

UNVEILING
THE MYTH OF

Saturn

Blending the Old and New

The Cassini mural is a wonderful depiction of the mythological story of Saturn combined with images of space-age exploration. In the upper left, the Roman god Saturn (the ancient symbol of time), is drawing back a veil to allow the Cassini spacecraft to reveal the mysteries of the sixth planet. In the center of the image, the Cassini spacecraft is seen firing its main engine to brake into orbit around Saturn on July 1, 2004. Beneath the spacecraft, the rings unfold as a vast sheet of orbiting particles.

In the lower left of the image, the Huygens probe is descending into the atmosphere of Titan, Saturn's largest moon. In the foreground, the orbiter points its large high-gain antenna toward Titan, collecting probe data for relay back to Earth.

Creativity in Action

The Cassini mural was painted by eight young master painters at an art academy in east Los Angeles, California. The academy — the Academia de Arte Yepes — gives promising young Hispanic painters an opportunity to develop their talents and skills at mural design without being burdened with tuition costs, while maintaining their normal home, school, and community duties. Working with Cassini Project personnel, the painters created a mural that is a stunning blend of art and science. The eight artists were Ulysses Garcia (lead artist), Gabriel Estrada, Abel Gonzales, Daniel Gonzales, Octavio Gonzales, Francisco Vasquez, Juan Solis, and Rebeca Robles.

Cassini Mission to Saturn

Unveiling Saturn's Scientific Mysteries

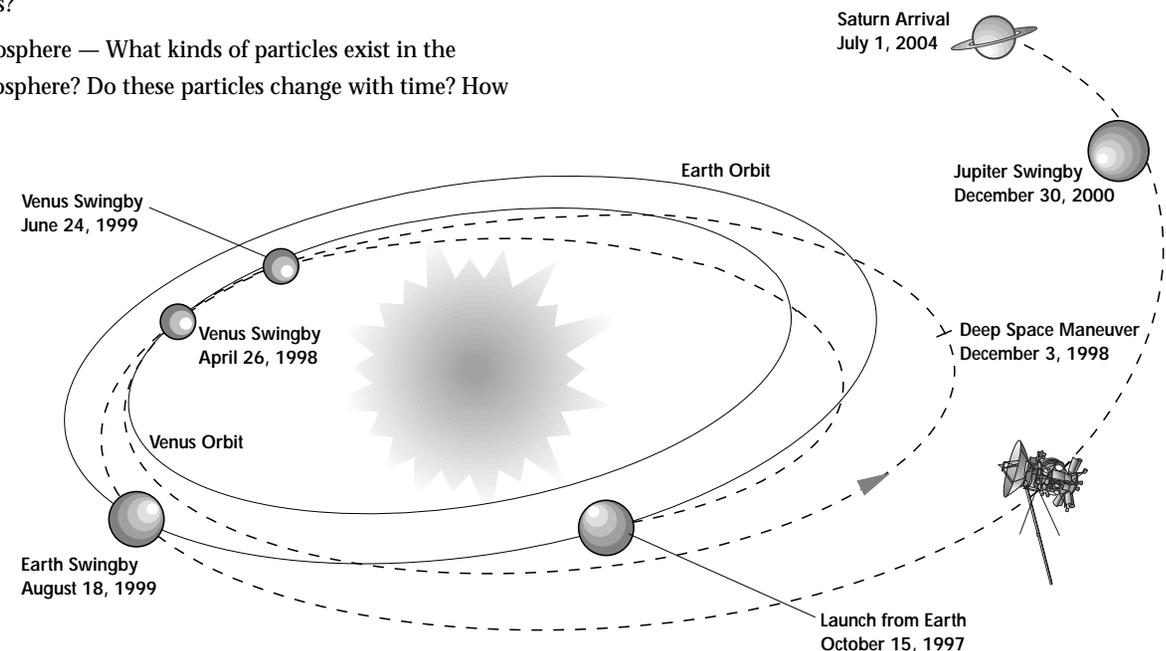
Cassini will spend four years in orbit around the sixth planet from the Sun, studying all aspects of the Saturn system. Some of the scientific questions Cassini will address include:

- Saturn — What is the nature of the atmosphere below the cloudtops? How do Saturnian storms start and die out? How do the polar regions differ from the equator? What is Saturn's interior like?
- Titan — What is Titan's surface like? Is there liquid on the surface? Does it rain? What are Titan's wind speeds and directions? How much sunlight reaches the surface? Could life ever exist there?
- Rings — What, aside from ice particles, makes up the rings? How big and how small are ring particles? How do rings form and change? Are there more moons hidden in the rings?
- Icy satellites — How did these moons form and evolve? Why do some moons share the same orbits? Why is Iapetus half bright and half dark? Are some of the moons captured asteroids?
- Magnetosphere — What kinds of particles exist in the magnetosphere? Do these particles change with time? How

does the magnetosphere interact with the rings and moons? Why is Saturn's magnetic field orientation different from that of the other planets?

Getting There Is Half the Fun

On October 15, 1997, the Cassini spacecraft began its journey to Saturn. Cassini was launched aboard a Titan IV B with a solid rocket motor upgrade (SRMU). This is the largest expendable launch vehicle in the U.S. fleet, capable of lifting 5,770 kilograms (12,700 pounds) into low-Earth orbit. Even using a launch vehicle with such a large lift capability, the spacecraft was too heavy to go directly to Saturn. The spacecraft was launched onto a path that takes it past three planets — Venus (twice), Earth, and Jupiter. Using the gravity of the planets to change the speed and direction of the spacecraft, these "swingbys" supply about the same amount of rocket power as the Titan launcher has, while using very little of Cassini's onboard rocket fuel. Cassini arrives at Saturn on July 1, 2004.



