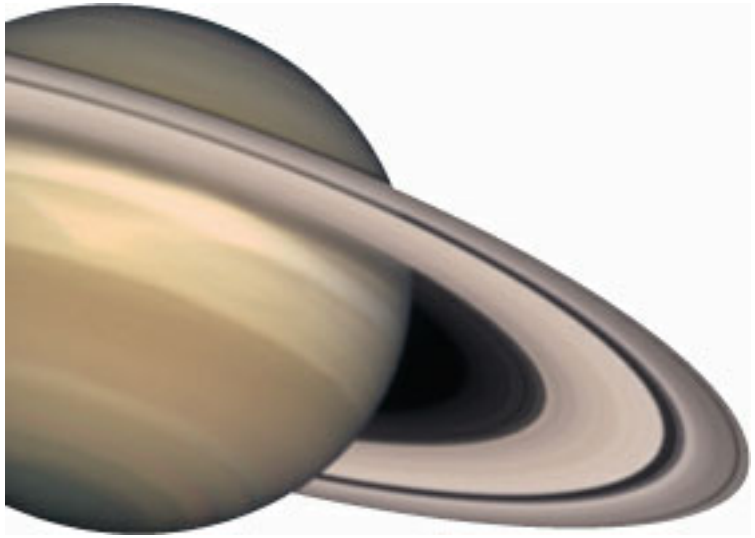
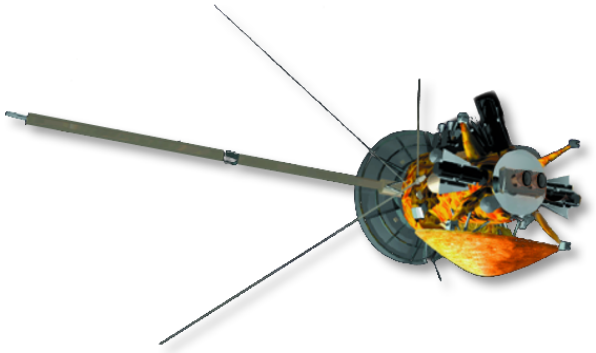


Cassini-Huygens

Mission to the Saturn System



CASSINI

MISSION TO SATURN

The Destination

Saturn is best known for its magnificent ring system. But the Saturn system is a unique environment combining rings, moons, and the planet.

Saturn Facts

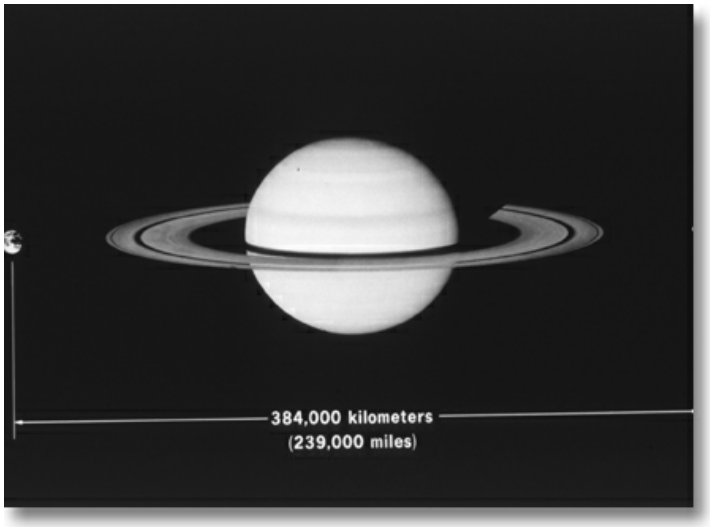
- Saturn is the second largest planet in the Solar System.
- Titan, the largest moon, has a thick nitrogen-rich atmosphere.
- Saturn emits 79% more energy than it receives from the Sun.
- Saturn receives 1/90th the amount of sunlight Earth receives.

CASSINI
MISSION TO SATURN

Saturn and Earth Compared

If you placed Saturn and its main rings (excluding the diffuse E-ring) between The Earth and the Moon, Saturn would barely fit.

Earth-Moon distance = 384,000 km (239,000 miles)
Saturn and ring system diameter =340,000 km (211,310 miles)



CASSINI

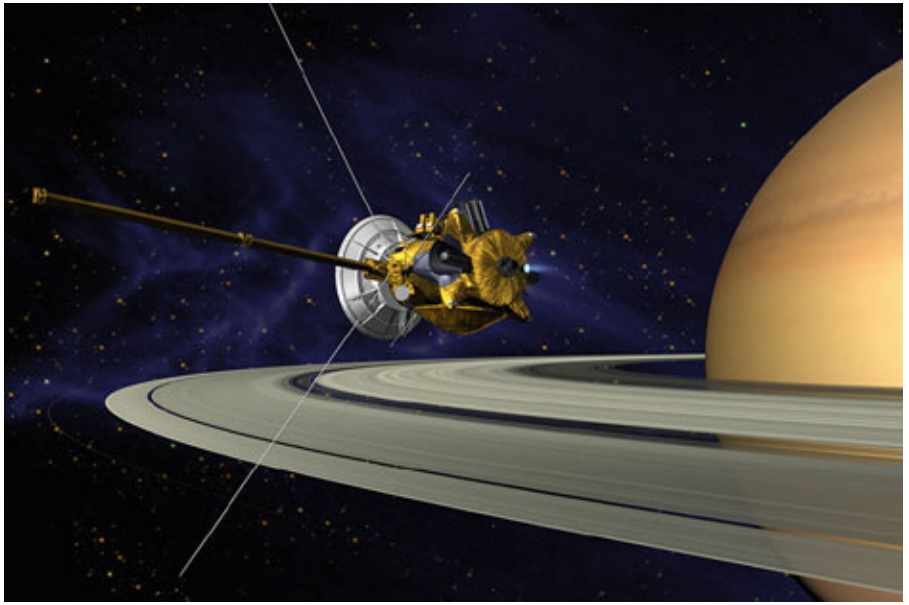
MISSION TO SATURN

Tour Highlights

Cassini will spend 4 years orbiting the Saturn system. During that time, the spacecraft will make 75 orbits about the planet and 45 flybys of Titan.

