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Stream Particles as the Probe of the Dust-Plasma-Magnetosphere Interaction at Saturn

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Abstract

Stream particles are nanometer-sized dust particles ejected with speeds higher than 100km/s originating from the Jovian and Saturnian system. In this work we analyse the dynamics and composition of Saturnian stream particles based on measurements during 2004 and 2005 carried out by the Cosmic Dust Analyser (CDA) on board the Cassini spacecraft. Since the impact parameters of stream particles are outside the CDA calibration range, both backward and forward methods are adopted to study the dynamical properties and ejection process of Saturnian stream particles. Backward tracing method uses in-situ Cassini solar wind measurements and provides constraints on stream particles' dynamical properties, whereas the ejection model employs Cassini plasma measurements in Saturn's magnetosphere as input to calculate the dynamical and charging evolution of nanometer-sized particles. Results from both methods show that stream particles from Saturn have sizes ranging from 2 to 8nm (radius) with ejection velocities between 50 and 200 km/s. Furthermore, the derived “source region” of stream particles is located in the outer part of Saturn's E ring and is indicative of the dust charging condition profile in the magnetosphere. An updated analysis of CDA stream-particle mass spectra confirms that the siliceous material is the most probable composition of Saturnian stream particles, in contrast to E ring particles whose composition is dominated by water ice. Our model explains this compositional discrepancy by considering the difference in plasma sputtering yield and the secondary electron emission yield between siliceous material and water ice, and suggests that old, strongly eroded E ring dust particles are the most probable source of Saturnian stream particles. Finally, we discuss the role of dust particles as a mobile neutral reservoir in Saturn's magnetosphere which may be responsible to certain neutral/plasma features observed by the Cassini spacecraft.