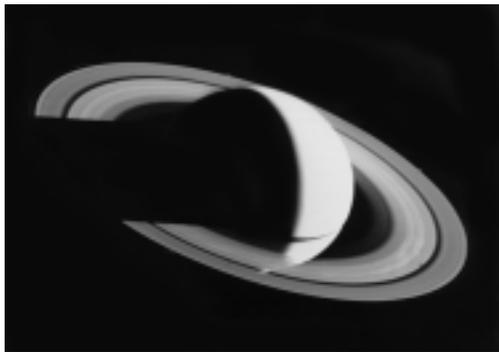
The Cassini Spacecraft

A Flying Science Laboratory

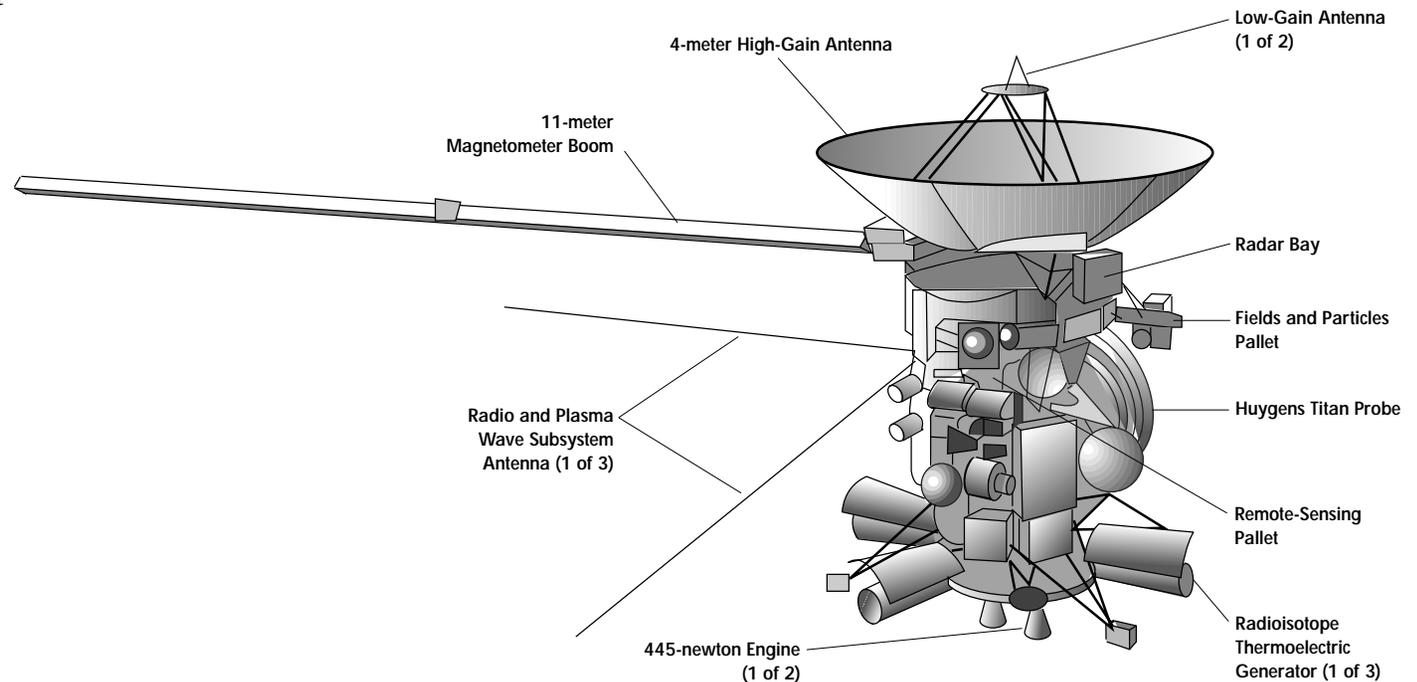
The Cassini orbiter and Huygens probe are designed to conduct a series of scientific investigations of the planet Saturn, its rings, magnetosphere, icy satellites, and Titan (Saturn's largest satellite). The mission is a joint effort of the National Aeronautics and Space Administration (NASA), the European Space Agency (ESA), and the Italian Space Agency (ASI). The Cassini mission is managed for NASA by the Jet Propulsion Laboratory (JPL), California Institute of Technology.

Data will be collected using a variety of instruments. All together, the Cassini orbiter carries 12 science investigations and the Huygens probe carries six science investigations. In addition to the science instruments aboard Cassini, the spacecraft contains solid-state (chip) recorders for data collection and storage, computers to process commands sent from Earth and to conduct spacecraft operations, navigation equipment, communications equipment, propellant to keep the spacecraft on the desired flight path, power sources to operate all the onboard electronics, and a host of other engineering support equipment. In total, there are 12 engineering subsystems on the spacecraft. As a result, the spacecraft is very large. When Cassini was launched, it weighed 5,574 kilograms (12,263 pounds). Cassini stands over 22 feet tall — comparable in size to a small school bus.