Some of the exciting events early in the Saturn tour include:

Phoebe encounter - 11 June 2004 (closest approach is 2,000 km, 1243 miles)
Saturn Orbit Insertion - 1 July 2004
Huygens Probe Release -
25 December 2004
Huygens Probe Mission -
14 January 2005

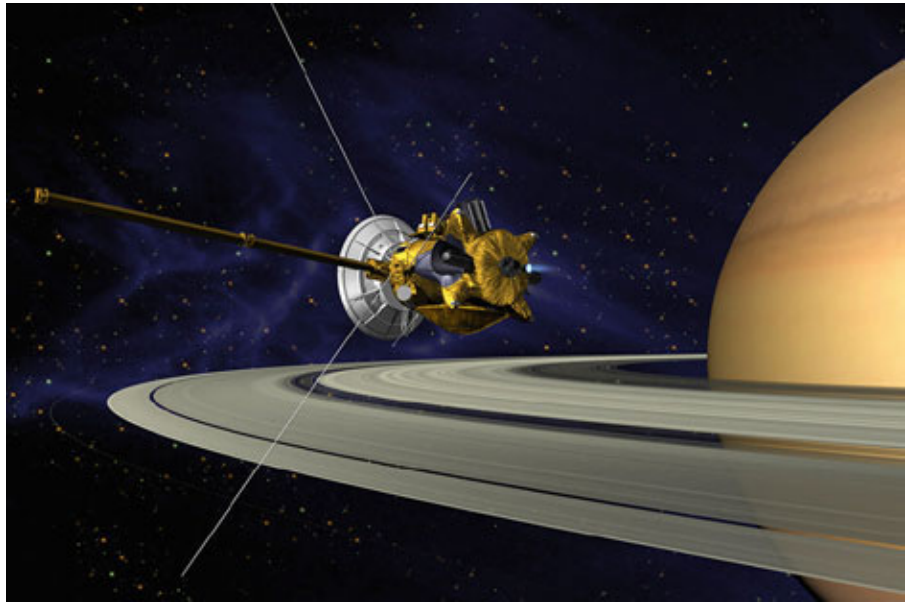


Saturn Orbit Insertion

Date: 1 July 2004
Approach is from below the ring plane.
Ascending Ring Plane Crossing at 158,500 km (98,508 miles) from Saturn
1 hour, 52 minutes before periapsis (closest approach)

Cassini crosses the ring plane between the F- and G-rings.

Burn Ignition: 01:12 UTC
(6:12pm Pacific Time on 30 June)
Burn Duration = 97 minutes
Burn Termination: 03:03 UTC
(8:03pm Pacific Time on 30 June)
Velocity Change = 632 m/sec
(approximately 1414 mph)



CASSINI

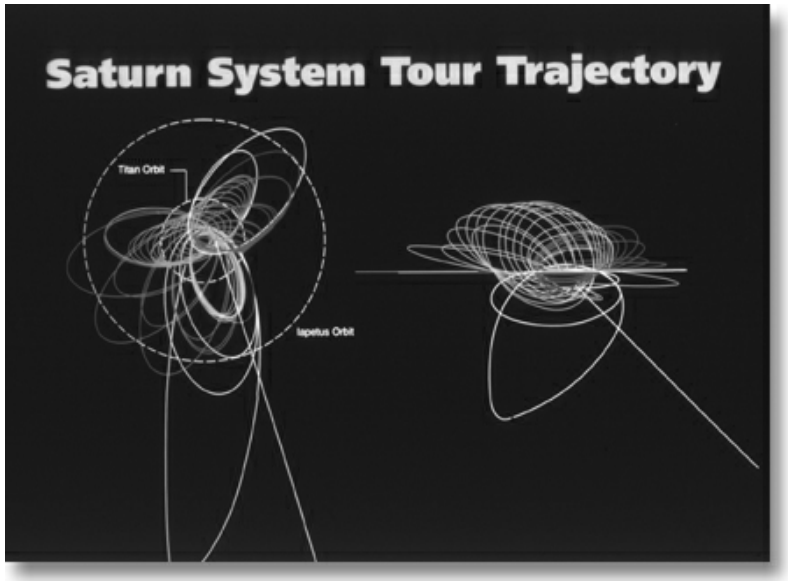
MISSION TO SATURN

Touring Saturn

During the 4-year tour, Cassini will make 75 orbits of Saturn, using Titan to turn the spacecraft's orbit.

Orbits will range in length from 7 to 118 days.

Cassini's orbital distance from Saturn will range from 156,858 km to 953,214 km (98,036- 592,422 miles). The spacecraft's orbit will change orientation from equatorial to an inclination of approximately 75°. This allows scientists to study Saturn's polar regions.



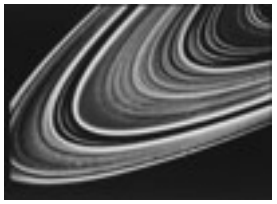
CASSINI

MISSION TO SATURN

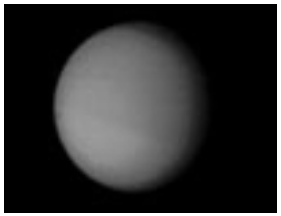
Science Targets

Cassini's 5 groups of science objectives at Saturn are:

