



# Cassini — The Grand Finale

With help from the public, members of NASA's Cassini mission to Saturn have chosen to call the spacecraft's final orbits the *Grand Finale*.

In late 2016, the Cassini spacecraft will begin a daring set of orbits that is, in some ways, like a whole new mission. The spacecraft will repeatedly climb high above Saturn's poles, flying just outside its narrow F ring. Cassini will probe the water-rich plume of the active geysers on the planet's intriguing moon Enceladus, and then will hop the rings and dive between the planet and its innermost ring 22 times.

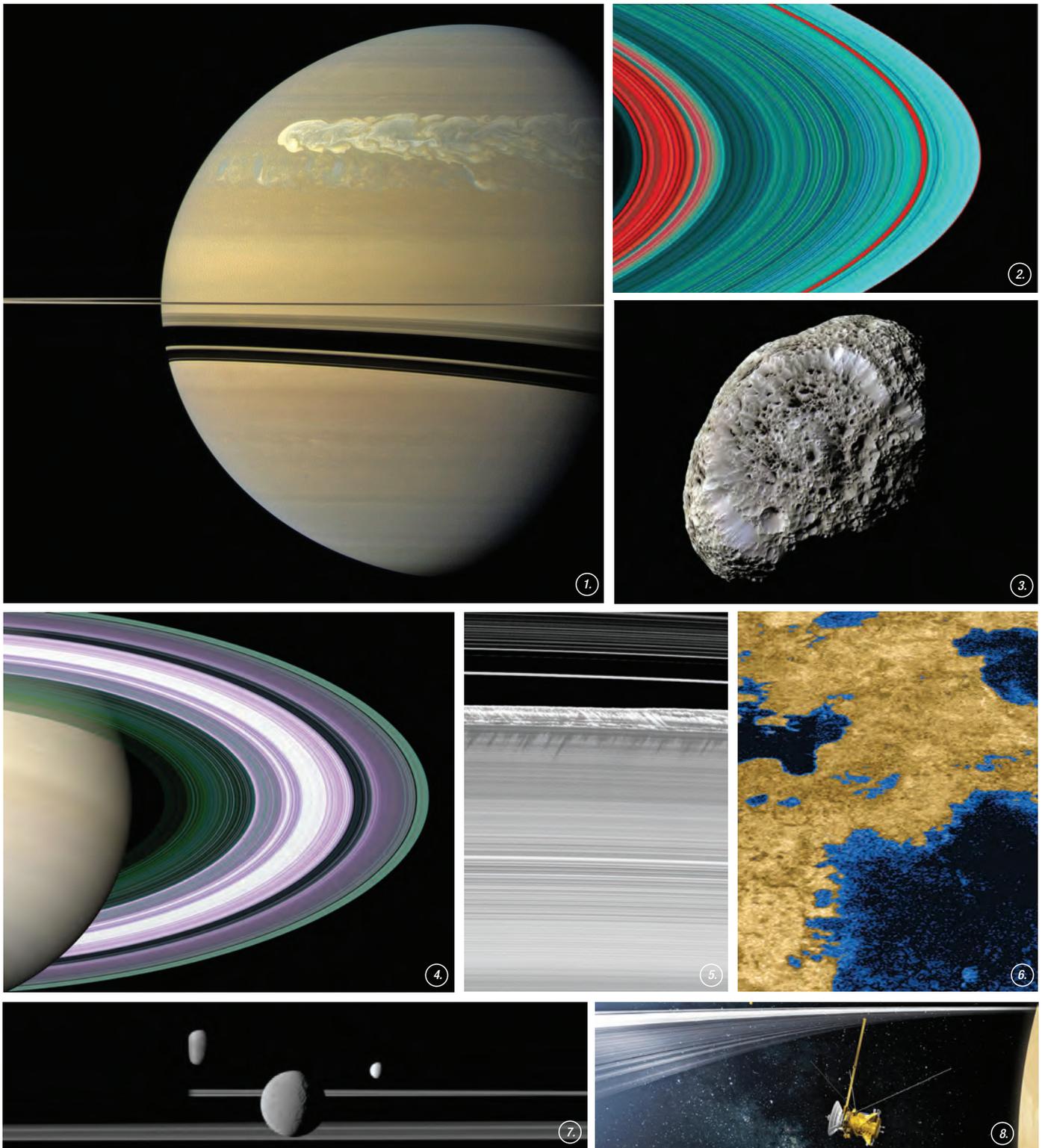
As Cassini plunges past Saturn, the spacecraft will collect some incredibly rich and valuable information that the mission's original planners might never have imagined. The spacecraft will make detailed maps of Saturn's gravity and magnetic fields, revealing how the planet is composed on the inside, and possibly helping to solve the irksome mystery of just how fast

the interior is rotating. It will vastly improve our knowledge of how much material is in the rings, bringing us closer to understanding their origins. Cassini's particle detectors will sample icy ring particles being funneled into the atmosphere by Saturn's magnetic field. And its cameras will take amazing, ultra-close images of Saturn's rings and clouds.

