

Understanding the Outer Planets and Planetary Atmospheres



The LASP-built UVIS instrument on the Cassini orbiter has enabled scientists to determine the structure, composition, and history of Saturn's rings.

(Courtesy NASA/JPL/Space Science Institute)

Planetary science focuses on many aspects of Solar System objects, from their deep interiors to the distant influences of a planet's gravitational or magnetic field far from the planet's surface. LASP planetary scientists study data from ground, telescope, and space-based instruments to understand the structure, processes, and origins of our solar system.

Scientists at LASP also develop theoretical models of different components of planetary systems, including:

- Geological processes on Mars
- Evolution of Saturn's ring system
- Interaction of magnetospheric plasma with the volcanic atmospheres of Io and Enceladus
- Escape of atmospheres from Mars, Mercury, Europa, and Pluto
- Bizarre chemistry of Titan's atmosphere
- Charging of dust grains on the surface of the Moon

Planetary Atmospheres

LASP scientists study planetary atmospheres to better understand each planet's environment and Earth's atmosphere. The gas giants—Mars, Venus, Pluto, and various moons and comets—all have interesting atmospheres. Scientists at LASP study the atmospheres of our Solar System and of exo-planets. We also study the atmosphere of the Earth during its early stages of evolution, when it was so different from its current state as to seem like another planet.

One example of our work in planetary atmospheres is the study of Mars. Studies indicate that the Martian atmosphere

has changed greatly over time, from a thicker atmosphere to the thin atmosphere we see now. What happened to the Martian atmosphere? Why did it change so dramatically? These are questions we will help address through the LASP-led NASA Mars Atmosphere and Volatile Evolution Mission (MAVEN).

Additional planetary atmospheres projects at LASP include:

- Global climate models for Mars and Titan
- Studies of the climate and chemistry of the early Earth's atmosphere
- Cassini observations of the atmospheres of Titan and Saturn
- Investigations of the atmosphere of Venus and planning for new spacecraft missions
- Investigations of the atmosphere of Pluto

Planetary Rings

One of the most enduring symbols of space exploration is a planet surrounded by a system of rings. This symbol inspires a celestial context: nothing on Earth is like it! What a wonderful surprise that the ringed planets are just as beautiful and scientifically compelling seen close-up.

We now know that planetary rings, once thought unique to the planet Saturn, exist around all the giant planets. These rings are not solid objects, but composed of countless particles with sizes ranging from specks of dust to small moons.

All rings lie predominantly within their planet's Roche limit, where tidal forces would destroy a self-gravitating fluid body. They are also within the planet's magnetosphere, and in the case

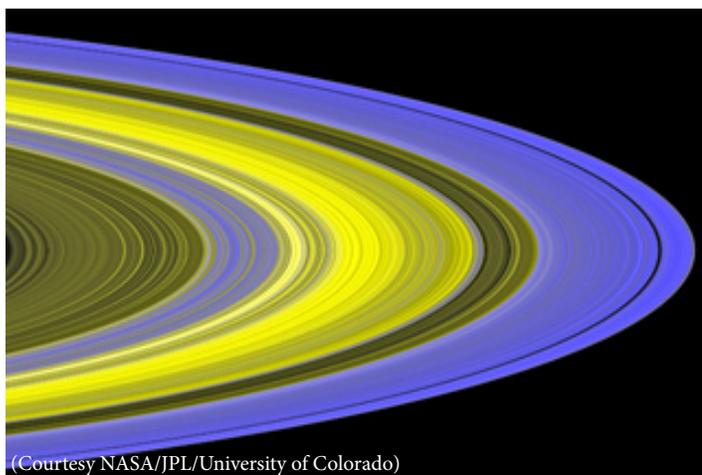
of Uranus, they are within the upper reaches of the planetary atmosphere.

For each planet, the rings are quite different. Jupiter's ring is thin and composed of dust-like small particles. Saturn's rings are broad, bright, and opaque. Uranus has narrow, dark rings among broad lanes of dust that are invisible from Earth. Neptune's rings include incomplete arcs restricted to a small section of their circumference.

