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# Mineral dust in the Saturnian system

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## Abstract

We present the chemical composition and potential origin of about 1800 sub-micron sized mineral dust grains detected in the Saturnian system by the Cosmic Dust Analyser aboard the Cassini space craft. The data set spans over the entire duration of the Cassini mission from 2004 to 2017. We use dynamical analysis to reconstruct orbital parameters in order to trace back the origin of the dust particles. The mass spectra recorded by the CDA gives insights into the chemical composition of the mineral particles and allows for further conclusions on their origin.

## 1. Introduction

The CDA records cationic mass spectra after impact ionization of individual micron and sub-micron sized grains. Mineral dust only takes up a small fraction within the large CDA spectra data set which is dominated by an overwhelming number of hundreds of thousands ice grain detections in Saturn's E ring. We employed several machine learning algorithms to identify and extract all mineral spectra from the CDA data base. Eventually a surprisingly large number of 1797 mineral dust spectra were found and, since late 2017, are subject to our compositional and dynamical analysis.

Several potential sources for mineral grains are in principle possible. Endogenic dust particles might result from impact ejecta of Saturn's outer moons released by micro-meteoroid bombardment. Interstellar dust, Kuiper Belt object, comets and the Oort Cloud are potential sources for exogenic dust grains crossing the Saturnian system on hyperbolic orbits. By analyzing the composition of these grains and linking them to their origin by a dynamical analysis we aim to characterize the composition of these sources or source bodies. The successful compositional characterization of 36 interstellar dust particles recorded by CDA [1] showed the potential of this approach. We give a progress report of this ongoing work.

## 2. Results

Our analysis shows that a greater part of the mineral grains are detected in groups. We define 36 swarms where at least 10 particles are detected with less than 3000 s time difference between two events. Some of these swarms can be dynamically determined to be of endogenic or exogenic origin. Endogenic swarm candidates noticeably accumulate at inclination between 150° indicating they originate from retrograde satellites including Phoebe. Most exogenic swarms enter the Saturnian system from similar directions, passing through the Saturnian system nearly perpendicularly to the planet's equatorial plane and are suggestive to be of cometary origin.

The composition of mineral spectra can be separated into two distinctive groups, iron rich minerals (58 %) and iron poor but mostly Mg rich minerals (34 %), only a minor fraction of spectra (8 %) do not belong to each of these two groups. The iron rich spectra are composed of sulfides, oxides and metallic iron, with no other metal exceeding the detection threshold. The iron poor minerals in cotranst are silicates and show other metallic constituents like Na, Mg, Al, Ca, K in varying concentration. In most cases Mg is the most abundant metal.

It can be shown that bound retrograde swarms contain a significantly higher fraction of iron rich grains whereas in exogenic candidates this fraction is significantly lower. This is just the first results of a three year project in the course of which we aim to study composition and dynamic of mineral grains at Saturn in greater detail.

## References

[1] Altobelli, N., et al. Flux and composition of interstellar dust at Saturn from Cassini's Cosmic Dust Analyzer. Science 352, 312-318 (2016)