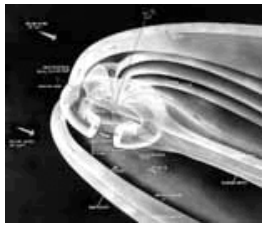
Saturn - the planet and its atmosphere



Saturn's extensive Rings



Titan



Magnetosphere

Icy Satellites

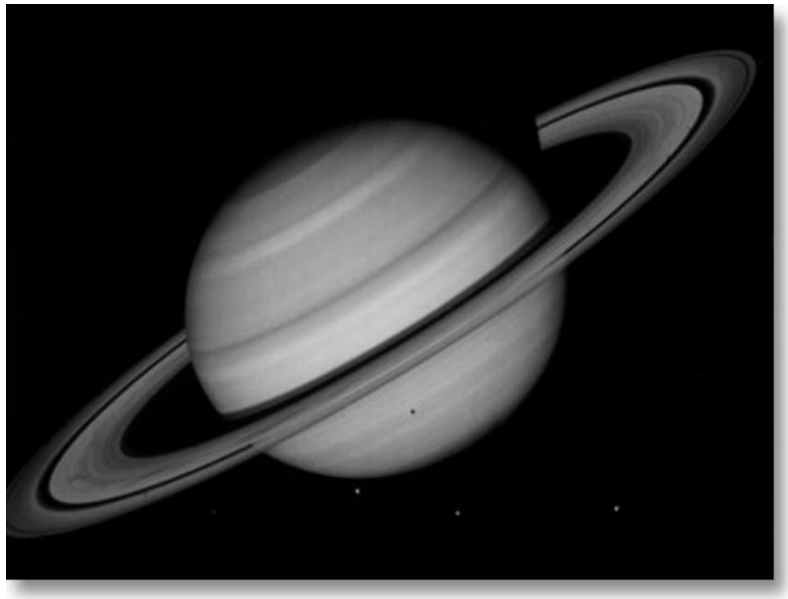
CASSINI

MISSION TO SATURN

Saturn Science Objectives

Saturn Science Objectives:

a) Determine the temperature field, cloud properties, and composition Saturn's atmosphere.
b) Measure the global wind field, including wave and eddy components; observe synoptic cloud features and processes.
c) Infer the internal structure and rotation of the deep atmosphere.
d) Study the diurnal variations and magnetic control of the ionosphere of Saturn.
e) Provide observational constraints (gas composition, isotope ratios, heat flux) on scenarios for the formation and the evolution of Saturn.
f) Investigate the sources and the morphology of Saturn lightning (Saturn Electrostatic discharges and lightning whistlers).



CASSINI

MISSION TO SATURN

Saturn Physical Facts

Saturn is the sixth planet from the Sun, orbiting at an average distance of 9.54 astronomical units (1429.4 million kilometers or 888 million miles).

Saturn receives approximately 1/90th the amount of sunlight the Earth receives.

Saturn physical facts:
Diameter = 120,660 km (75,412 miles)
- compare to Earth (12,756 km)
Mass = 569×10^{24} kg
(95 times more massive than Earth)
Rotation Period = 10 hours and 40 minutes

CASSINI
MISSION TO SATURN

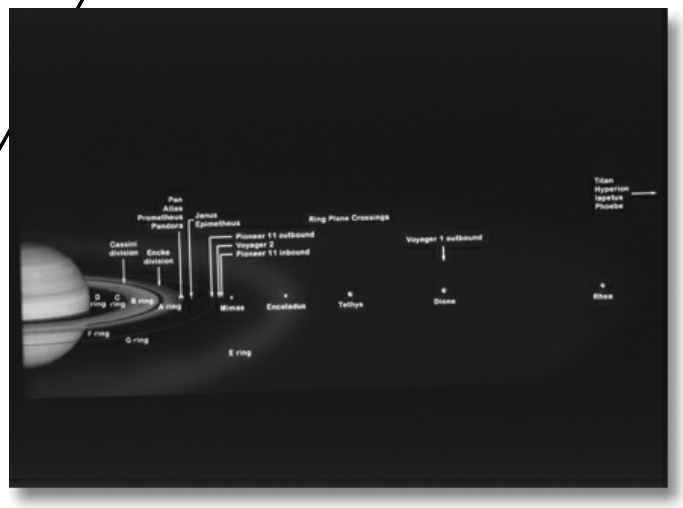
Saturn's "Road Map"

The order of the rings and moons, starting with the closest to Saturn, is:

Saturn
D-Ring
C-Ring
B-Ring
Cassini Division
A-Ring
Encke Division
Pan
Atlas
Prometheus
Pandora
F-Ring

Epimetheus
Janus
G-Ring
Mimas
E-Ring
Enceladus
Tethys
Telesto
Calypso
Dione
Helene
Rhea

Titan
Hyperion
Iapetus
Phoebe
New Satellites



CASSINI

MISSION TO SATURN

Saturn's Atmosphere

Saturn's primary atmospheric contents are:

Hydrogen (94%)

Helium (6%)

In addition, there are traces of ammonia, methane, ethane, phosphine, acetylene, methylacetylene, and propane.

Did you know?

What makes those colorful golden bands in Saturn's upper atmosphere?

---Ammonia ice crystals

CASSINI
MISSION TO SATURN

Saturn's Wild Winds

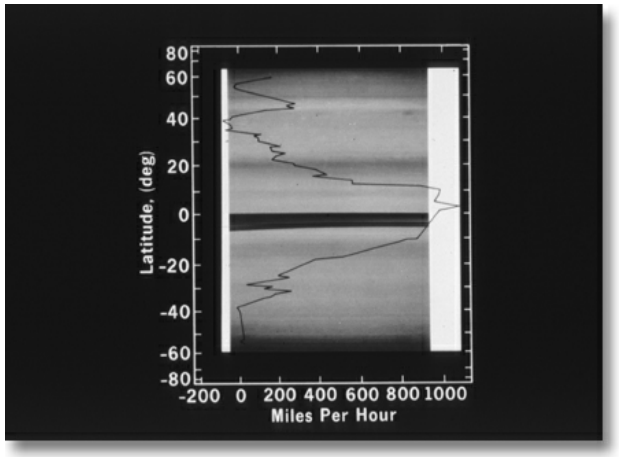
Saturn has the second fastest measured winds in the Solar System.
Only Neptune has faster winds.

