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Mass Spectral Features of Enceladus'Organic Enriched Ice Grains: Plume Vs E ring

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Ocean worlds in the outer Solar System are prime targets for the search of life beyond Earth [1]. So far, Enceladus is the only extraterrestrial ocean world whose subsurface material was sampled by the Cassini spacecraft. Enceladus throws its subsurface material into space in the form of ice grains and gas from the moon's south polar region. Most of the ice grains fall back onto the surface and only a fraction of these grains leaves the moon's gravity and become a part of Saturn's E ring [2]. During it's entire mission, Cassini's Cosmic Dust Analyzer (CDA, [3]) frequently sampled ice grains in Enceladus'plume and Saturn's E ring. The detection of nanophase silica (SiO2; [4]) particles indicated hydrothermal activity at the sea floor, which further increased astrobiological potential of Enceladus.

Previous analyses of ice grains revealed a variety of organic species in E ring ice grains, which led to the discovery of complex (mass > 200 u) and simple (mass < 100 u) organic compounds [5,6]. This indicated rich organic chemistry in Enceladus's subsurface ocean e.g., Friedel Crafts and serpentinization reactions. The Cassini's flybys of Enceladus plume on the other hand provided an opportunity for CDA to sample freshly ejected subsurface oceanic material, particularly organic compounds. Here, we try a detailed compositional analysis of organic material in ice grains measured directly in the plume by CDA soon after they are ejected from the moon's South Pole during the flyby-E5 in 2008. Previously, CDA time of flight (ToF) mass spectra of these grains have only been assigned as Type 2 "the spectra of organic enriched ice grains", without a detailed compositional investigation of the organic species [7]. The spectra of these freshly emitted grains were recorded at fluxes of up to 5 s-1 at flyby speed 17.7 km/s, albeit with reduced mass resolutions and mostly ranges (2-120 u).

At this high speed, organic molecules in ice grains fragment more when impacting CDA's target, providing new insights of their molecular structures in comparison to previously sampled and analysed Type 2 spectra in E ring. Our results confirm the presence of aromatic and O-bearing species in the ice grains that were previously sampled in the E ring [5,6]. In addition, spectra of these freshly ejected organic-bearing grains also exhibit certain spectral features, which were not observed in the lower impact speed spectra of E ring ice grains.

References

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Primary author: KHAWAJA, Nozair (Freie Universität Berlin, Germany)

Co-authors: HILLIER, Jon (Freie Universität Berlin, Germany); NAPOLEONI, Maryse (Freie Universität Berlin, Germany); POSTBERG, Frank (Freie Universität Berlin, Germany)

Presenter: KHAWAJA, Nozair (Freie Universität Berlin, Germany)

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