosion of rings and moon surfaces
  - Stochastic forces => Diffusion of Dust Complexes => stochastic charging => fluctuation of fields => Dust as „Field tracers“
- Comparison with CDA (& UVIS) Data => model corrections
- Mission Planning => Sensitivity Simulations => Spacecraft Hazard

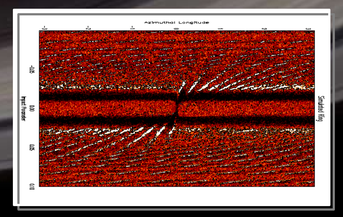


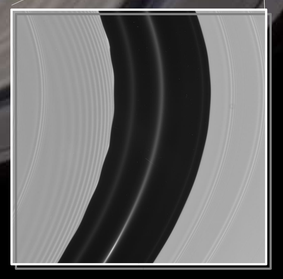
Dust around Moon Rhea – Isodensity plot of the Dust distribution around that satellite => Mission Planning

Dense Planetary Rings => Structure Formation & Origin
- Kinetics and hydrodynamics of dense rings => Instabilities/Oscillations vs. Clustering
- Evolution of Size- & Velocity Distribution => Transport Coefficients
- **Moonlet-induced** structures => **Detection of embedded Moons!**



Gaps & Ringlets & Waves





The Figures above show a comparison of the results theoretical modeling of structures caused by embedded moonlets (satellites) of differents sizes – left => house-sized object; middle: 10 kilometers in diameter – with structures caught by Cassini at SOI (Saturn Orbit Insertion) near the orbit of the moon Pan. Similarities in the structures are obvious.

Cooperations:
- **group of Prof. Dr. Eberhard Grün; Principal Investigator (PI) Cassini CDA**
- **group of Prof. Dr. Larry W. Esposito; PI Cassini UVIS-Experiment**

Cassini-Related Projects:
- **DLR => Dr. A.V. Krivov (since 1997; BAT II a/ I b position) => Dust Dynamics, Mission Planning**
- **DFG => Dr. N.V. Brilliantov (since 2004; BAT II a; 2 years +) => Kinetics of rings & Comparison with Cassini measurements**
- **DFG => Dipl. Phys. Miodrag Sremcevic (since 2000, BAT II a/2) => Dust clouds & ring structures**
- **Studienstiftung d. dt. Volkes: Dipl. Phys. Nicole Albers (since 2003) => Rings near the Roche zone**