Wind speeds at similar latitudes north and south of the equator are nearly the same.

Equatorial Speeds: blow to the East at 500 meters/second (1,100 miles per hour)

How fast is that?

•A jet airplane travels at an average speed of 550 miles per hour.
•The strongest hurricane (cyclone) winds top out at about 220 miles per hour.
•A tsunami travels along the open water at 550 miles per hour.
•The speed of sound is 660 miles per hour at 30,000 feet.



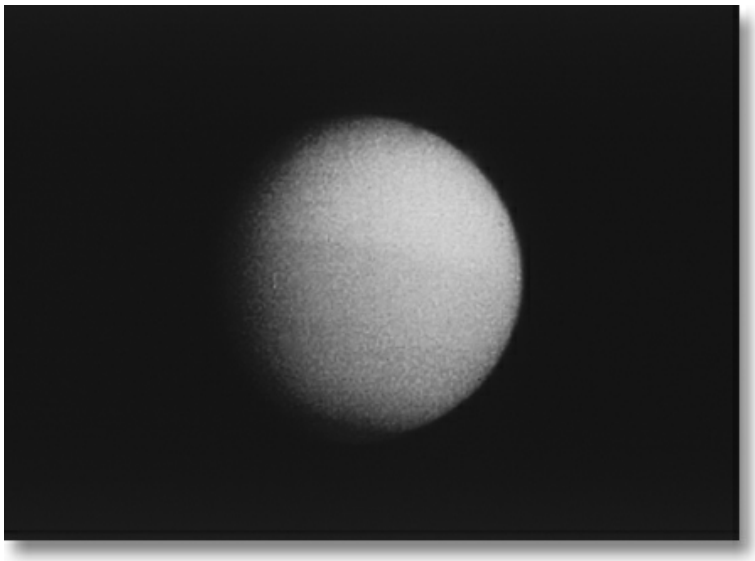
CASSINI

MISSION TO SATURN

Titan Science Objectives

Titan Science Objectives:

a) Determine the abundance of atmospheric constituents (including any noble gases), establish isotope ratios for abundant elements, constrain scenarios of formation and evolution of Titan and its atmosphere.
b) Observe vertical and horizontal distributions of trace gases, search for more complex organic molecules, investigate energy sources for atmospheric chemistry, model the photochemistry of the stratosphere, study formation and composition of aerosols.
c) Measure winds and global temperatures investigate cloud physics, general circulation, and seasonal effects in Titan's atmosphere; search for lightning discharges.

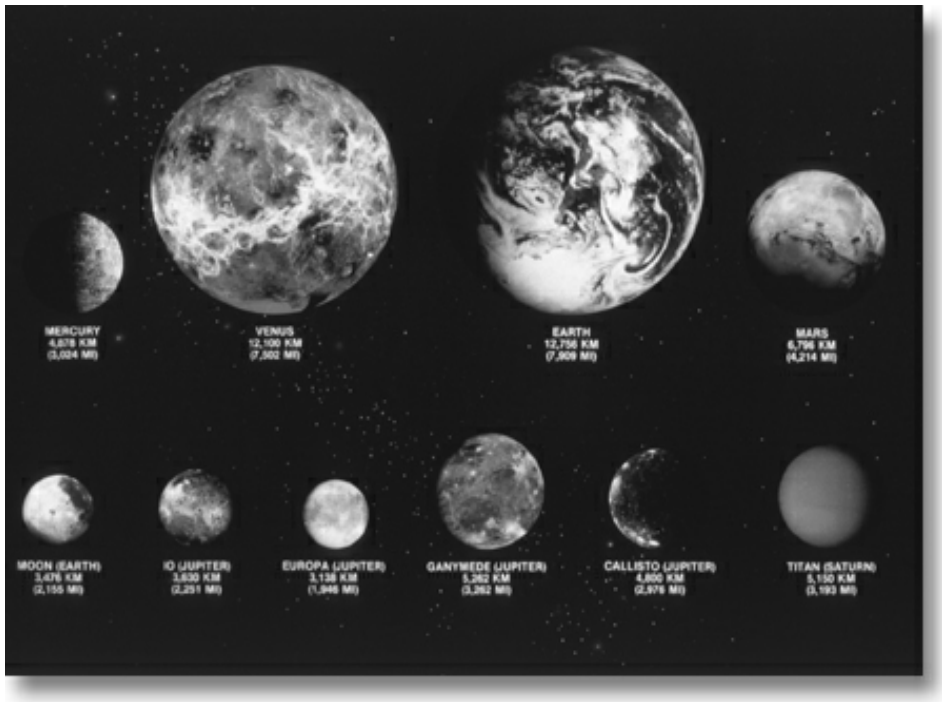


CASSINI
MISSION TO SATURN

Titan Physical Facts

Titan has a thick atmosphere that is primarily composed of Nitrogen.

Nitrogen ~ 95%
Methane ~ 5%
traces of hydrocarbons and
hydrogen cyanide



Distance from Saturn = 1,222,000 km
(759,478 miles)
Orbital Period = 15.94 days
Diameter = 5150 km (3200 miles)
40% the diameter of Earth
Surface Temperature = 95° Kelvin
(-178° C, -288° F)

Did you know?

Titan has a larger diameter than Mercury or Pluto.

