EPSC Abstracts
Vol. 10, EPSC2015-577, 2015
European Planetary Science Congress 2015
© Author(s) 2015

Dust Populations in the Outer Solar System: 10 years of monitoring by CASSINI-CDA

N. Altobelli (1), S. Kempf (2), F. Postberg (3), M. Horanyi (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

Abstract

The analysis of different CDA subsystems data, acquired since SOI, reveals that the Saturnian system is permanently crossed by dust grains originating from the Interplanetary medium, as well as from the neighboring interstellar medium surrounding the Solar System. We observe two main types of particles: on the one hand, those with low injection velocity with respect to Saturn, and whose flux is significantly enhanced by gravitation focusing. On the other hand, particles with fast injection velocities, essentially unperturbed by gravitation focusing. The fast grains are found to be interstellar dust (ISD) from the Local Interstellar Cloud (LIC), as well as particles on retrograde orbits around the Sun, most likely dust released by Halley-type comets. The dynamics of the slow grains is found to be compatible with collisional debris from the Kuiper-Belt, migrating inward the Solar System under influence of the Poynting-Robertson drag. Alternatively, we show that the origin of the slow grains entering the Saturnian System can be the recently discovered cometary activity of Centaurs.

1. Introduction

We report in this paper on the analysis of 10 years of Cassini-Cosmic Dust Analyser (CDA) data obtained in the Saturn's system. The signature of exogenic dust in the Saturnian System has been confirmed by different subsystems of CDA, including the Impact Ionization Detector (IID), the Chemical Analyser Target (CAT), as well as the Entrance Grid detector (EG). Each subsytem has a different sensitivity, opening a window on the different dust populations at, and beyond Saturn's orbit. We review the knowledge gained so far, combining the data from all CDA subsystems.

2. 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. Having measured nearly continuously for over 10 years provides enough integration time in these regions for our study to be done with reliability. We use in this paper the data of the EG, IID and CAT subsystems of CDA.

3. Results and Discussion

We find the signature of exogenous dust in the dataset of all CDA subsystems. This fact by itself is an important result that will constrain evolutionary processes in the Saturnian System, 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.

Our data suggest two main dynamical types of exogenous particles crossing the Saturnian system: the 'slow' and 'fast' populations, in term of injection velocity when entering Saturn's Hill sphere. The fast populations contains ISD grains from the contemporary Local Insterstellar Cloud, as they cross the Solar System on hyperbolic orbits. These grains could be identified by their directionality and impact speed de-

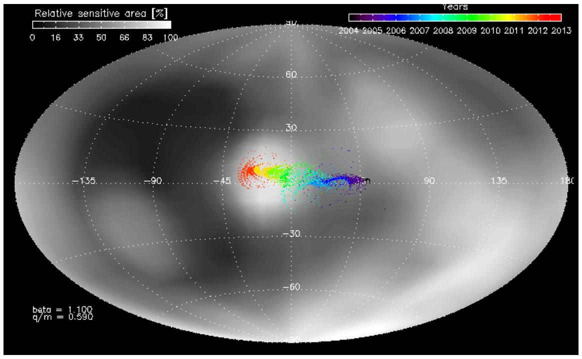

Figure 1: Integrated sensitive area achieved by Cassini-CDA monitoring the different directions on the sky sphere. The directions expected for the fast population of ISD grains is shown as dots, whose color coding is function of the elapsed time.

rived from CAT time-of-flight spectra signals (Fig. 1). The chemical composition appear to be consistent with silicates-magnesium-iron signature. A second component of the fast exogenous population, identified in the EG data appears to consist of grains on nearly parabolic, prograde and retrograde solar orbits. However, such grains are rare in the EG data compared to heliocentric bound particles, with low injection speeds at Saturn, a result also supported by our modeling of the CDA-IID data.

The heliocentric orbital elements of the grains detected by the EG detector were derived (Fig. 2). Three main known types of grains in the outer Solar System were discussed to explain our observations. We find that JFC comet 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 that can explain the bulk of our 'slow' population. 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.

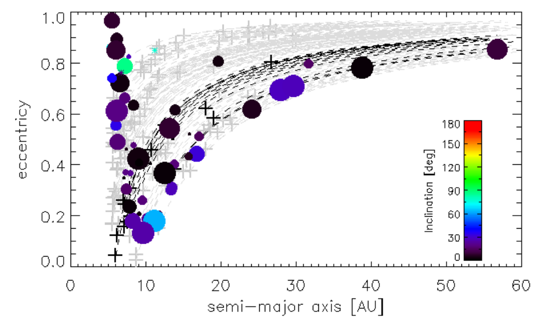

Figure 2: This plot shows the distribution of the semi-major axis and eccentricity values for the exogenic particles detected by the EG subsystem. The radius of the circle symbols is proportional to the logarithm of measured grain radius, the color code stands for the heliocentric inclination values. The grey crosses show the konwn Centaurs (lower panel). The black crosses indicate the Centaurs for which a cometary activity has been reported from ground-based observations. The dashed lines indicate the possible (a,e) values for dust grains released by the parent body, parameterized by the solar radiation pressure efficiency.