



## **SATURN, THE RING WORLD**

**Houston Museum of Natural Science**

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Five, four, three, two, one, zero .....lift-off. We have lift-off.

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!

### **BEFORE CASSINI**

*Observatory* 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 - - to bridge the gap ... and go there!

*Voyager II* 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.

*Collages* 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.

### **THE JOURNEY TO SATURN**

*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 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.

## **JUPITER ENCOUNTER**

*GALILEO* 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.

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.

## **SATURN APPROACH**

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.

## **CASSINI AT TITAN**

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 ...

15 minutes 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 rich in organic compounds that may hold secrets to the evolution of life on our planet.

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.

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.

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.

Finally ... the surface. Will Huygens discover multi-colored dunes of hydrocarbon "snows"? ... lakes or seas of liquid ethane and methane? or an even more exotic world? Soon, we will know as Titan gives up its secrets.

## **SATURN'S MOONS**

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. Cassini will sail 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.

Past Rhea, a cratered world with mysterious wispy, white streaks – perhaps snow exuded from fractures in its frozen crust. 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. And Iapetus, a satellite with one face as black as asphalt .... And the other as white as newly fallen snow.

## **RING RESEARCH**

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. Cassini will focus in on the mysterious F-ring that appears to periodically braid and unbraid like a girl's hair.

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.

## **ENDING**

Exotic worlds lie at our door step. Soon, they will be opened to us like never before and we can only wonder what new wonders we shall soon behold And, in the center of it all .... Saturn. Ancient god; Magnificent celestial jewel; Object of intense fascination ... to artists, poets, and scientists alike. Soon ... we will return ... this time ... to stay.