

SATURN, THE RING WORLD - 2
Houston Museum of Natural Science
Edited from a production distributed by NASA's Jet Propulsion Laboratory

0:00 1. INTRO SEQUENCE – Lights Down

0:25 Five, four, three, two, one, zerolift-off. We have lift-off.

0:46 Its name is Cassini-Huygens. On October 15, 1997, it sailed out from the port of Earth on a seven year, two billion mile odyssey to the outer solar system. The size of a school bus with a total weight of over 12,000 pounds, and an array of 18 packages of scientific instruments, Cassini-Huygens represents the combined effort of scientists and engineers in 18 countries, and is one of the largest, heaviest, and most sophisticated interplanetary spacecraft ever launched. Its destination?... One of the most intriguing objects in the solar system -- a world of unparalleled beauty and the undisputed "Lord of the Rings" - Saturn!

0:42 Opening Credits

2. BEFORE CASSINI

2:12 – Antique Observatory all sky

As the centuries passed, telescopes grew ever larger and more sophisticated. And, with them, astronomers steadily discovered more details in Saturn's atmosphere and rings and an ever-increasing number of Saturnian moons.

But the turbulent nature of Earth's atmosphere frequently caused images to ripple and distort and the billion mile gulf between Earth and Saturn still limited how much could be seen ... and learned. There was but one solution - - bridge the gap ... and go there!

3:07 – Voyager II plus SATURN

Between 1979 and 1981, Pioneer 11 and Voyagers I and II became the first spacecraft to reach Saturn. The result was nothing short of an explosion in our knowledge of the ringed giant and its satellites.

3:29 – Collages with slides

Indistinct bands in the planet's atmosphere were transformed into intricate weather systems driven by 1100 mile per hour winds. Saturn's rings were divided and divided again into hundreds, then thousands of "ringlets". And many of Saturn's satellites instantly grew from mere dots in the best telescopes on Earth into amazingly different worlds.

3. THE JOURNEY TO SATURN

4:03 – Animation inside mission control

For Cassini, the road to Saturn is both long and winding... a complex but clever routing carefully designed to not exceed the limited fuel available, and, at the same time, take advantage of some extra sightseeing and science along the way.

April 26, 1998: More than 5 months after launch Cassini swings by its first port of call -- Venus. The planet's gravitational pull tugs on the spacecraft, providing a "gravity assist".

In so doing, Venus gives Cassini a "kick" speeding it up and redirecting its path. A firing of Cassini's main engine in what is called the Deep Space Maneuver makes an additional adjustment.

423 days later, when Cassini crosses the orbit of Venus again, the timing is perfect, for Venus, once again, is there to meet it.

This second gravity assist sends the spacecraft onward on what will now be a long journey away from the sun.

55 days later, Cassini pays a brief return visit to the home of its creators -- our fragile planet spinning in space.

The encounter with Earth now propels the spacecraft farther and farther from the sun -- across the orbit of Mars, through the asteroid belt, and on to the first of the giant planets, mighty Jupiter.

4. JUPITER ENCOUNTER

6:05 -- *GALILEO ANIMATION*

\ During the late 1990s, a spacecraft named Galileo arrived here, went into orbit around Jupiter, and provided unprecedented reconnaissance of the planet and many of its satellites.

Now, in what becomes known as the "Millennium Fly-by", Cassini adds its cameras and scientific instruments to the effort.

(6:40) Working in tandem, Cassini and Galileo map Jupiter's immense magnetic field in three dimensions as high energy particles, streaming from the distant sun, buffet the field and continually reshape its outer boundaries.

Some of the particles along with others from Jupiter's volcanic moon Io are channeled along specific paths toward the planet's magnetic poles.

7:33 There they collide with Jupiter's upper atmosphere and set vast regions aglow with shimmering displays of the Northern and Southern Lights.
In three years and three months, Cassini has come a long way Encountering Venus twice followed by a close swing past Earth --- and on to Jupiter. Now a final gravity assist from the giant planet is all that is needed to set the stage for

the main event – Cassini’s encounter with Saturn and its entourage of fascinating satellites.

5. SATURN APPROACH

8:08 Cassini races toward its rendezvous at Saturn, drawn by the ringed planet’s strong gravitational field.

As Cassini plunges onward, its speed approaches 50,000 miles per hour-- fast enough to fly coast to coast across the United States in 3 minutes!

A moment of truth has arrived -- a "hold your breath moment" upon which the entire rest of the mission hangs for, at this speed, Cassini is moving too fast and would simply fly past Saturn. The spacecraft streaks inward skirting just above the rings and then ...

... for nearly 100 minutes, Cassini's main engine fires in just the right way to change the spacecraft's speed by 1300 miles per hour and allow it to drop into orbit around Saturn.

Cassini’s instruments take advantage of this closest approach to scrutinize the rings and monitor the innermost regions of the planet’s magnetic field.

6. CASSINI AT TITAN

9:42 – Animation

For the next 6 months, Cassini completes three carefully executed orbits of Saturn, as images and other data stream toward Earth. During these three orbits, engineers also painstakingly adjust Cassini's speed and prepare the spacecraft for the next critical part of the mission.

Now, it is time for Cassini's piggybacking Huygens probe to take center stage. The product of the European Space Agency, Huygens' mission is to detach from Cassini, descend into the atmosphere of Saturn's largest satellite, Titan, and actually land on its surface. A final system's check and then ...

10:47 4 Hours before Huygens encounters Titan's upper atmosphere, a wake up call sounds and Huygens' array of instruments come alive. Larger than the planets Mercury and Pluto, Titan is one of the most intriguing satellites in the solar system. It has a substantial atmosphere -- a thick, smoggy shroud of an atmosphere.