CASSINI
MISSION TO SATURN

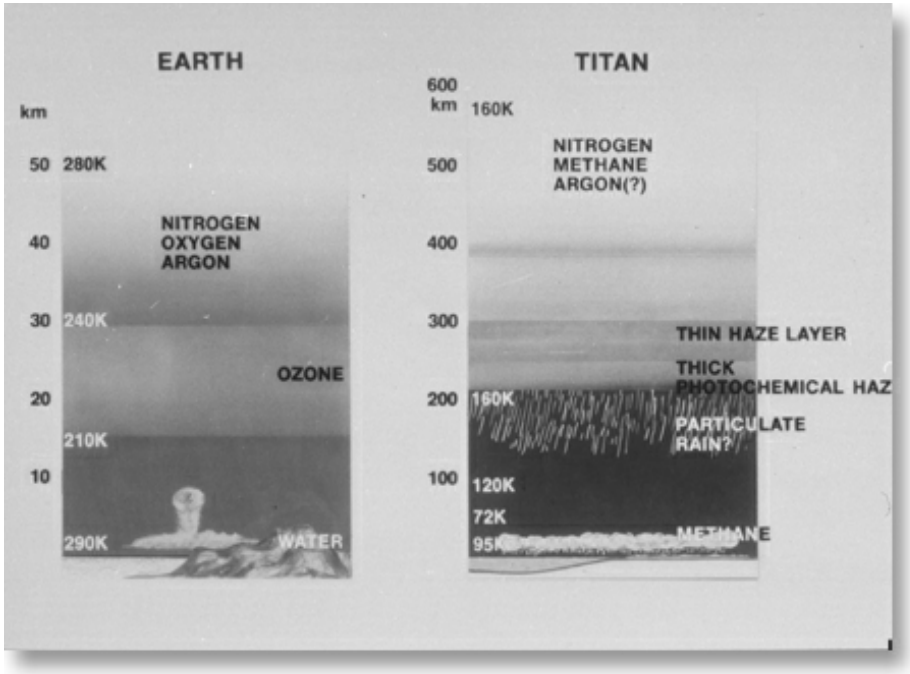
Titan and Earth

While Titan is only 40% the diameter as Earth, its atmosphere extends 10 times higher into space than Earth's atmosphere.

Titan's atmosphere is composed primarily of nitrogen (90-97%) and methane (2-10%).

Earth's atmosphere is composed primarily of nitrogen (78%) and oxygen (21%).

Of course the surface temperature on Titan is a chilling 95°K (-178°C or -288°F) compared to Earth's balmy 290°K (17°C or 63°F)



CASSINI

MISSION TO SATURN

Huygens Probe Release

The Huygens Probe has no onboard thrusters. Therefore, both the orbiter and the probe will be placed on a collision course with Titan.

The probe release is scheduled for 24 December 2004

3 days following the probe release, the orbiter will perform an orbit deflection maneuver, moving the spacecraft off its collision course with Titan and placing it on the correct trajectory to relay the probe data to Earth.

The probe will continue its 21 day journey to Titan, arriving at the moon on 14 January 2005.

CASSINI
MISSION TO SATURN

The Probe's Descent to Titan

Descent

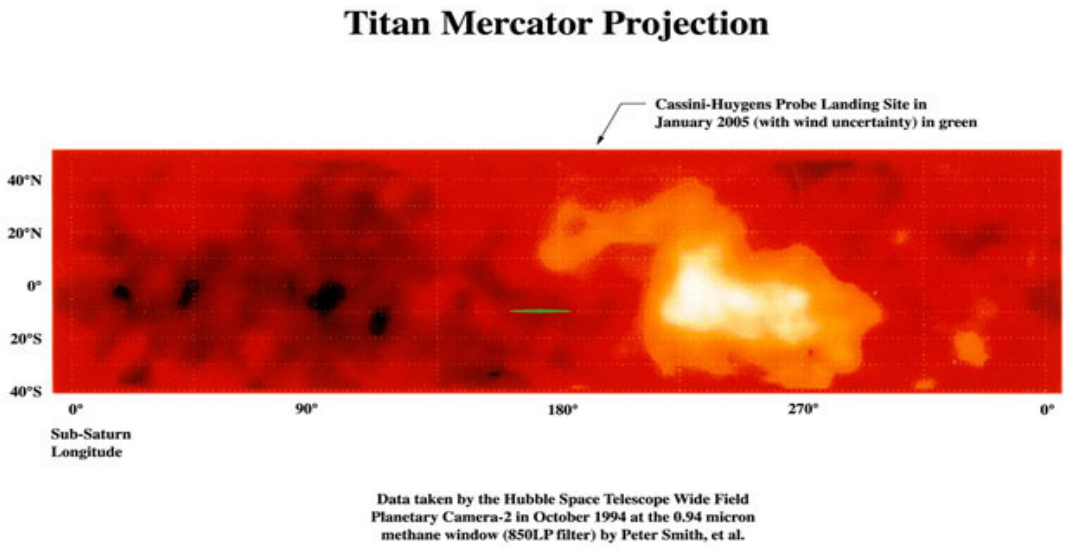
As the probe enters Titan's atmosphere and slows, a small parachute is released which deploys the main probe parachute. Once the parachute is fully open, the decelerator shield is jettisoned and the probe drifts toward Titan's surface. About 40 kilometers (24.86 miles) above the surface the main chute is jettisoned and a smaller drogue chute carries the probe the remaining distance.

Descent time = 2.5 hours
Impact Speed = 15 miles per hour or 7 m/sec
(comparable to a skydiver landing
with an open parachute)
Surface collection time = 30 minutes

CASSINI
MISSION TO SATURN

Landing Location

While mathematics allow us to pin down the latitude of Huygens' landing location, we cannot identify the landing longitude so accurately. This is because we do not have a good understanding of the prevailing winds on Titan.



Landing Location: -10° latitude (±0.7°), 160° E longitude (±13°)

CASSINI

MISSION TO SATURN

Why such a short mission?

The environment on Titan's surface is very cold (temperatures on the surface average 95° Kelvin which is -178 C, -288° F) and the batteries are not expected to last longer than a couple of hours in those conditions.

