A Voyage into Unique Territory: Cassini’s Grand Finale. L. J. Spilker and S. G. Edgington, 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 periapses 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.

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 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).
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.

Acknowledgements: We would also like to gratefully acknowledge all of the Cassini team members who designed, developed and operated the Cassini-Huygens mission, which is a joint endeavor of NASA, the European Space Agency (ESA), and the Italian Space Agency (ASI) and is managed by JPL/Caltech under a contract with NASA.

Additional Information: The research described in this paper was carried out in part at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration. Copyright 2018 California Institute of Technology. Government sponsorship is acknowledged.