| Cassini Orbiter Investigation | Area of Study at Saturn |
|---|---|
| Cassini Plasma Spectrometer (CAPS) | Explores plasma within and near Saturn's magnetic field. |
| Composite Infrared Spectrometer (CIRS) | Studies temperatures and compositions of Saturn and its moons and rings. |
| Cosmic Dust Analyzer (CDA) | Studies ice and dust grains in and near the Saturn system. |
| Dual Technique Magnetometer (MAG) | Studies Saturn's magnetic field and its interactions with the rings, the moons, and the solar wind. |
| Imaging Science Subsystem (ISS) | Takes pictures in visible, near-ultraviolet, and near-infrared light. |
| Ion and Neutral Mass Spectrometer (INMS) | Studies extended atmospheres and ionospheres of Saturn, Titan, and icy satellites. |
| Magnetospheric Imaging Instrument (MIMI) | Takes images of the distribution of charged particles in and near Saturn's magnetic field. |
| Radar | Maps the surface of Titan and measures the height of its surface features. |
| Radio and Plasma Wave Science (RPWS) | Investigates plasma waves, natural emissions of radio energy, and dust. |
| Radio Science Subsystem (RSS) | Searches for gravitational waves; measures masses and structures of atmospheres. |
| Ultraviolet Imaging Spectrograph (UVIS) | Studies structure, chemistry, and composition of atmospheres, surfaces, and rings. |
| Visual and Infrared Mapping Spectrometer (VIMS) | Identifies chemical composition of atmospheres, surfaces, and rings. |



Saturn casts a shadow across the rings. Image taken in November 1980 by Voyager 1.



The Huygens Probe

Mission to Saturn's Largest Moon

The Huygens probe was built and is managed by the European Space Agency. The probe's six science investigations are designed to study the atmosphere and surface of the moon Titan by conducting detailed measurements. The Huygens probe weighs 350 kilograms (770 pounds), and the heat shield is 2.7 meters (8.9 feet) in diameter.

Free-Falling to Titan

Huygens does not carry any rocket motors. On December 25, 2004 — during Cassini's third orbit around Saturn — the Huygens probe will be released from the orbiter and coast for 20 days before reaching Titan. The probe will enter Titan's atmosphere at a speed in excess of 6 kilometers (3.73 miles) per second. A rounded, conical heat shield protects the probe during its entry and initial slowing in Titan's atmosphere. The heat shield is then released and a pilot parachute deploys that will slow down the probe.

Less than two minutes after entering Titan's atmosphere, the probe's speed will slow to 400 meters (1,312.3 feet) per second. At this point, the pilot parachute and aft cover are released and the main parachute, which measures 8.3 meters (27.23 feet) in diameter, is deployed.

The main parachute is too large to allow the probe to reach the surface before Huygens' batteries wear out. Therefore, after 15 minutes, the main parachute is jettisoned and a 3-meter-diameter (9.84-foot-diameter) stabilizer parachute is deployed. The probe will reach the surface about 2.5 hours after entering Titan's atmosphere.

Huygens Probe Investigation

Aerosol Collector and Pyrolyser (ACP)

Descent Imager/Spectral Radiometer (DISR)

Doppler Wind Experiment (DWE)

Gas Chromatograph/Mass Spectrometer (GCMS)

Huygens Atmospheric Structure Instrument (HASI)

Surface Science Package (SSP)

Area of Study at Titan

Collects Titan's aerosols for chemical composition analysis.

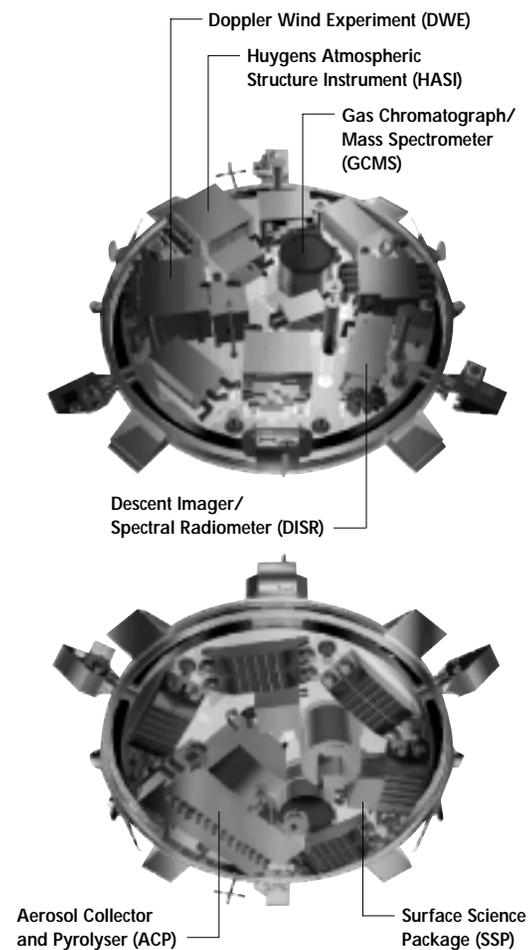
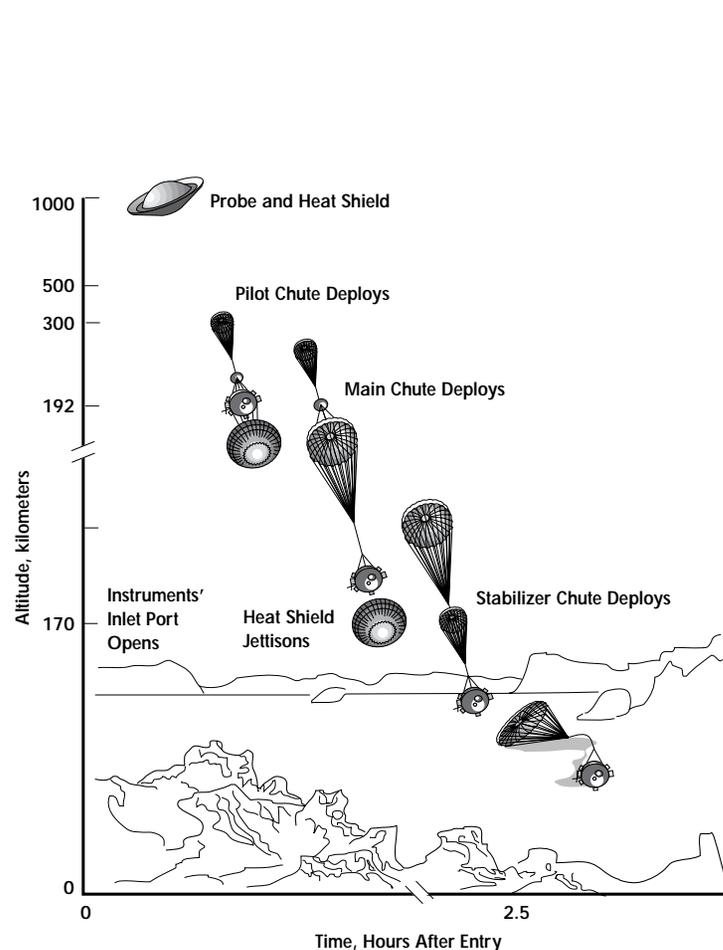
Makes spectral measurements and takes pictures of Titan's surface and atmospheric hazes.

