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Dust in the Outer Solar System as measured by Cassini-CDA: KBOs, Centaurs and TNOs as parent bodies?

N. Altobelli (1), S. Kempf (2), R. Srama (3)
(1) ESA/ESAC, Madrid, Spain (2) LASP, University of Boulder, USA, (3) University of Stuttgart, Germany,
nicolas.altobelli@sciops.esa.int

Introduction

We analyse 13 years of data acquired by the Cosmic Dust Analyser (CDA)-Entrance Grid (EG) subsystem on-board the Cassini spacecraft around Saturn. We confirm the presence of exogenous dust, originating from the interplanetary space and permanently crossing the Saturnian system. We analyse the range of possible heliocentric orbital elements in order to identify their possible origin. We observe particles whose dynamics is compatible with 'old' collisional debris from the Kuiper-Belt, migrating inward the Solar System under influence of the Poynting-Robertson drag, or relatively fresh grains from recently discovered cometary activity of Centaurs. A population of particles entering the Saturn's system with high velocities can be linked to Halley-type comets as parent bodies.

1. Data analysis

The major difficulty we are facing is the identification of comparatively very rare exogenous particles in an environment dominated by E ring particles. In the densest regions of the E ring, the CDA instrument is saturated by E ring impactors, therefore 'masking' contributions from other sources. Fortunately, the Cassini spacecraft has been flying on orbits for a wide range of inclinations and eccentricities while touring Saturn during the past seven years such that regions with reduced E ring contribution can be exploited for our study. Regions more favorable for the search of exogenous particles are typically as far as possible from Saturn, or, 'far enough' from the equatorial plane of Saturn, in order to avoid the bulk of the E ring particles, as well as regions were the plasma density saturates the EG subsystem. When EG data could be acquired, the particles orbital elements can be constrained to sufficient accuracy to inambiguously discriminate E ring particles from interplanetary dust particles (IDPs).

2. Results and Discussion

The orbital elements of the IDPs are plotted on Fig. 1. The presence of IDP raining onto the Saturn's system is by itself an important result providing constraints on evolutionnary processes like, for example, the compositional evolution of atmosphere-less icy surfaces (icy moons and Saturn's main ring system) and of the atmospheres of Titan and Saturn. As importantly, from its vantage point at Saturn, about 10 AU from the Sun, the CASSINI-CDA data cast light on the dust populations of the outer solar system, their parent bodies and generation process.

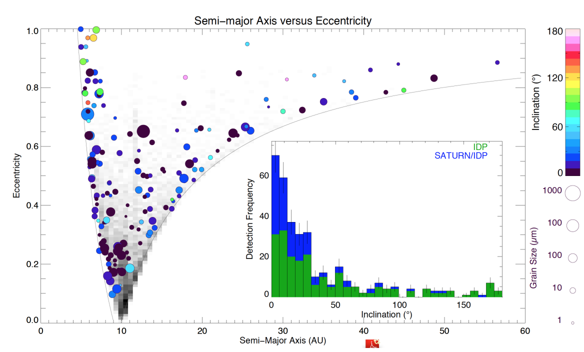

Figure 1: Orbital elements of the exogenous particles. The circles represent the heliocentric orbital elements of all exogenous solutions in an eccentricity versus semi-major axis plot. The symbol color indicates the inclination of the IDP orbits with respect to the ecliptic and the symbol size scales with the particle radius. The inset shows the corresponding inclination distribution.

We find that Jupiter Family Comets (JFCs) cannot be a dominant source for the dust that CDA measures at Saturn. In turn, our measurements appear in good qualitative and quantitative agreement with the dynamical signature of KBO dust expected at Saturn. We find, however, that KBO dust cannot be distinguished at Saturn dynamically from particles released by Centaurs/TNOs, whose cometary-like activity at large heliocentric distances has been recently discovered. Grains released by Halley types comets, with high-heliocentric inclinations, or even of interstellar origin (distinct from the interstellar dust flow observed by Ulysses, Galileo and Stardust) are reported.