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Compositional differentiation of Enceladus' plume

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The Cosmic Dust Analyser (CDA) on board the Cassini spacecraft sampled Enceladus' plume ice particles emanated directly from Enceladus' fractured south polar terrain (SPT), the so-called "Tiger Stripes", during two consecutive flybys (E17 and E18) in 2012. The spacecraft passed through the dense plume with a moderate velocity of ~ 7.5km/s, horizontally to the SPT with a closest approach (CA) at an altitude of ~75km almost directly over the south pole. In both flybys, spectra were recorded during a time interval of ~ ±3 minutes with respect to the closest approach achieving an average sampling rate of about 0.6 sec^{-1}. We assume that the spacecraft passed through the plume during an interval of about ±60(sec) from the CA. Particles encountered before and after this period are predominately from the E-ring background in which Enceladus is embedded.

Most CDA TOF-mass spectra are identified as one of three compositional types: (i) almost pure water (ii) organic rich and (iii) salt rich [2]. A Boxcar Analysis (BCA) is performed from a count database for compositional mapping of the plume along the space-craft trajectory. In BCA, counts of each spectrum type are integrated for a certain interval of time (box size). The integral of counts represents frequencies of compositional types in absolute abundances, which are converted later into proportions. This technique has been proven to be a suitable for inferring the compositional profiles from an earlier flyby (E5) [1].

The inferred compositional profiles show similar trends on E17 and E18. The abundances of different compositional types in the plume clearly differ from the E-ring background and imply a compositional differentiation inside the plume. Following up the work of Schmidt et al, 2008 and Postberg et al, 2011 we can link different compositional types to different origins. The E17/E18 results are compared with the E5 flyby in 2008, which yielded the currently best compositional profile [2] but was executed at much higher velocity (~17.6km/s) and a very different, highly inclined, flyby geometry.

References

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