The ringed planets are not just objects of beauty, but complicated physical systems that provide a local laboratory and analogy for other cosmic systems like galaxies and planet-forming disks.

The common occurrence of ring material around the planets is one of the major scientific findings of the last 25 years. The new ring systems were discovered by both spacecraft and ground-based observers, often surprising us by contradicting our expectations. The rings' appearance and composition vary among the planets and within each ring system. The broadest set of rings and the most identified processes are found around the planet Saturn, which is the target of the US/European Cassini space mission.

LASP continues to study Saturn's rings with its Ultraviolet Imaging Spectrograph (UVIS), which will continue operating throughout Cassini's extended "Solstice Mission," ending in 2017.



(Courtesy NASA/JPL/University of Colorado)

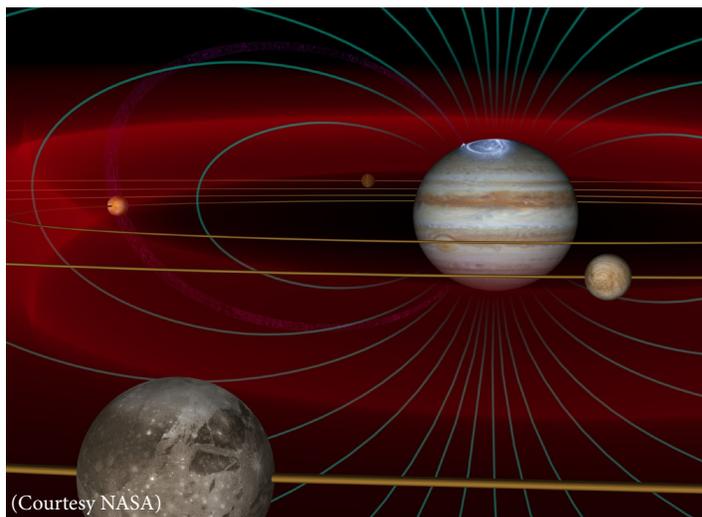
This false-color image of Saturn's main rings was made by combining data from multiple star occultations using the LASP-built Ultraviolet Imaging Spectrograph (UVIS).

Magnetospheres of the Outer Planets

A magnetosphere is the sphere of influence of a planet's magnetic field. The giant planets of the outer Solar System have strong magnetic fields whose influence extends far beyond their planets, encompassing many of their moons.

The stronger the magnetic field, the larger the magnetosphere. The Earth's magnetosphere is about ten times the planet's size—but the whole of this magnetosphere would fit inside the planet Jupiter. Over a thousand suns would fit inside the vast volume of Jupiter's magnetosphere.

The volcanic moons Io and Enceladus eject up to a ton of gases every second into the surrounding space. The interaction of magnetospheric material with the gases from these moons produces a range of phenomena, including strong electrical currents, radio emissions, and bright auroras.



(Courtesy NASA)

Scientists at LASP study the powerful magnetospheres of the outer planets.

Magnetospheres can be studied in several ways: We apply the physics of plasmas to model magnetospheric processes and compare model calculations with measurements made by particle detectors flying through a magnetosphere, and with different forms of emissions detected by telescopes and spectrographs based at Earth or on spacecraft.

LASP scientists are:

- Studying how the solar wind interacts with the giant magnetospheres of Jupiter and Saturn
- Modeling how magnetospheric plasma interacts with the volcanic moon Io spreading tons of neutral and ionized components across the Jovian system
- Simulating Cassini spacecraft observations of water products spewed out in volcanic plumes from Saturn's moon Enceladus
- Analyzing particle data obtained by the New Horizons spacecraft as it flew past Jupiter on its way to Pluto
- Participating in the Juno mission to Jupiter; and the flyby of Pluto by New Horizons (2015)

To read more about Planetary Sciences at LASP, visit: <http://lasp.colorado.edu/home/science/planetary>.

The Laboratory for Atmospheric and Space Physics (LASP) combines all aspects of space exploration through our expertise in science, engineering, mission operations, and data management. As an institute at the University of Colorado Boulder, LASP includes students throughout our activities. Learn more at <http://lasp.colorado.edu>.