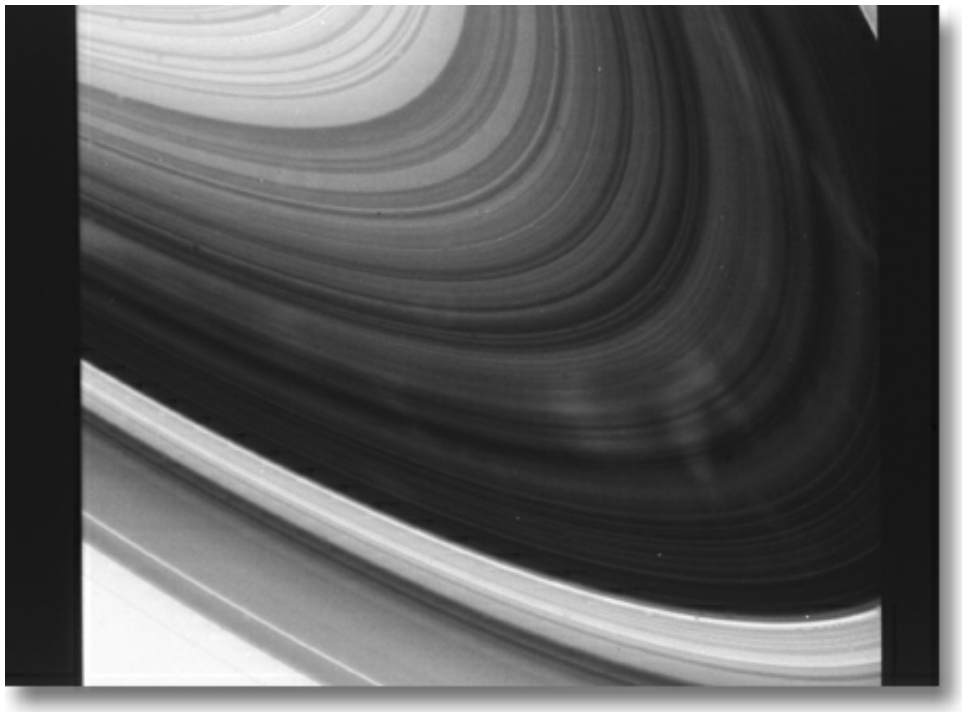
The probe will use the Cassini Orbiter as a relay station back to Earth. All the science data Huygens collects will be transmitted directly to Cassini. Once the Cassini Orbiter dips below Huygens' horizon, the probe and the orbiter will no longer be able to communicate with each other. By the time the orbiter returns to Titan, many months will have passed and the probe's systems will be frozen.

CASSINI
MISSION TO SATURN

Rings Science Objectives

Rings Science Objectives:

a) Study the configuration of rings and dynamical processes (gravitational, viscous, erosional, and electromagnetic) responsible for ring structure.
b) Map composition and size distribution of ring material.
c) Investigate interrelation of rings and satellites, including imbedded satellites.
d) Determine dust and meteoroid distribution in the vicinity of the rings.
e) Study interactions between the rings and Saturn's magnetosphere, ionosphere, and atmosphere.

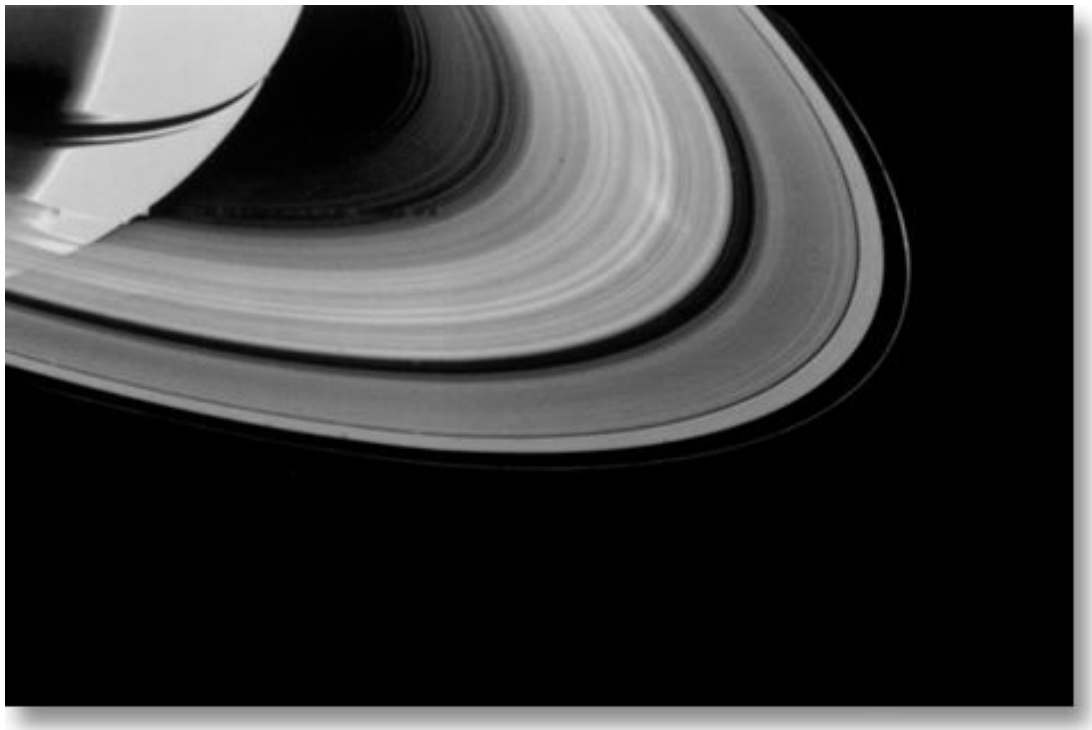


CASSINI

MISSION TO SATURN

Saturn's Magnificent Rings

Saturn's rings are made primarily of water ice. False color images of Saturn's rings show different colors that illustrate some of the possible variations in chemical composition.

