Astrobiology in the Saturn System: Observations and Laboratory Experiments

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Since the Saturn orbit insertion of Cassini on July 1rst, 2004, and the descent of Huygens in the atmosphere of Titan on January 14, 2005, five years of close observation by remote sensing and in situ instruments have revealed many aspects of astrobiological interest in the Saturnian system, especially for two of its moons, Titan and Enceladus.

Titan does not look any more like a frozen primitive Earth but like an evolving planet, still geologically active today. Cryo-volcanism, eolian erosion, a methane cycle with clouds and precipitations, very similar to the water cycle on Earth, are some of the processes which control its evolution. The Cassini-Huygens data show that a complex organic chemistry is taking place from the high atmosphere to the surface of Titan, particularly in the ionosphere, where high molecular weight ions, of up to ~10 000 Daltons, are present. In spite of the low surface temperature, the organics reaching the surface are probably evolving once in contact with water ice eventually mixed with ammonia and may form organic molecules of biological interest.

Another discovery of tremendous astrobiological importance made by the Cassini-Huygens mission is the surprising strong geological activity of Enceladus. Large plumes have been observed on the south polar regions of the satellite. They are mainly composed of water vapor and ice and also include some organic compounds. This suggests the potential presence of a complex organic chemistry going on in the presence of liquid water in the interior of this small satellite.

What the level of complexity is currently reached by the organic chemistry going on in Titan and Enceladus environments? What are the habitability potentialities of these two astrobiologically interesting planetary objects? The extended-extended Cassini-Huygens mission, named the Solstice mission, may bring some partial answers to these questions. But it seems that a new mission, with full capability of surface and low atmosphere analysis on long time scale is needed. Before such a mission is launched, ground studies, both experimental and theoretical, can also help answering these questions. In particular at LISA, several experimental programs are carried out to study Titan's organic chemistry. Simulation experiments are developed to perform deep studies of methane-dinitrogen photochemical coupling. Other programs are more concerned with Titan's tholins: determination of their chemical behaviorin the presence of water-ammonia at low temperature, and study of their photodegradation using Erath-orbit space experiments.

The astrobiological aspects of Titan and Enceladus as senn from Cassini-Huygens, will be presented and discussed, as well as some of the experimental laboratory data concerning Titan.

Keywords: Titan, Enceladus, Astrobiology, tholins

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