Uses radio signals to deduce wind speeds on Titan.

Identifies and quantifies various atmospheric constituents on Titan.

Measures the physical and electrical properties of the Titan atmosphere.

Determines the physical properties of Titan's surface.



Detail of the probe's interior showing investigations on both sides.

Saturn System Facts and Figures

A Fascination with Saturn

Saturn is the sixth planet from the Sun. Best known for its vast ring system, Saturn has long captured the imagination of humankind. Saturn was the most distant planet known to ancient sky observers. It is the second largest planet in the Solar System. Saturn has an atmosphere composed primarily of hydrogen, and its magnetosphere is unlike that of any other planet. Saturn emits 79 percent more energy than it receives from the Sun. The planet's average density is less than that of water — it would float in a giant bathtub! Orbiting around the planet are Titan (the only moon in the Solar System known to have a thick, nitrogen-rich atmosphere), 29 or more smaller moons, and an expansive ring system. Saturn is clearly one of the most fascinating places to study.

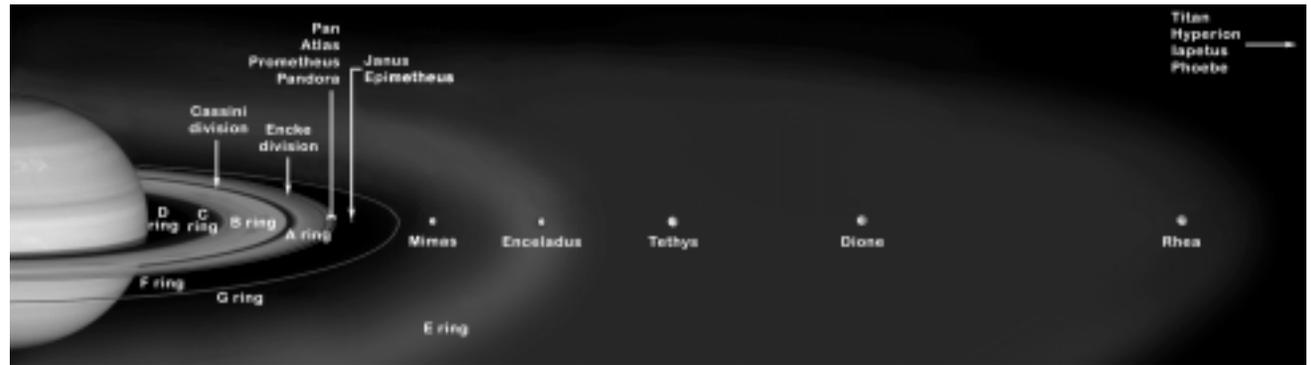
Saturn's Wild Winds

Saturn has the second-fastest sustained winds in the Solar System. At the equator, sustained wind speeds have been clocked at 500 meters per second; that's 1,100 miles per hour! By comparison, a jet airplane travels at an average speed of 550 miles per hour; Earth's strongest hurricane (cyclone) winds top out at around 220 miles per hour; a tsunami travels across the open water at 550 miles per hour; and the speed of sound at 30,000 feet is 660 miles per hour.

Just Another Smoggy Afternoon on Titan

Titan is the only moon in the Solar System with a thick atmosphere. Titan's atmosphere is composed mostly of nitrogen (between 90 and 97 percent) with the remaining components being methane, other hydrocarbons, and other trace gases. By comparison, Earth's atmosphere is also composed mainly of nitrogen, but nitrogen accounts for only 78 percent of Earth's atmosphere: the remainder is oxygen (21 percent) and traces of other gases. These similarities between the atmospheres of Earth and Titan have led scientists to hypothesize that Titan's atmosphere is reminiscent of Earth's atmosphere shortly after our home planet was formed.