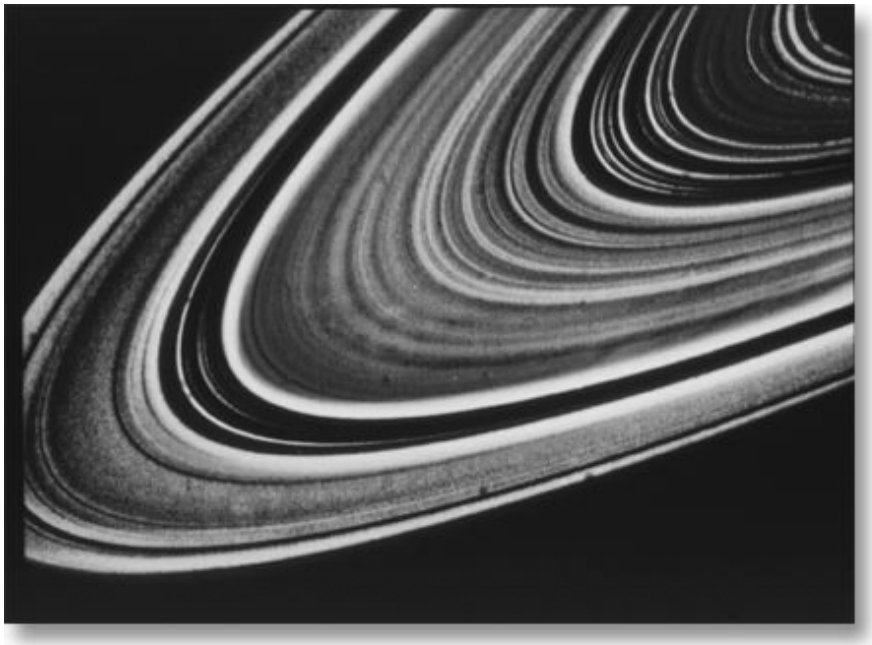


Did you know?
Typical ring particle sizes range From micrometers (roughly the size of cigarette smoke) to ice boulders larger than tens of meters.

Cassini's Ring Focus

The mission will focus on four critical questions:

- How did the rings form?
- How old are the rings?
- How are the rings maintained?
- What are the dynamics and relationships of the rings to Saturn, its satellites, and its electromagnetic fields?



Icy Satellite Objectives

Icy Satellites Objectives:

a) Determine the general characteristics and geological histories of the satellites.
b) Define the mechanisms of crustal and surface modifications, both external and internal.
c) Investigate the compositions and distributions of surface materials, Particularly dark, organic rich materials and low melting point condensed volatiles.
d) Constrain models of the satellites' bulk compositions and internal structures.
e) Investigate interactions with the magnetosphere and ring systems and possible gas injections into the magnetosphere.

CASSINI

MISSION TO SATURN

Icy Satellite Facts

The term “icy satellites” serves to separate Titan from the other, smaller moons.

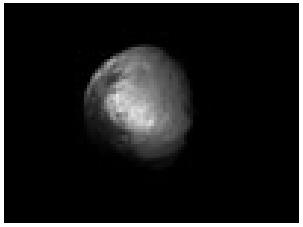
Before 2000, Saturn had 17“icy satellites”. Today there are 29 recognized “icy satellites” of Saturn.

- The original 17 are named after figures in Greek and Roman mythology.
- The 12 new additions carry temporary names.

Did you know?
16 of Saturn’s satellites rotate synchronously (they always show the same face toward Saturn just like Earth’s Moon does).

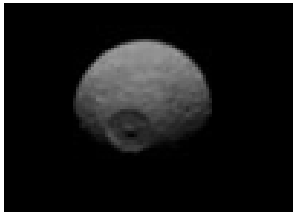
CASSINI
MISSION TO SATURN

Icy Satellite Highlights



Iapetus - with one hemisphere extremely reflective and the other as dark as black velvet, this satellite has a split personality.

Enceladus is very bright and may re-supply the E-ring with materials through water eruptions.

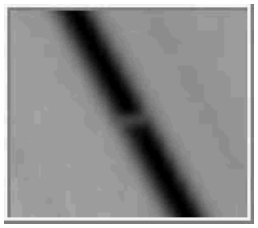


Mimas has an enormous crater on one side hat nearly split the satellite apart.

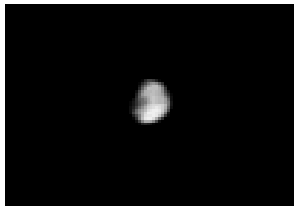
CASSINI
MISSION TO SATURN

More Unique Satellites

Hyperion has an odd shape (like a hamburger patty) and rotates chaotically due to the gravitational influence of Titan.



Tiny Pan orbits within Saturn's A-ring and helps clear the Encke Gap of material.



Phoebe does her own thing taking 550 days to orbit the planet. And that orbit is retrograde meaning she travels backward to her neighbors.

CASSINI
MISSION TO SATURN

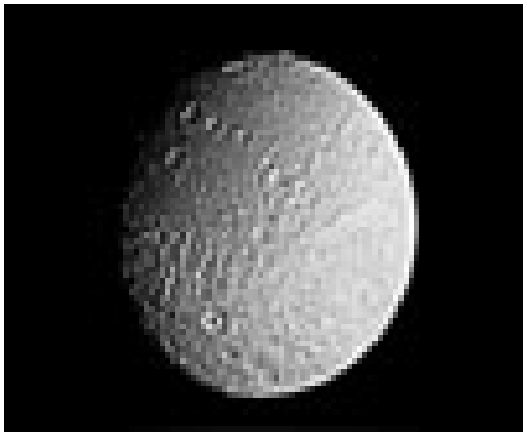
Lagrangian Satellites

Lagrangian satellites are pairs of moons that share an orbit. A small satellite orbits in the Langrangian point of a larger satellite.

Lagrangian points are locations within an object's orbit where a less massive body can move in an identical, stable orbit.

Lagrangian points lie 60° ahead or behind the larger satellite.