No other mission has explored this unique region so close to the planet. What we learn from these activities will help to improve our understanding of how giant planets — and families of planets everywhere — form and evolve. At the end of its final orbit, as Cassini falls into Saturn's atmosphere, it completes its 20-year mission by ensuring that the biologically interesting worlds Enceladus and Titan could never be contaminated by hardy microbes that might have stowed away and survived the journey intact. It's inspiring, adventurous and romantic — a fitting end to this thrilling story of discovery.

**NASAfacts**





1. This huge northern hemisphere storm wrapped around the entire planet.

2. This view of Saturn's rings in the ultraviolet indicates there is more ice toward the outer part of the rings.

3. Cassini captured this false-color view of the tiny moon Hyperion in 2005. The color differences may indicate differences in surface material composition.

4. Color was used in this simulated image to represent information about ring particle sizes based on measurements of three radio signals sent to Earth by Cassini.

5. Vertical structures rise from the edge of the B ring, perhaps formed as moonlets disturb the ring particles streaming nearby.

6. Radar imaging data from Cassini indicate the presence of large bodies of liquid on Titan's surface.

7. Three of Saturn's moons are seen against the darkened nightside of the planet. Dione (at left) is partly obscured by Saturn.

8. The final part of Cassini's mission — the Grand Finale — will take the spacecraft to previously unexplored regions of the Saturn system.

## Mission Science Objectives

**Saturn** — cloud properties and atmospheric composition; winds and temperatures; internal structure and rotation; ionosphere; origin and evolution

**Rings** — Structure and composition; dynamical processes; interrelation of rings and satellites; dust and micrometeoroid environment

**Titan** — Atmospheric constituent abundances; distribution of trace gases and aerosols; winds and temperatures; surface state and composition; upper atmosphere

**Icy Satellites** — Characteristics and geological histories; mechanisms of surface modification; surface composition and distribution; bulk composition and internal structure; interaction with magnetosphere

**Magnetosphere** — Configuration and current systems; particle composition, sources and sinks; dynamics of the magnetosphere; interaction with solar wind, satellites and rings; Titan's interaction with solar wind and magnetosphere

## A Decade of Discoveries

As of its 10th anniversary in Saturn orbit, July 2014, the stalwart spacecraft has beamed back to Earth more than 500 gigabytes of scientific data through NASA's Deep Space Network, enabling the publication of more than 3,000 scientific papers. Cassini has completed more than 200 orbits of Saturn, carried out 132 close flybys of Saturn's moons and discovered seven new moons.

Representing just a sampling, 10 of Cassini's top accomplishments and discoveries are:

- The European Space Agency's Huygens probe, carried to the Saturn system aboard the Cassini orbiter, parachutes to Titan, making the first landing on a moon in the outer solar system.
- Cassini discovers active, icy plumes spraying from "tiger stripe" fractures on Saturn's moon Enceladus.
- Saturn's rings are found to be active and dynamic — a laboratory for how planets or moons form.
- Titan, Saturn's largest moon, is revealed to have rain, rivers, lakes and seas; it is shrouded in a thick, nitrogen-rich atmosphere that might be similar to what Earth's was like long ago.

## Mission Timeline

1997

The orbiter, the largest interplanetary spacecraft ever constructed by NASA, launches on October 15 (EDT) from Cape Canaveral Air Force Station in Florida, with the European Space Agency's Huygens probe aboard.

1997 – 2004

Seven-year cruise to Saturn on a gravity-assist trajectory: two swingbys of Venus, one of Earth and one of Jupiter to give the spacecraft the boost needed to reach Saturn.

2004

Arrival and orbit insertion on June 30 (PDT). Cassini passes between the F and G rings and allows itself to be captured as a satellite of Saturn.

2005

Released on December 24, 2004, the Huygens probe descends through Titan's atmosphere, lands on Titan and relays data to Earth on January 14, 2005.

2004 – 2008

Cassini's four-year prime mission orbital tour consists of 45 Titan encounters, 10 icy satellite encounters and 76 orbits of Saturn.

