Cassini-Huygens at Saturn!

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The stream of discoveries continues to flow from the *Cassini-Huygens* mission as it explores the Saturnian system: the rings, Titan, icy satellites, the magnetosphere, and, of course, the planet Saturn itself. The amazing discoveries have redefined our concept of the whole system. We are seeing many features and processes for the first time. Some of them are beautiful; some astound us; and others tax our abilities of explanation.

In many ways Titan resembles the Earth. Both have atmospheres that are predominately nitrogen gas. The surface pressure is 1.5 times that at the surface of the Earth. There are aerosol layers and clouds that come and go. *Huygens* discovered that the surface of Titan looks much like the surface of the Earth, with terrestrial analogs for many of the landscapes. Whether it be fluvially carved surfaces with networks of stream and river channels, lakes (some of them dry), impact craters, possible lava flows, or sand dunes --- these are all familiar features on the Earth. This suggests that similar processes operated on both surfaces. However the big difference at Titan is the very cold the temperature. Ice plays the role of rock and liquid methane plays the role of water.

Enceladus, at ~500 km diameter, was 'known' to be too small to be active. Yet, it supports eruptive plumes. If that is not enough, its south polar region is radiating ~15 GW of power. There is no consensus as to from where this power comes.

Iapetus, the most distant from Saturn of the regular satellites, is renouned for its strange 'black and white' surface markings. However, *Cassini-Huygens* has discovered something much more important. Some of Iapetus' geophysical properties allow the determination of its absolute age! At ~4.563 Ga it is older than the Earth!

The ring-plane is passing through the sun this month (August 11, 2009). Near this time, features otherwise too small to be seen will cast very long shadows. At this small scale the rings are lumpier than previously suspected. In some places chaotic variability and transient structures are seen. How old are the rings? They may be very old if they are continuously regenerating themselves.

As the seasons change, the discoveries will continue. How will the magnetosphere respond? Surely there will be dramatic changes in some of its many structures and in the nature of some of its plasmas. On the planet the winds and distribution of storms are expected to change as the atmospheric circulation adjusts. Not

only is the apparent position of the Sun changing from one saturnian hemisphere to the other, but the shadow of the rings will be falling upon new latitudes. We expect seasonal effects on Titan too. Will the size and number of the lakes in the South grow as winter comes? Will we see the northern likes and seas diminish or dry up as summer progresses?

Much work remains for future missions. Titian has many different environments to explore. Concepts for future missions feature mobility by balloon and vessels on the lakes and seas. At Enceladus the fact that the 'sample comes to you', makes flying through the plumes very attractive. While *Cassini-Huygens* will make many more discoveries, we now know some of its limitations. For example, more capable instruments are required in order to obtain complete inventories of the vast collections of organic chemicals at Titan and Enceladus. Until then, a fully accurate assessment of habitability will not be possible.

Saturn is showing us that the outer solar system is very exciting!

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