

A Voyage into Unique Territory: Cassini's Grand Finale. L. J. Spilker¹ and S. G. Edgington², ¹ Jet Propulsion Laboratory, California Institute of Technology, Pasadena, United States (linda.j.spilker@jpl.nasa.gov), ² Jet Propulsion Laboratory, California Institute of Technology, Pasadena, United States (scott.g.edgington@jpl.nasa.gov).

Brief Abstract: Key science findings acquired during Cassini's unique dives between the rings and Saturn (Grand Finale), and during its Ring Grazing orbits are presented.

Introduction: After more than 13 years in orbit around Saturn, the Cassini-Huygens mission ended in a science-rich blaze of glory on September 15, 2017. The Grand Finale and Ring Grazing orbits marked the final phase of Cassini's mission covering a period of roughly ten months and ending the mission with the first time in-situ exploration of the region between the rings and planet. On its final orbit, Cassini plunged into Saturn's atmosphere, vaporizing and satisfying planetary protection requirements, while sending back its final bits of unique science data.

Cassini's End of Mission:

Ring Grazing Orbits. In late 2016, Cassini's trajectory transitioned to a series of 20 Ring Grazing orbits with peripases located within 10000 km of Saturn's F ring (Figure 1). These orbits provided the high-resolution views of Saturn's F ring and outer A ring, and prime viewing conditions for fine scale ring structures such as propellers (Figure 2). They also included the closest flybys of tiny ring moons, including Pan, Daphnis and Atlas (Figure 2). Plasma and dust composition measurements were also conducted in this region.

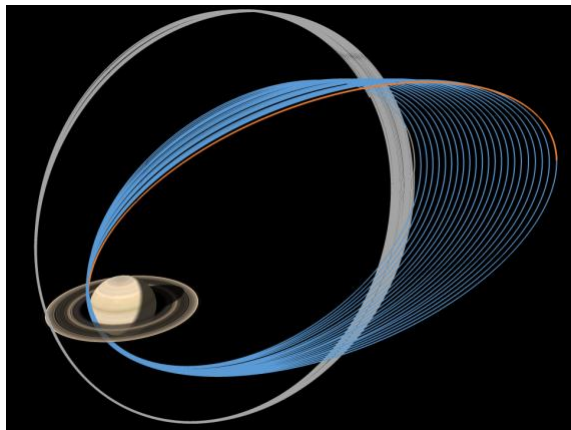


Figure 1: Cassini's 20 Ring Grazing (gray) and Grand Finale (blue) orbits. The last orbit (orange) will take Cassini into Saturn's atmosphere for vaporization.

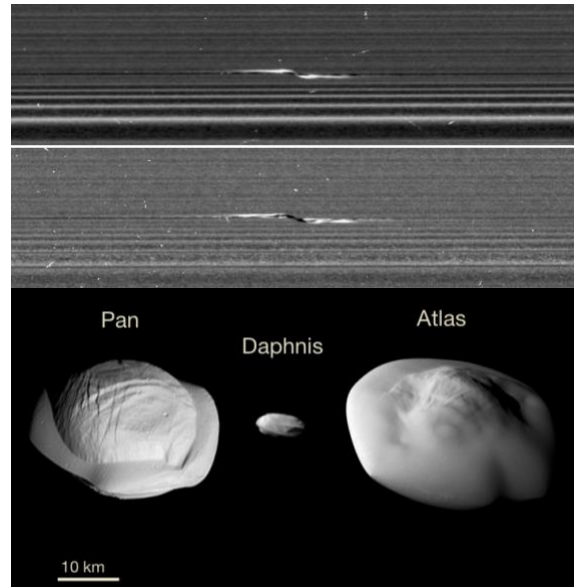


Figure 2: Ring propeller Santos-Dumont on lit (top) and unlit (middle) sides of the rings. Comparison of the ring moons, Pan, Daphnis, and Atlas (bottom).