Titan's atmosphere is 10 times deeper than Earth's. While Earth's surface is visible from space, Titan's thick haze at 200 kilometers (120 miles) above the surface obscures the surface from view. Titan's atmosphere appears yellow-orange in images because the nitrogen and methane in the atmosphere produce photochemical haze (or smog).



Understanding the Saturn System

Saturn's collection of moons spans a range from within the main rings out almost 13 million kilometers (about 8 million miles) from the planet. Saturn's rings extend from near the top of its atmosphere to about one-half million kilometers (about 300 thousand miles) away. The inner rings, from the planet outward, are known as D, C, B, A, F, and G, and are only a few hundred meters thick. The outermost E ring is much thicker, like a donut.

Saturn Physical Facts

| | |
|---------------------------|---|
| Average Distance from Sun | 9.55 astronomical units (1,429.4 million kilometers or 888 million miles) |
| Orbital Period around Sun | 29.42 years |
| Rotation Period | 10 hours, 40 minutes |
| Orbital Inclination | 2.5 degrees (to the Ecliptic) |
| Diameter (at Equator) | 120,660 kilometers (9 Earth diameters) |
| Diameter (at Poles) | 107,629 kilometers (66,891 miles) |
| Mass | 569×10^{24} kilograms (95 Earth masses) |
| Average Density | 0.7 gram/cubic centimeter (less than water!) |
| Gravity | 1.06 (Earth = 1.00) |
| Albedo | 0.5 (Earth's varies between 0.3 and 0.5) |
| Escape Speed | 36 kilometers/second (Earth = 11.2 kilometers/second) |
| Temperature at Cloudtops | 134 kelvins (-139 °C or -218 °F) |

Titan Physical Facts

| | |
|------------------------------|--|
| Distance from Saturn | 1,222,000 kilometers (759,560 miles) |
| Orbital Period around Saturn | 15.94 days |
| Diameter | 5,150 kilometers (3200 miles) (40% the size of Earth but still larger than Mercury or Pluto) |
| Mass | 1.37×10^{23} kilograms |
| Average Density | 1.88 grams/cubic centimeter |
| Temperature at Surface | 95 kelvins (-178 °C or -288 °F) |

Who Was the God Saturn?

Since the earliest times, the Romans worshipped Saturn as their god of agriculture. Later, when the Romans accepted the Greek pantheon of gods, Saturn was identified with Kronos. Eventually, Saturn became associated with time and was often depicted with wings and a scythe. Until the middle of the 19th century, the satellites of Saturn bore numerical designations only. In 1847, John Herschel proposed that the satellites be named after Saturn's brothers and sisters, "the Titans and Titanesses." However, the Titans and Titanesses were brothers and sisters not of Saturn, but of Kronos, Saturn's Greek counterpart. Hesiod, Homer's younger contemporary, gives us the family history of the tribe of the Titans. Using some of Hesiod's own words, here is an outline of the story.

In the beginning, there was Chaos, and after him came Gaia (the Earth). Gaia's first-born was Ouranos (the Sky), the "one who matched her every dimension." Gaia and Ouranos became parents of Okeanos, Koios, Krios, Hyperion, Iapetus, Theia, Rhea, Themis, Mnemosyne, Phoebe, and Tethys. Gaia's youngest-born was the "devious-devising Kronos, most terrible of her children." Hesiod assigned the name Titans to the 12 children. Kronos, upon urging from Gaia, attacked his father Ouranos with the sickle Gaia provided. Following the attack, Kronos became the supreme ruler of the world.

Saturn's Family Tree

Kronos took Rhea as his wife and they had five children. Remembering the fate of his father, Kronos swallowed each child right after it was born. Zeus was the sixth-born. To save the baby, Rhea tricked her husband into swallowing a stone instead, and Zeus survived to grow up. At some later point, Kronos was made to regurgitate the stone as well as the five children he swallowed. (Hesiod does not say when and how this happened.) With his siblings' help, Zeus initiated a rebellion against Kronos and the Titans. The Titans suffered a defeat in a terrible battle during which "all earth was boiling." Zeus imprisoned the



defeated gods in Tartaros, "a moldy place, at the uttermost edges of the monstrous earth" and, along with his Olympian allies, assumed the lordship over the world. Although Kronos' rule passed, it was long remembered as the golden age of mankind, when people "lived as if they were gods, their hearts free from all sorrow, without hard work or pain." Saturn, a Latin deity perhaps associated with farming, received some of the attributes of Kronos. The Romans also adopted the legend of the golden age. In their version, Saturn was the king of Italy in the long-forgotten days when, as in the age of Kronos, life was all play and no work.

Mythological Names of the Satellites of the Planet Saturn

Atlas (AT-less)

Son of Iapetus. After the defeat of the Titans, Zeus ordered Atlas, "at earth's uttermost places, near the sweet-singing Hesperides" to uphold the vault of the sky. Hesiod refers to the Pillars of Hercules, the westernmost edge of the world known to the ancient Greeks. Atlas was so strong that he supported the weight of the Universe on his shoulders.

Calypso (kuh-LIP-soh)

A daughter of Tethys and Okeanos, an Okeanide. Calypso, whose name means "I hide," was a nymph who lived alone on the island of Ogygia. In the course of the Odysseus' tortuous return to his home, Ithaca, his ship ran aground on the fabled island of Ogygia. Odysseus kept her company for seven years, after which he departed "on a jointed raft."