11:18 The cameras on Cassini begin to see through the haze to reveal tantalizing light and dark features below. With Huygens on final approach, the landing zone narrows. The descent phase has begun as Huygens slams into Titan's upper atmosphere at nearly 14,000 miles per hour. Over the next three minutes, temperatures immediately in front of Huygens' heat shield will soar from 300 degrees below zero to over 21,000 degrees Fahrenheit-- twice the surface

temperature of the sun! In the same three minutes, atmospheric drag also brakes the probe's speed from nearly 14,000 miles per hour to less than 900! At one and a half times the speed of sound, a pilot chute is released, pulling off Huygens' aft cover.

Almost immediately, the probe's main parachute unfurls. We are 110 miles from the surface. Within 30 seconds, Huygens has slowed to little over half the speed of sound. The heat shield has done its work and is jettisoned.

- 12:58 For the next 15 minutes, the probe descends under its main chute as initial scientific measurements begin. High above, Cassini collects the data transmitted by Huygens and stands ready to relay it to Earth. Finally, a smaller drogue chute takes over. Altitude: 85 miles.
- 13:32 For the next two and a quarter hours, as it continues its descent towards the surface, Huygen's instruments will be busy. Winds build to 250 Miles per hour as Huygens sniffs Titan's atmosphere, recording its chemical composition. There is abundant Nitrogen as on Earth, but also a mix of more exotic chemicals like methane, benzene, and diacetylene.
- 14:02 Nonetheless, many scientists believe the chemistry of Titan's atmosphere mimics that of Earth long ago. If so, Titan may well provide scientists with the equivalent of a "time machine" to travel back to an era before life first developed on our world.
- 14:20 Finally, descending through the last layer of cloud, we see the surface. A closeup view of a tiny portion of the largest unexplored landscape in the solar system. Our brains struggle to interpret what Huygen's eyes reveal... As Huygens spins beneath its drogue chute, descending from an altitude of 9 down to 5 miles, a rich mosaic of light and dark areas is stitched together.
- 15:00 Soon cameras zero in on an array of intriguing and mystifying features. Areas of white that may be banks of fog or mist. Bright spots that may be chains of islands or higher elevation peaks amid a level plain. Dark regions where springs of liquid methane instead of water may bubble to the surface. And what may well be a coastline of sorts, where rivers or streams of liquid methane flow down hills of ice to a broad dark region below.
- 15:40 At last Huygens comes to rest, with more of a splat than a thud or a splash, indicative of a surface with the consistency of wet sand. Its batteries running low, Huygens still remains active for another few hours, recording a surface temperature near 300 degrees below zero Fahrenheit, wafts of methane gas on a light breeze, a landscape of orange colored chunks of ice under an orange sky.

7. SATURN'S MOONS

- 16:19 As Huygens' mission draws to a close, that of Cassini has barely begun. For at least the next 3 and a half years, Cassini will tour the Saturnian system.
- 16:44 Cassini routing calls for several close calls past Enceladus where giant ice volcanoes or geysers may resurface the landscape and even blast particles far into space to be captured by, and replenish Saturn's outer ring.
- 17:06 Already, close passes have transformed what previously appeared to be smooth plains on Enceladus into a varied landscape. Here, rope-like ridges up to a half-mile high suggest places where water from the interior has escaped and frozen on the surface. Elsewhere, we see a myriad of large faults, fractures, folds, crevasses and troughs, evidence of a dynamic geological history.
- 17:45 Past Rhea, a cratered world with mysterious wispy, white streaks – perhaps snow exuded from fractures in its frozen crust.
- 18:00 And Dione, another heavily cratered ice moon, also showing curious wisp-like features
- To Tethys, where Ithaca Chasma, an ice canyon 60 miles wide and up to 3 miles deep, cracks this moon nearly pole to pole
- Past Mimas, with a crater so large -- its birth almost shattered this moon to bits.
- Over potato-shaped Hyperion, home to amazing ice cliffs over 6 miles high.
- 18:56 Cassini has also had its first close look at Iapetus, a satellite with one face as black as asphalt And the other as white as newly fallen snow. Bisecting Iapetus' dark side, Cassini has discovered an incredible ridge of ice that runs over 800 miles along the moon's equator and contains mountains three times as high as Everest.

8. RING RESEARCH

- 19:33 Cassini will also study Saturn's magnificent rings -- nearly 200,000 miles from edge to edge, yet no more than a hundred feet thick!
- From a distance, the rings look solid. But, in reality, they are an enormous blizzard of millions upon millions of pieces of ice that range in size from grains of sand to boulders larger than a house. Each races around Saturn in a separate orbit at speeds up to 50,000 miles per hour.
- 20:16 Other orbits will take Cassini on rare excursions high above the rings. From such a vantage point, Cassini will be able to study curious, dark spoke-like features in Saturn's broad B ring that were first discovered by Voyager. Could

these "spokes" be dust particles suspended above the ring and swept along by Saturn's magnetic field? Cassini may provide the answer.

In addition, light from selected stars will be scanned as they blink on and off through the intervening rings. From such periodic tracings, scientists will gather valuable information on the size distribution of icy chunks and particles within the rings and how the rings change over time.

9. ENDING

21:29

Exotic worlds lie at our doorstep. Now, they are opening to us like never before and we can only wonder what new wonders still lie ahead.

And, in the center of it all Saturn. Framed by rings of glistening ice. Thanks to Cassini/Huygens, and the dedicated work of hundreds of scientists and engineers, we are there.

And the exploration continues.

Credits