EGU24-20219, updated on 07 May 2024
https://doi.org/10.5194/egusphere-egu24-20219
EGU General Assembly 2024

The Leaky Cauldron; an experimental study of the icy plumes of Enceladus

Yael Bourgeois[1,2], Fabrizio Giordano[1], Stephanie Cazaux[1,2], and Ferry Schrijer[1]
[1]TU Delft, Astrodynamics and Space Missions, Planetary Exploration, Delft, Netherlands (y.bourgeois@tudelft.nl)
[2]Leiden University, Leiden Observatory, Leiden, Netherlands

The discovery of vast subsurface oceans hidden under kilometers of ices on icy moons in our Solar System has sparked worldwide interests in ascertaining their potential habitability. In the case of Saturn's moon Enceladus, supersonic plumes of water vapour and icy grains have been observed by the Cassini mission spewing from the surface, giving us indirect knowledge of the composition of this subsurface ocean. The exact mechanisms of the plumes however, and their effect on the composition of the ejected matter has yet to be clearly understood. The focus of this study is to experimentally investigate physical characteristics of the plumes located at the South Polar Terrain (SPT) of Enceladus. Using facilities at TU Delft faculty, we simulate experimentally the topology of the ice crevasses and the subsurface ocean with a narrow channel mounted atop a liquid water reservoir placed inside a vacuum chamber. We inquire upon the dependence of the channel walls temperature on the plume's exhaust velocity. Using a straight channel, our results show that colder wall temperatures enable a saturated water vapour flow with a minima 1.5-3 % solid fraction and vent velocities reaching around 400-500 m/s. The data ranges for velocities and solid fraction extrapolated from the Cassini data (550-2000 m/s and 7-70 %) thus cannot be explained by straight channel models. Using a channel with an expansion ratio of 1.73 however, the measured supersonic plume velocity becomes comparable to some of the in situ Mach number determined at Enceladus. Using a method based on the energy conservation law, it is possible to extrapolate from our experimental data some plausible geometries of the ice crevasses of Enceladus. This work lays the ground work for a coming comprehensive parametric study of the channel geometry and its effect on exhaust Mach number, temperature and solid fraction.