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The salty spray of Enceladus - Implications for the plume formation

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Abstract

The unexpected discovery of plumes of water vapour and ice particles emerging from warm fractures of Saturn's small, icy moon Enceladus raised the question of whether they emerge from either a subsurface liquid source or from ice decomposition. Previous compositional analyses by Cassini's dust detector of particles injected by the plume into Saturn's diffuse E ring have already indicated the presence of liquid water[1,2]. However, the mechanisms driving the plume emission are still hotly debated[3]. Recently an analysis of the first in-situ compositional measurements of particles during plume traversals showed that salt-rich ice particles are found to dominate the total mass flux of ejected solids (>99%) but are eventually depleted in the population escaping into Saturn's E ring[4].

Here we discuss the consequences of this and other recent results for the processes forming the plume. Previous Cassini observations were compatible with a variety of plume formation scenarios and contributions from "dry" sources (such as ice sublimation or clathrate decomposition) were viable. A plume source dominated by micron sized salt-rich ice grains, as reported here, eliminates significant contributions from dry, sodium poor sources and severely constrains or rules out non-liquid models in their present form. The resent measurements strongly imply that a salt-water reservoir with a large, but probably non-contiguous or porous, evaporating surface[1,4,5] injects most of the matter forming the plume. The relatively low abundance of non-soluable gases[6,7] in the plume is in agreement with a contribution from warm ice-sublimation to the gas flux.

References

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