Grand Finale Orbits. A final close flyby of Titan in late April 2017 propelled Cassini across Saturn's main rings and into its Grand Finale orbits. Comprised of 22 orbits, the spacecraft repeatedly dove between Saturn's innermost rings and upper atmosphere (Figure 1) attempting to answer fundamental questions unattainable earlier in the mission. The Grand Finale was like a brand-new mission, exploring a region of the Saturn system that was unexplored by any previous outer planet spacecraft.

Saturn's gravitational field was measured to unprecedented accuracy, providing information from which constraints on the interior structure of the planet, winds in the deep atmosphere, and mass distribution in the rings could be derived (Figure 3). Probing the magnetic field provided insight into the physics of the magnetic dynamo, the structure of the internal magnetic field, and placed constraints on the location of the metallic hydrogen transition region.

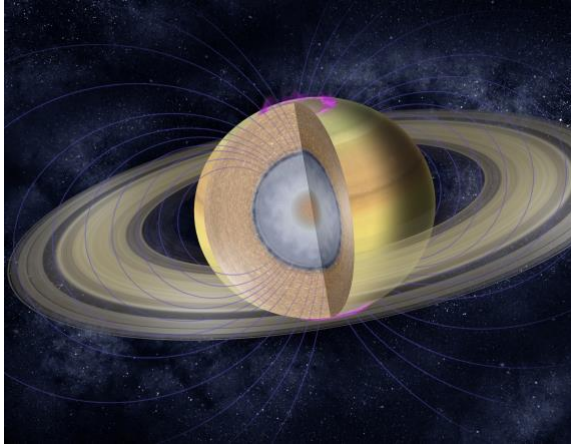


Figure 3: Grand Finale science goals focus on studying ring mass and composition, interior structure, magnetic dynamo, aurora, and atmospheric composition.

The Grand Finale orbits provided the highest resolution observations ever of both Saturn's C and D rings and Saturn's atmosphere (Figure 4). Direct in-situ sampling of the ring particle composition and the innermost radiation belts was also achieved. The ion and neutral mass spectrometer sampled the exosphere and upper atmosphere for molecules that escape the atmosphere and water-based molecules originating from the rings. The cosmic dust analyzer directly sampled the composition from different parts of the main ring particles for the first time.

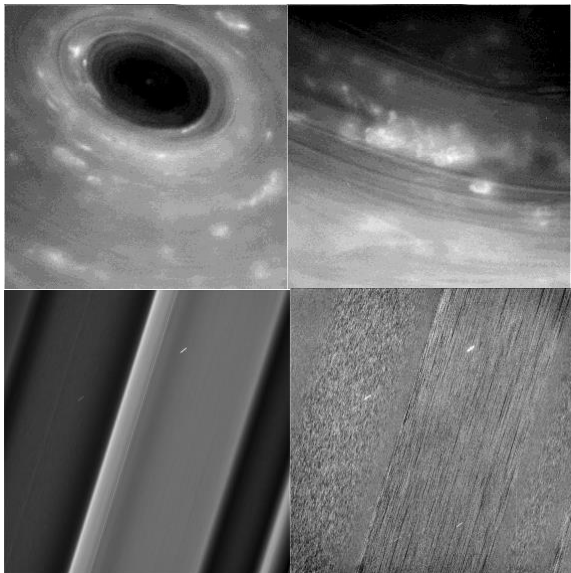


Figure 4: Saturn's north polar vortex (upper left) and convective clouds over the hexagon jet stream (upper right). C ring "Plateau" features (lower left) and same image after processing to reveal differing ring particle "textures" in neighboring regions.

Cassini's Final Half-orbit. The last orbit turned the spacecraft into the first Saturn atmosphere probe with all of fields and particle instruments gathering data as long as the spacecraft remains stable. Approximately one additional scale height of atmosphere was probed prior to loss of signal from the spacecraft.

During this talk, science highlights and new mysteries gleaned from the Ring Grazing and Grand Finale orbits will be discussed.

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