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Saturnian Stream Particles as a Probe from Enceladus' Interior

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Abstract

Stream particles are nanometer-sized dust particles ejected from Saturn's magnetosphere into interplanetary space with speed higher than 100 km/s. Using the TOF mass spectrometer of the Cosmic Dust Analyser (CDA) onboard the Cassini spacecraft we obtained a compositional characterisation from the faint impact signals. In contrast to most of the dust in the Saturnian system these particles are not predominantly made of water ice and mostly show an abundant siliceous compound, which raises the question of their origin.

Because these particles are so small and fast that their dynamical properties cannot be derived directly from the instrument signals they have to be modelled to restore their primitive dynamical properties. Adopting the latest plasma measurements of Saturnian magnetosphere, our ejection model reproduces nicely the dynamical properties derived from backward simulations. It is shown that stream particles are predominantly ejected from certain regions of Saturn's E ring. Moreover, our model demonstrates that, with respect to water ice grains, siliceous nanoparticles are more likely to be ejected as stream particles due to differences in material properties. This result not only agrees with the CDA chemical analysis but also explains the compositional discrepancy between the water ice-rich environment and stream particles. Combining results, we conclude that Saturnian stream particles are mainly siliceous nanoparticles embedded in E ring icy grains eventually released by plasma erosion in the outer E ring. In contrast, a significant contribution to the stream particles from the recently reported icy nanograin population expelled from Enceladus' plumes (Jones et al. 2009) is unlikely.

As Enceladus is the main source of Saturn's E ring, from which the stream particles derive, these particles may in turn serve as a probe to study the interior of Enceladus. It is remarkable that the silicates identified in stream particles are poor in metals. The composition is not in agreement with the composition expected from interplanetary dust (like olivine or pyroxene) and in many cases seems to be dominated by silica. To produce these metal poor nano-minerals specific conditions have to be met. Since the silicates very likely originate from rock inside Enceladus, this bears interesting consequences for the geophysical and geochemical history of the moon.

Reference

Jones, G. H. et al., (2009), Fine jet structure of electrically charged grains in Enceladus' plume, *Geophys. Res. Lett.*, *36*, 16,204, doi:10.1029/2009GL038284.