Dione (die-OH-nee)

Dione was an ocean nymph and possibly a daughter of the Titan Atlas. Dione was loved by Zeus before he married the goddess Hera. Dione became the mother of Zeus' daughter, the Olympian goddess Aphrodite, called Venus by the Romans. Some believe she later became a powerful Earth goddess who ruled over both land and sea.

Enceladus (en-SELL-uh-duss)

A giant and son of the Titans, his name literally means "battle-cry." He was human in appearance except that he had large snakes for feet! In the war between the Olympian gods and the Titans, the goddess Athena struck Enceladus with a large rock, then buried him alive under so much rock that the island of Sicily was formed in what is now Italy.

Epimetheus (ep-ih-MEE-thee-us)

Son of Iapetus, brother of Prometheus, husband of Pandora. Pictured as weak-minded, he is the one who lifted the lid on Pandora's jar that contained the misfortunes let loose upon the world.

Helene (huh-LEE-nee)

The divinely beautiful wife of Menelaos, the king of Sparta, Helen (Helene) was abducted by Paris, the son of Priam, the king of Troy. Over Helen, the Greeks fought the all-destructive Trojan War. Helene's brothers were Castor and Pollux, the Gemini twins.

Hyperion (high-PEER-ee-on)

The fourth-born Titan, Hyperion's name means "dweller on high." He was one of the older gods that ruled before Zeus. He took for a wife his sister Theia. She was the mother of the god Helios (the Sun), the goddess Selene (the Moon), and the goddess Eos (the Dawn). Helios ruled before Apollo, the Olympian god of the Sun. Selene ruled before Artemis, the Olympian goddess of the Moon.

Iapetus (eye-APP-eh-tuss)

A Titan and the father of Atlas, Iapetus was also the father of three Titans who judged the souls of the dead in Hades: Menoetius, Prometheus, and Epimetheus. Iapetus fought Zeus in the war between the Titans and the Olympian gods. He was vanquished and imprisoned with the other Titans after they lost that war.

Janus (JANE-uss)

An exalted Roman god, a figure of great antiquity and obscure origin, Janus is always represented as having two faces, one looking forwards, the other backwards. He presided over the past, present, and future, over gates, doorways, entrances, and beginnings in general, and over war and peace. At every sacrifice, in every prayer, he was the first god invoked. When war was declared, the portals to the sanctuary of Janus on the Forum were opened. They were shut again on the declaration of peace.

Mimas (MY-muss)

Mimas was a giant and son of the Titans. During the war in which Zeus and his kind conquered the Titans, Mimas was killed by the crippled god Hephaestus (Vulcan

in Roman mythology). Hephaestus was a blacksmith and poured molten metal from his forge onto Mimas, who became petrified into a massive rocky hill.

Pan

Half-goat, half-human, the Arcadian Pan was worshipped as the patron of shepherds and the personification of nature.

Pandora (pan-DOR-uh)

She was a work of art transformed into a human, and her name means "many gifts." Zeus created Pandora to punish mankind for Prometheus' brazen acts of disobedience. Pandora arrived equipped with a jar that contained all the misfortunes, curses, and plagues. Once the lid was lifted, the evil asserted itself in the world. "Hope was the only spirit that stayed there, in the unbreakable closure of the jar, this was the will of the cloud-gathering Zeus."

Phoebe (FEE-bee)

Phoebe is another name for the goddess that the Greeks called Artemis and the Romans called Diana. She was the youthful goddess of Earth's Moon, forests, wild animals, and hunting. Sworn to chastity and independence, she never married and was closely identified with her brother, Apollo.

Prometheus (pro-MEE-thee-uss)

Hesiod presents Prometheus, son of Iapetus, as an immortal who sided with the mortals and as a prankster who liked to annoy his cousin Zeus. The ultimate annoyance was stealing "the far-seen glory of weariless fire" and giving it to mankind. For this, Zeus fastened Prometheus to a mountain in the Caucasus, and he let loose on him "the wing-spread eagle, and it was feeding on Prometheus' imperishable liver, which by night would grow back to size from which the spread-winged bird had eaten in the daytime."

Rhea (REE-uh)

Rhea was the wife of the Titan Kronos (Saturn) and the mother of the Olympian gods Zeus, Poseidon, Hades, and the goddesses Demeter, Hera, and Hestia.

Telesto (tel-LESS-toe)

A daughter of Tethys and Okeanos, an Okeanide. She was a muse whose "specialty" has been forgotten.

Tethys (TEE-thiss)

The youngest of the Titanesses, Tethys married her brother Okeanos, and bore him 3,000 Okeanides, the "light-stepping" sea-nymphs, and "as many Rivers, the murmuringly running sons."

Titan (TIE-ten)

A generic name for the children of Ouranos and Gaia. In the Orphic version, the Titans are the ancestors of the human race. The Titans devoured the limbs of Dionysus, the son of Zeus, who intended the child to have dominion over the world. Enraged, Zeus struck the Titans with lightning. The fire burned them to ashes, and from the ashes man was formed.

Follow-Up Activity

Almost all human cultures have their own names for, and stories about, the Sun, the Moon, the planets, and the stars. Collect sky and star myths of many cultures through libraries, museums, observatories, the Internet, and by speaking with persons from various cultures. Share the star stories and have students discuss the similarities and differences. For example, both ancient Arabs and Native Americans imagined the constellation of the Big Dipper as part of a large bear. Have students consider: if western culture had used names for the stars and planets of, say, Hindu gods or Australian spirits, would astronomical research change? Would we in the 20th century view the Universe differently? It's clear that despite diverse visions and interpretations, the composition of the Saturn system, indeed the Solar System and beyond, remains dependent on physical laws. The real Universe is accessible to scientific observation and exploration, no matter what names we use.