2008 – 2010

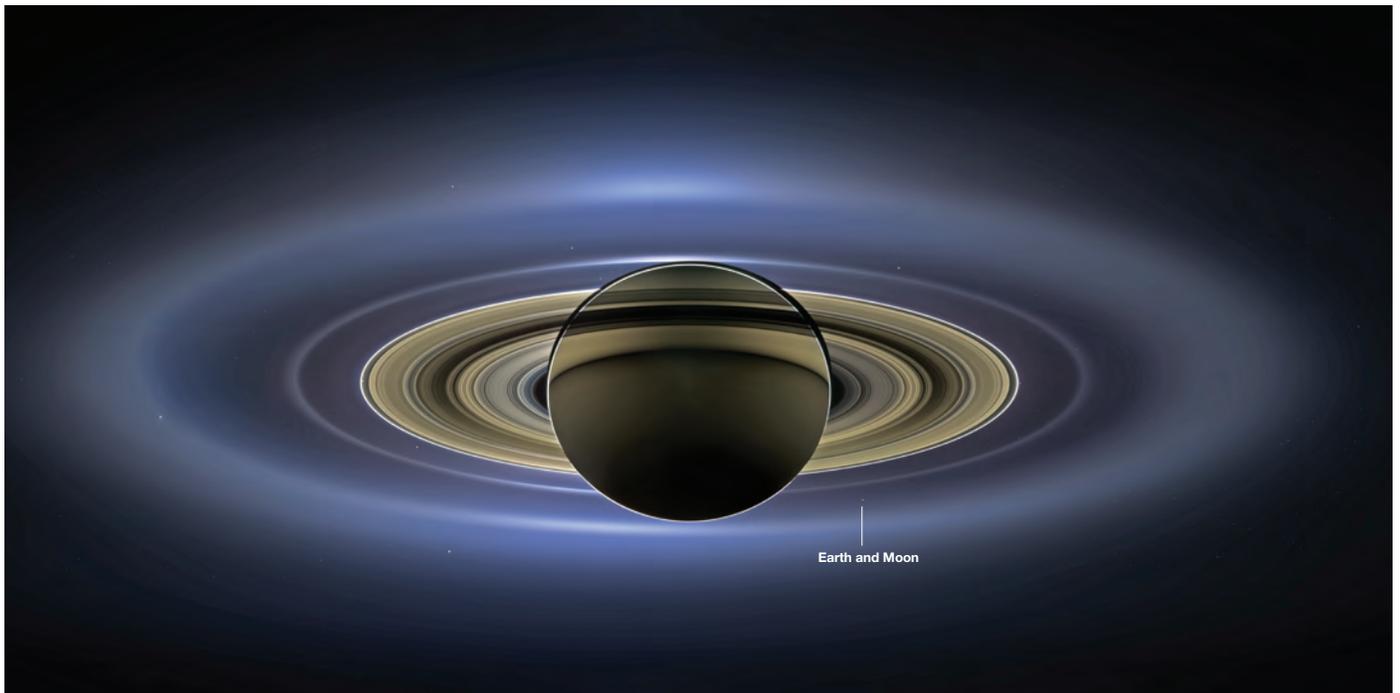
Equinox Mission: two-year mission extension, 64 orbits, 28 Titan encounters, 8 Enceladus encounters, 3 with other smaller icy satellites; equinox crossing in August 2009.

2010 – 2017

Solstice Mission: seven-year mission extension consisting of 155 orbits, 54 Titan encounters, 11 Enceladus encounters, 5 other icy moon encounters; opportunity to observe spring-early summer in northern hemisphere.

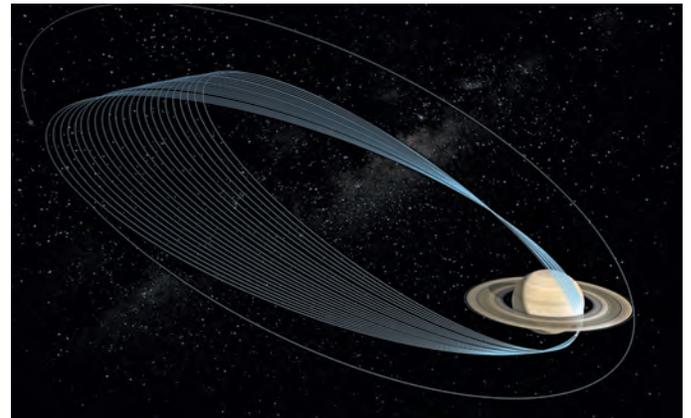
2017

Grand Finale: at the spacecraft's final orbit, it falls into Saturn's atmosphere, ending its extraordinary 20-year mission of discovery.



*With Saturn sheltering Cassini from the sun's glare, the spacecraft captured 141 images to create a panoramic mosaic. Some of Saturn's moons can be discerned in this contrast-enhanced image, as well as the tiny dots of our own planet and its moon.*

- Saturn's great northern storm of 2010–2011, which eventually encircled the entire planet for months, is imaged and characterized.
- Studies reveal radio-wave patterns are not tied to Saturn's interior rotation, as previously thought.
- Vertical structures in the rings are imaged for the first time; they appear to be made up of particles piled up in bumps or ridges more than 2 miles (3 km) high.
- Titan's prebiotic chemistry is studied.
- The mystery of the dual, bright–dark surface of the moon Iapetus is solved — it is thought that one side of the moon's topmost ice layer has sublimated (vaporized), leaving a dark, carbon-rich coating on that side while the ice condensed on the other side, making it appear brighter.
- Cassini captures the first complete view of the north polar hexagon and discovers giant hurricanes at both of Saturn's poles.



*Cassini will end its historic mission with 22 daring loops passing through the gap between Saturn and the innermost ring.*

The Jet Propulsion Laboratory, a division of the California Institute of Technology, manages the Cassini mission for the National Aeronautics and Space Administration (NASA). Cassini is a cooperative mission of NASA, the European Space Agency and the Italian Space Agency, with participation by hundreds of scientists and engineers from Europe and the U.S.

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