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Chemical 'aging' of icy dust grains in Saturn's E-ring

Lenz Nölle (1), Frank Postberg (1), Nozair Khawaja (1), Jon Hillier (1), Zenghui Zou (1), Sean Hsu (2), Thomas Albin (3) and Ralf Srama (3)
(1) Institute of Geological Sciences, Freie Universität Berlin, Germany,
(2) Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, Colorado, USA,
(3) Institute of Space Systems, University of Stuttgart, Germany
(lenz.noelle@fu-berlin.de)

Abstract

The Cosmic Dust Analyzer (CDA) [1] onboard the Cassini spacecraft has detected a wide range of non-water ingredients in icy dust within the Saturnian system. These µm to sub-µm water grains are ejected from the cryo-volcanoes at the southern polar region of Enceladus [2-4]. Besides the predominant, almost pure, water ice dust (Type 1), there are also water ice grains carrying salts (Type 3) or organic material (Type 2). Latest results reveal the presence of complex organic material, such as large and highly unsaturated organic macromolecules as wells as nitrogen- and/or oxygen-bearing volatile organics [5,6].

Many of these ejected dust grains are able to leave Enceladus' Hill sphere, forming Saturn's diffuse E-Ring [7,8]. During their lifetimes they slowly migrate outwards from Enceladus to Titan [9] under continuous exposure to plasma sputtering and electromagnetic radiation. Along the particles' journeys from their source near Saturn, these effects should continuously alter not only the dust grains' sizes but also their compositions. Therefore, mapping of salty or organic compounds in the E-ring will reveal the evolution of their constituents as well as the strength of any exogenic influences.

Here we will present the first results of such a mapping, made using in situ Time of Flight (TOF) mass spectra of organics and salts in the water ice dust grains, as detected and recorded by the CDA. In our statistical evaluation we find clear indications of physical and chemical alteration of both salt-bearing (Type 3) and organic- bearing (Type 2) grains with age. These alterations change the relative abundances and grain sizes of the compositional families as well as the composition within the compositional families. These aging effects start to become significant at a Saturnian distance of about 6 Saturnian radii, approaching Dione's orbit.

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