



Discovering habitable environments and life in the Saturn System (Jean Dominique Cassini Medal Lecture)

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One of the most notable scientific adventures of our time is being conducted jointly by Europe and the United States around the solar system's great ringed planet, Saturn. The Cassini-Huygens mission arrived in orbit in 2004, and the Huygens probe descended through Titan's atmosphere in January 2005. Titan's surface has been found to host a rich and still-enigmatic methane cycle, complete with lakes, seas, rivers and rain. Enceladus is jetting its interior volatiles into space, where the Cassini Orbiter detected and measured a number of species within the resulting plume. These include water, organic molecules, nitrogen compounds, and salts. Cassini radio science detected the presence within both Enceladus and Titan of internal water oceans. Variability with orbital phase of the Enceladus plume, also discovered by the Cassini Orbiter, makes a convincing case for the jets themselves being derived from the deep interior and controlled by tidal forces.

Both Enceladus and Titan host potentially habitable environments, and they represent unique opportunities for testing whether either or both of these bodies harbor life. Titan's interior will be difficult to access, but its large surface hydrocarbon seas can be explored in situ with Huygens-like vehicles. The Cassini Orbiter determined the liquid in Titan's seas to be methane and ethane, which raises the question of whether simple chemistry can evolve into autocatalysis and self-replication in a non-aqueous liquid environment. In effect, is there an exotic kind of "life" in the Titan seas? Enceladus is perhaps more straightforward: given that the interior water ocean as expressed through the plume appears to satisfy the formal requirements for habitability, is biological activity occurring there? Answering these questions will require a new generation of robotic vehicles beyond Cassini-Huygens — and new opportunities for international collaborations in planetary exploration.