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Cassini at Saturn: The Final Two Years

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Abstract

After 11 years in orbit, the Cassini-Huygens Mission to Saturn, a collaboration of NASA, ESA, and ASI, continues to wow the imagination and reveal unprecedented findings. Every year Cassini produces answers to questions raised by the Voyager flybys, while at the same time posing new questions that can *only* be answered with a long duration mission using a flagship-class spacecraft. Here we sample a few of Cassini's discoveries from the past year and give an overview of Cassini's final two years.

1. Exploring the Saturn System

Cassini's exploration of the Saturn System is composed of five broad, overlapping scientific disciplines: Titan, the atmosphere of Saturn, rings, magnetosphere, and icy satellites (Figure 1).

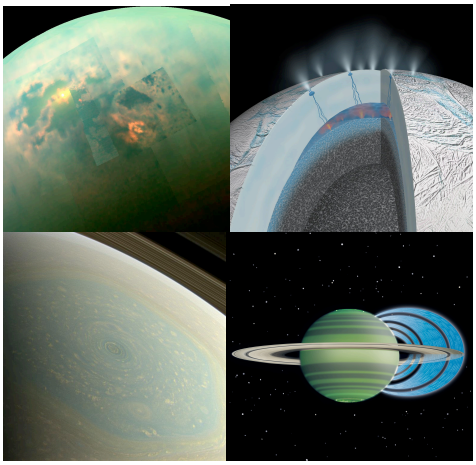

Figure 1: The five major science disciplines of the Cassini-Huygens Mission include (clockwise from upper left hand) Titan, icy satellites, magnetosphere and rings, and Saturn.

In each area, Cassini made major discoveries, provided answers to old questions, and posed new questions that may be answered in the mission's final two years. Among many firsts, Cassini: discovered icy jets of material streaming from tiny Enceladus' south pole proving that it is the source of the E Ring and that its water dominates the magnetosphere; found hydrocarbon lakes and seas on Titan; detected sub-surface oceans in Enceladus and Titan; provided multi-wavelength coverage of a great northern storm, the first of its kind on Saturn since 1990; demonstrated that the Saturn Kilometric Radiation period does not reflect the planet's internal rotation; revealed curtain-like aurorae and their true color flickering over Saturn's poles;; and constrained and complicated our understanding of the 3D structure and dynamics of multi-particle ring systems. In addition, the Huygens probe sent back amazing images of Titan's surface and made detailed measurements of atmospheric composition, structure and winds.

In just the last three years, Cassini discovered that: the majority of Titan's lakes and seas are located near the north pole; Enceladus harbors a subsurface ocean with possible hydrothermal activity where the ocean and rocky core meet; a huge hurricane rages at Saturn's north pole; tidal stresses control Enceladus' particulate jets with plume activity greatest near apoapse; the depth of Titan's Ligeia Mare is 150-200 meters; meteorite impacts, embedded propellers migrating inwards and outwards, and the effects of Saturn internal oscillations can be witnessed in the rings; Titan has a subsurface water ocean; interactions between a strong solar wind and Saturn's magnetosphere can help us understand supernovae shockwaves; Titan's south polar haze is a seasonal phenomenon; ephemeral "islands" exist in Titan's lakes; and methane ice clouds can be present in Titan's stratosphere..

Cassini continues to inform the planning of future missions. Over the next two years, Northern Summer Mission (NSM) will complete Cassini's investigation of the Saturn system throughout half the

planet's year. We will monitor seasonal changes on Saturn and Titan in a previously unobserved seasonal phase. As northern summer approaches, long-dark regions throughout the system have become sunlit with the reverse occurring in the south, allowing Cassini's science instruments to probe as-yet unsolved mysteries, observe seasonal and temporal changes, and address new questions that have arisen during the mission thus far.

2. F Ring and Proximal Orbits

The final phase of Cassini's Northern Solstice Mission covers a period of roughly ten months and will end the mission by exploring for the first time the region between the rings and planet, a rich source for discovery. It will begin with 20 orbits with periapse just outside the F Ring (Figure 2) before transitioning to 22 Proximal Orbits, with periapse between the rings and planet. The last orbit will take the spacecraft into Saturn on September 15, 2017, where it will be vaporized by the planet's atmosphere.

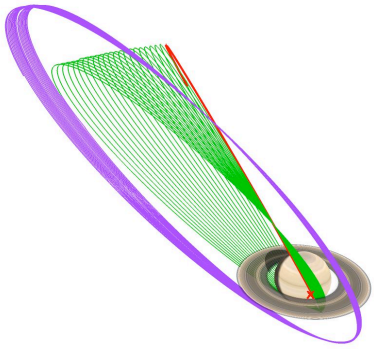

Figure 2: F Ring and Proximal Orbit phase: 20 F Ring (purple) orbits and 22 Proximal Orbits (green). The last orbit (red) will take Cassini into Saturn (red x) for vaporization by Saturn's atmosphere.

During this phase, Cassini will attempt to answer fundamental questions related to Saturn's interior structure and rotation rate, the internal magnetic field and dynamo, the total mass of the main rings, and the dust, gas, and plasma composition between the rings and planet, in addition to acquiring the mission's closest views of the rings, ring moons, aurora, and planet, revealing their detailed structure (Figure 3).

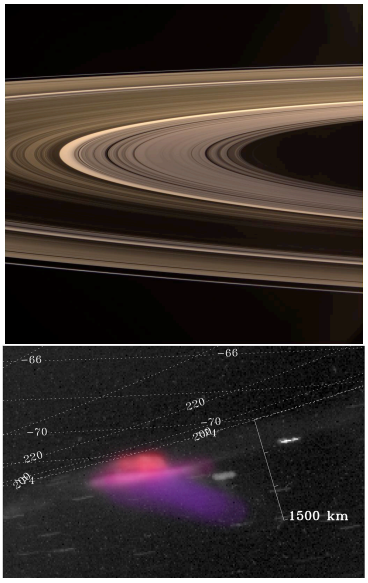

Figure 3: Image of the unlit side of the rings with the innermost, much fainter D ring (above). Saturn's aurora in true-color (below).

3. Summary and Conclusions

Cassini-Huygens exploration of Saturn has yielded 11 years of unprecedented discoveries, and answers to many scientific mysteries. The healthy spacecraft is poised to embark on the final two years with an exciting end of mission that will answer fundamental questions about Saturn, the rings and magnetosphere.

The year 2017 will be an exciting time for giant planet research, as Cassini and Juno simultaneously probe the interiors of Saturn and Jupiter. The new data will attract an array of experts in giant planet research, and the outcome will be a huge leap in understanding our two gas giants.

Acknowledgements

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