The Value of a Mural

By integrating science, art, and history in this classroom activity, students will gain a greater appreciation for all of these subjects. The goal of this activity is to have students create their own murals while applying mathematical concepts of fractions and strengthening their research skills. This activity can be done on individual, group, class, or school-wide scales depending on the space and time available for the project.

Steps Toward Building a Mural

1. Read and discuss the story of the creation of the Saturn mural.
2. Read and discuss the mythology connected to Saturn. The mythology section of this wallsheet provides a beginning; students can perform independent or group research at the library and on the Internet. Using good mythology sources, students should prepare short summaries of the mythological story of Saturn, the Titans, and Saturn's moons. These summaries will give the students the background necessary to build an accurate mural. All students should research the mythology surrounding the moon Titan.
3. Have the students give short presentations on their findings about Titan mythology.
4. Have the students or student teams design their murals. One way to approach the mural design is to have the students combine these four themes:
 - a) Facts about the Huygens probe.*
 - b) Titan mythology.
 - c) How the Huygens probe impacts everyday life — what discoveries might Huygens make that could change your everyday life?*
 - d) What the students think the Huygens probe will discover about Titan.*

* Requires research.

If the students are working together to build one mural, have each group design one of the above themes. The individual themes can then be integrated by a fifth student team. Of course, there are many other possible themes to incorporate into the mural; these are just some suggestions for themes.

Adding a Math Component

Have the students create their mural on a grid sheet. Here is one example for creating a mural using a 12-part grid:

- 1/12 of the mural space — Information on the Huygens probe.
- 2/12 of the mural space — Titan mythology.
- 3/12 of the mural space — How the Huygens probe impacts daily life.
- 3/12 of the mural space — What the probe will discover.
- Remaining 3/12 of the mural space — Can be used to incorporate other themes or provide smooth transitions between themes.

An example on the next panel shows how a 12-part layout might look. However, don't have the students draw a different picture in each square. A mural similar to the Saturn mural has different themes, but is still just one picture.

Notes for the students that will make researching Titan mythology easier — Kronos (or Cronos) and Saturn are one and the same. Look for the story of Saturn, and the story of Titan will generally be included. If students are using the Internet, the key words "Roman mythology" and "Greek mythology" will elicit good resources.

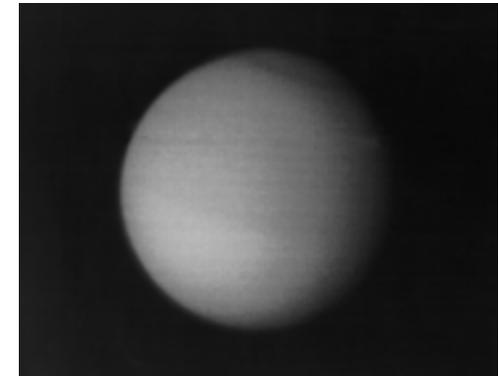
Note to Educators — It is recommended that the educator pre-select some Internet sites for the students to use. Some Internet sites discussing mythology talk about incest and infidelity and pictures may contain nudity. Libraries often have books on mythology that are age-appropriate.

Extending the Activity

Ask the students to respond to this question: Now that you have researched the mythology surrounding Titan and Saturn, if new moons are discovered by the Cassini mission, what should we name them? Why?

