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10 Years at Saturn, and More Excitement to Come!

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Abstract

After 10 years in orbit, the Cassini-Huygens Mission to Saturn, a collaboration of NASA, ESA, and ASI, continues to wow the imagination. 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. In this talk, we sample a few of Cassini's discoveries from the past decade and give an overview of what comes next.

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).

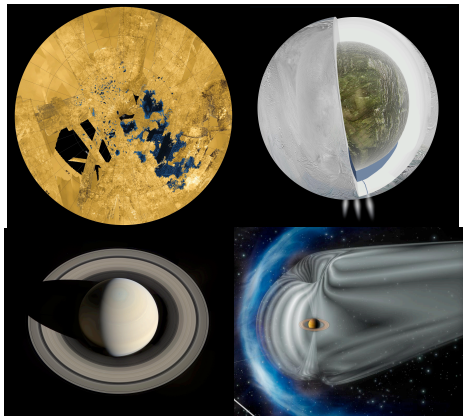

Figure 1: The five major science disciplines of the Cassini-Huygens Mission include (clockwise from upper left hand) Titan, icy satellites, magnetosphere, Saturn and its rings.

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 years. Among many firsts, Cassini: discovered cryovolcanic jets at Enceladus; found hydrocarbon lakes and seas on 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; proved that Enceladus is the source of the E Ring and that its water dominates the magnetosphere; and constrained and complicated our understanding of the 3D structure and dynamics of multi-particle ring systems.

In just the last two years, Cassini discovered that: the majority of Titan's lakes and seas are located near the north pole; Enceladus harbors a subsurface ocean; a huge hurricane rages at Saturn's north pole; tidal stresses control Enceladus' particulate jets; plume activity is 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; and Titan's south polar haze is a seasonal phenomenon.

Cassini continues to inform the planning of future missions. Over the next three 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, and extend the observational baseline of temporal changes across the system.

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.

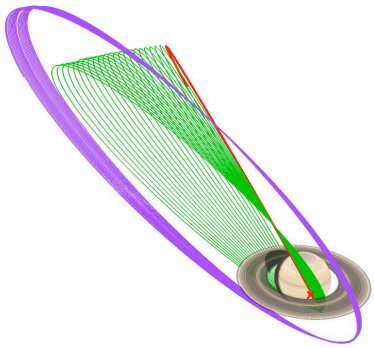

Figure 2: F Ring and Proximal Orbit phase: 20 F Ring (purple) orbits and 22 Proximal Orbits (green). The last orbit (red) will take Cassini into Saturn (red x) for vaporization by Saturn's atmosphere.

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 and gas composition between the rings and planet, in addition to acquiring the mission's closest views of the rings and planet, revealing their detailed structure.

3. Summary and Conclusions

Cassini-Huygens exploration of Saturn has yielded 10 years of unprecedented discoveries, and answers to many scientific mysteries (Figure 3). The healthy spacecraft is poised to embark on the final three years with an exciting end of mission that will answer fundamental questions about Saturn, the rings and the magnetosphere.

Acknowledgements

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Figure 3. A sampling of science highlights from previous mission phases. NSM will complete nearly half a solar year investigation of the Saturn system and provide an exciting grand finale yielding fundamental new science.