

# Planetary Geology, Astrobiology, and Dusty Plasmas



Planetary science focuses on many aspects of planetary 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 origins of our Solar System and the planets, planetary dust, and electric fields within it.

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, and Pluto
- Bizarre chemistry of Titan's atmosphere
- Charging of dust grains on the surface of the Moon

## Astrobiology

Astrobiology is a scientific discipline that studies the phenomenon of life and its relation to the physical universe. Astrobiologists study how life came to exist on Earth, and whether life exists or was present in the past elsewhere in our Solar System.

Astrobiology is multidisciplinary, and LASP scientists collaborate on research projects with colleagues in several university departments, including geologic sciences, biology, atmospheric sciences, philosophy, and chemistry.

A number of LASP scientists are actively involved in astrobiology research. These projects encompass a variety of different approaches, including:

- Participation in spacecraft mission teams
- Field studies on Earth
- Laboratory simulations
- Computer modeling

Our projects include:

- Studies of the evolution of the atmosphere, surface geology, and hydrology of Mars in relation to its habitability
- The investigation of terrestrial analogs of environments such as volcanic fumaroles and deep-sea hydrothermal vents that might be capable of supporting life on other planetary bodies
- Laboratory simulations of geologic environments that can supply chemical forms of energy to support microbial communities, or "chemosynthesis"

Graduate and undergraduate students participate in these and other astrobiology-related research projects. LASP also hosts the Center for Astrobiology at the University of Colorado Boulder (CU), which coordinates astrobiology research and education across the university.

## Planetary Geology

Planetary geology and geophysics has long been a research focus at CU and within LASP and its associated departments:

- Geological sciences
- Astrophysics and planetary sciences
- Atmospheric and oceanic sciences
- Aerospace engineering
- Physics
- Molecular, cellular, and developmental biology

Our faculty studies varied fields such as the history of water on Mars, the composition of Saturn's moons, and the evolution of the interiors of terrestrial planets.



(Courtesy LASP)

*LASP scientists study life in extreme environments and analog sites to better understand the potential for life elsewhere in our solar system.*

In addition:

- Professor Bruce Jakosky has been selected to lead the NASA 2013 MAVEN mission to Mars, which will reveal the climate history of the planet
- Professor Brian Hynek works inside of active volcanoes in Central America to better understand the early history of Mars and its astrobiological potential
- Professor Brian Toon studies the climatic history of Mars and other planets
- Dr. Mihály Horányi is characterizing lunar dust for upcoming human exploration

Many others at CU contribute to detailing the evolution of the terrestrial planets and in some cases assess if life is, or ever was, possible beyond Earth.

## Dusty Plasmas

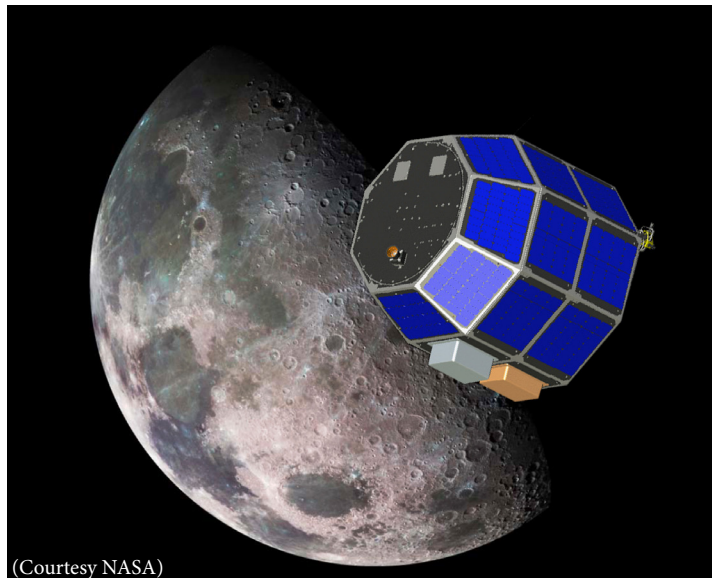
Dusty plasmas are ionized gases that contain microscopic charge carriers—often simply referred to as dust—representing a large variety of possibilities, including ice particles, and water drops. Interplanetary space, comets, planetary rings, asteroids, the Moon, and aerosols in the atmosphere are all examples where electrons, ions, and dust particles coexist. This emerging field bridges plasma physics studies with celestial and granular

materials mechanics.

Researchers at LASP study the dusty plasma environment through a combination of modeling, theoretical work, and laboratory experiments.

Scientists are interested in dusty plasmas for a variety of reasons:

- Dust particles immersed in plasmas and bathed in UV radiation collect electrostatic charges and respond to electromagnetic forces and gravity.
- Dust particles in plasmas are unusual charge carriers: they are heavier and can have larger negative or positive time-dependent charges, introducing new temporal and physical characteristic scales.
- Dust particles can communicate non-electromagnetic effects, such as gravity, drag, and radiation pressure to the plasma—acting as free energy sources. Dust can influence the collective plasma behavior, altering the traditional plasma wave modes and triggering new types of waves and instabilities.



(Courtesy NASA)

*The Lunar Atmosphere and Dust Experiment Explorer mission carries a \$6 million LASP-built instrument known as the Lunar Dust Experiment.*

LASP, the CU Departments of Physics, and the CU Department of Aerospace Engineering have a rapidly growing program in dusty plasma theory, laboratory investigations, rocket experiments, and spacecraft instrumentation. We recently established the Colorado Center for Lunar Dust and Atmospheric Studies (CCLDAS), which is a member of the NASA Lunar Science Institute, to study basic physical and applied questions regarding lunar dust and dusty plasma, including issues important to ensure human safety and long-term usability of mechanical and optical devices on the Moon.

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>.*