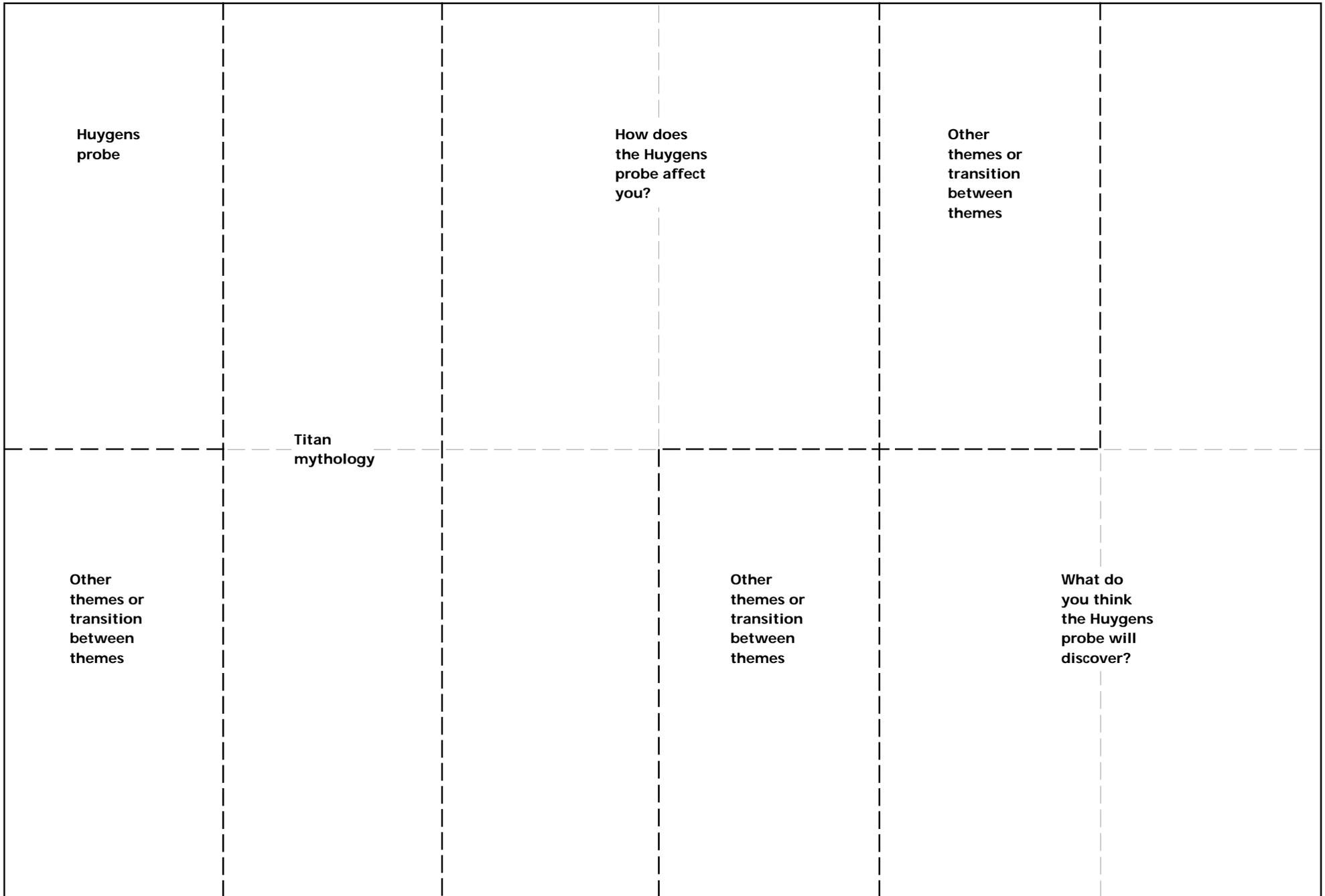
Follow-Up Activity

After the classroom teams have created their murals, have students read about the Huygens team — information can be found on the Cassini mission home page on the World Wide Web at <http://www.jpl.nasa.gov/cassini>. Have the students discuss what it might have been like building a space probe to explore Saturn with people from around the world.



Titan's thick atmosphere hides the moon's surface from the camera on Voyager 2.

Example of 12-part grid layout with themes.



Information about the Cassini Mission and Saturn

Cassini Outreach Office
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California 91109-8099

World Wide Web Sites

Numerous Web sites exist that contain information about Saturn, Cassini, and other space-related subjects.

- Cassini Mission Homepage — <http://www.jpl.nasa.gov/cassini>
- European Space Agency Homepage — <http://www.esrin.esa.it>
- ESA's Huygens Probe — <http://sci.esa.int/huygens>
- Jet Propulsion Laboratory Homepage — <http://www.jpl.nasa.gov>
- NASA Homepage — <http://www.nasa.gov>
- NASA Spacelink — <http://www.spacelink.nasa.gov>

For Educators

NASA Materials

Educators can get NASA-produced audiovisual materials from the NASA Central Operation of Resources for Educators (CORE). Visit the CORE Web site at <http://core.nasa.gov>. For a catalog of CORE products, send a written request on school letterhead to:

NASA CORE
Lorain County Joint Vocational School
15181 Route 58 South
Oberlin, Ohio 44074
Telephone: (216) 774-1051 ext. 293 or 294

Educator Resource Centers

NASA provides many resources for educators. The nationwide Educator Resource Centers (ERCs) provide classroom materials, including publications, books, educational supplements, CD-ROMs, audiocassettes, videotapes, slide sets, lithographs, posters, and other materials. To find the ERC closest to you, go to NASA's Spacelink Web site and follow the link titled "Educational Services."

Educational Standards

The Mid-Continent Research for Education and Learning (McREL) Web site (<http://www.mcrel.org>) yielded the following standards and included benchmarks that may be applicable to this activity.

- Primary (K-2) Mathematics Standard 2. Understands and applies basic and advanced properties of the concepts of numbers. Understands the concept of a unit and its subdivision into equal parts (e.g., one object, such as a candy bar, and its division into equal parts to be shared among four people).
- Upper Elementary (3-5) Mathematics Standard 2. Understands and applies basic and advanced properties of the concepts of numbers. Understands equivalent forms of basic percents, fractions, and decimals (e.g., $1/2$ is equivalent to 50% is equivalent to 0.5) and when one form of a number might be more useful than another.
- Upper Elementary (3-5) Mathematics Standard 2. Understands and applies basic and advanced properties of the concepts of numbers. Understands the relative magnitude of whole numbers, fractions, decimals, and mixed numbers.

- Elementary School (K-4) Visual Arts Standard 3. Knows a range of subject matter, symbols, and potential ideas in the visual arts. Selects prospective ideas (e.g., formulated thoughts, opinions, concepts) for works of art.
- Elementary (K-4) Visual Arts Standard 4. Understands the visual arts in relation to history and cultures. Knows how history, culture, and the visual arts can influence each other.
- Middle School (5-8) Visual Arts Standard 4. Understands the visual arts in relation to history and cultures. Understands the historical and cultural contexts of a variety of art objects.
- High School (9-12) Visual Arts Standard 4. Understands the visual arts in relation to history and cultures. Knows a variety of historical and cultural contexts regarding characteristics and purposes of works of art.

Acknowledgments

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Pasadena, California

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