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ENCELADUS PLUME BIOSIGNATURE SAMPLE RETURN MISSIONS

Abstract

The discovery of jets emitting salty water from the interior of Saturn's small moon Enceladus is one of the most astounding results of the Cassini mission to date. The measured presence of organic species in the resulting plume, the finding that the jet activity is valved by tidal stretching at apochrone, and the modeled lifetime of E-ring particles, all indicate that the textbook conditions for habitability are met at Enceladus today: liquid water, biologically available elements, and source of energy, longevity of conducive conditions. Enceladus may be the best place in our solar system to search for direct evidence of biomarkers, and the plume provides a way to sample for and even return them to Earth for detailed analysis.

It is straightforward to imagine a Stardust-like, fly-through, plume particle and gas collection and return mission for Enceladus. An international team (LIFE, Life Investigation For Enceladus) has dedicated itself to pursuing such a flight project. Concept engineering and evaluation indicate that the associated technical, programmatic, regulatory, and cost issues are quite unlike the Stardust precedent however, not least because of such a mission's Category-V, Restricted Earth Return, classification.

The paper presents a strategic framework that systematically integrates the cultivation of science advocacy, resolution of diverse stakeholder issues, development of verifiable and affordable technical solutions, validation of cost estimation methods, alignment with other candidate astrobiology missions, complementarity of international agency goals, and finally the identification of appropriate research and flight-mission opportunities. Resolving and using this map is essential if we are to know the astrobiological state of Enceladus in our lifetime.