Which are the Lagrangian Satellites of Saturn?
Helene is the Lagrangian satellite of Dione
Calypso and Telesto are Lagrangian satellites of Tethys.

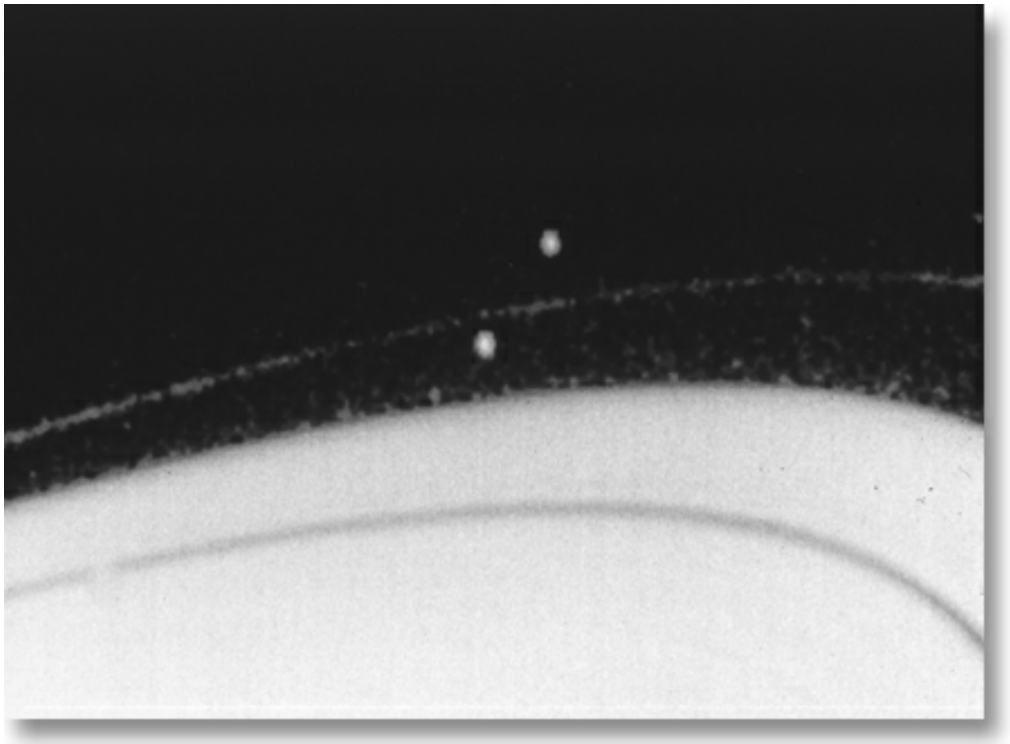


Tethys

CASSINI
MISSION TO SATURN

Shepherd Satellites

Shepherd Satellites help constrain the ring material, helping define the edges of the rings they orbit with.



Atlas lies several hundred kilometers from the outer edge of the A-ring.
Prometheus and Pandora orbit on opposite sides of Saturn's F-ring.

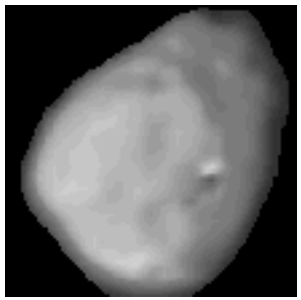
Did you know?
16 of Saturn's moons, including Titan and Iapetus, rotate synchronously (they always show the same face toward Saturn just like Earth's moon does).

CASSINI
MISSION TO SATURN

Co-orbital Satellites

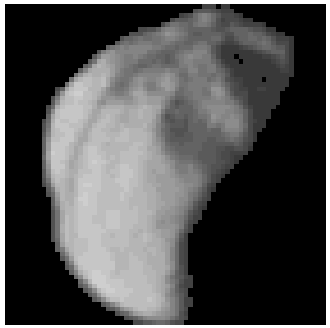
Janus and Epimetheus move in almost identical orbits at about two and one-half Saturn radii. This is 151,000 kilometers (94,375 miles).

They are called “co-orbital” satellites because of this.



Janus

Epimetheus



Did you know?

Because Epimetheus orbits slightly faster than Janus, Epimetheus overtakes Janus In their orbit once every four years.

Magnetospheres Objectives

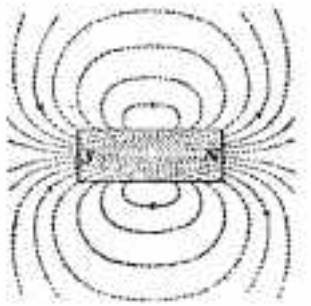
Magnetospheres Objectives:

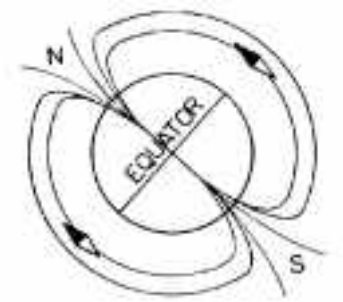
a) Determine the configuration of the nearly axially symmetric magnetic field and its relation to the modulation of Saturn Kilometric Radiation (SKR)
b) Determine current systems, composition, sources, and sinks of magnetospheric charged particles
c) Investigate wave-particle interactions and dynamics of the day-side magnetosphere and the magnetotail of Saturn and their interactions with the solar wind, the satellites, and the rings.

CASSINI
MISSION TO SATURN

Magnetosphere Facts

Magnetic fields such as those of Earth and Saturn are approximated by a dipole (a simple structure with a north and south pole like a bar magnet).





There is no measurable off-set between the magnetic dipole and Saturn's rotation axes. This is unique in the Solar System (by comparison, Earth's magnetic field is off-set from the rotation axis by 11.4°).

What is a magnetosphere?

Saturn generates a magnetic field that shields the planet, its rings, and moons from the solar wind. This shield is called a "magnetosphere."