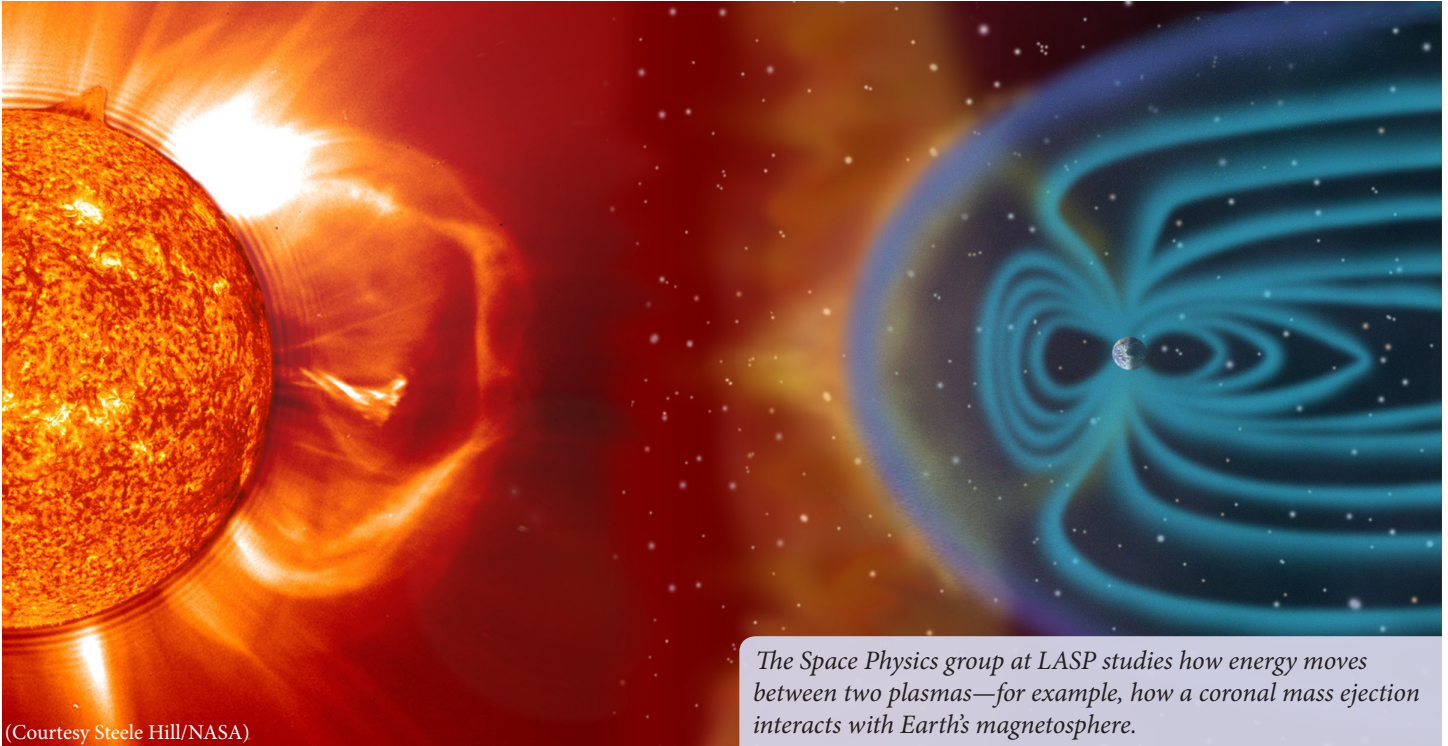


# Space Physics



*The Space Physics group at LASP studies how energy moves between two plasmas—for example, how a coronal mass ejection interacts with Earth's magnetosphere.*

In our daily environment, we encounter matter in three different states: solid, liquid, and gas. In space, a fourth state of matter exists: the plasma state. Plasma is like a gas, with individual particles moving freely under the influence of gravity. However, the particles in plasmas are charged, move primarily under the influence of electromagnetic forces, and are usually collisionless.

Plasmas make up 99% of the material in the Universe. It is important to understand the natural physical processes of space plasmas because those in near-Earth space can seriously affect modern technologies like GPS.

LASP research focuses on space plasma within our Solar System, and includes numerical modeling of plasma, designing space missions, building instruments, and analyzing and interpreting plasma observations.

Our interests include:

- The physical processes that create the aurora
- The origins and dynamics of the Van Allen radiation belts
- The spatial and temporal evolution and origin of the solar wind
- The interaction of the solar wind plasma with magnetic obstacles such as the magnetospheres of Earth and Mercury
- The interaction of the solar wind with weakly or non-magnetic objects such as Mars and the Moon
- Energy transport and conversion in space plasmas

## Space Weather Prediction

In today's technologically driven world, people are increasingly reliant upon space- and Earth-based technological systems. However, these systems are vulnerable to the hazards of space weather. For example, electromagnetic interference, dangerous plasma conditions, and sub-storms—rapid fluctuations in the plasma currents above the atmosphere—can cause wide-scale power outages, reduce the accuracy of critical GPS units, and damage sensitive electronic equipment. High-energy particles can also affect human tissues, and any space activity involving humans must consider potential radiation exposure to astronauts.

LASP researchers study aspects of the space environment that can have an impact on human activities, and analyze historic space data to predict and mitigate episodes of severe space weather. At LASP, we use historic solar wind data to develop software that predicts several of the most common space plasma indexes. By running the code on real-time solar wind data, the indexes can help predict the activity level of space weather. Some of these LASP models provide near real-time solar wind observations.

LASP is also active in the Center for Integrated Space-Weather Modeling (CISM) program, where codes developed by scientists are evaluated and converted from scientific resources into operational space weather prediction tools.

## Mission and Instrument Design

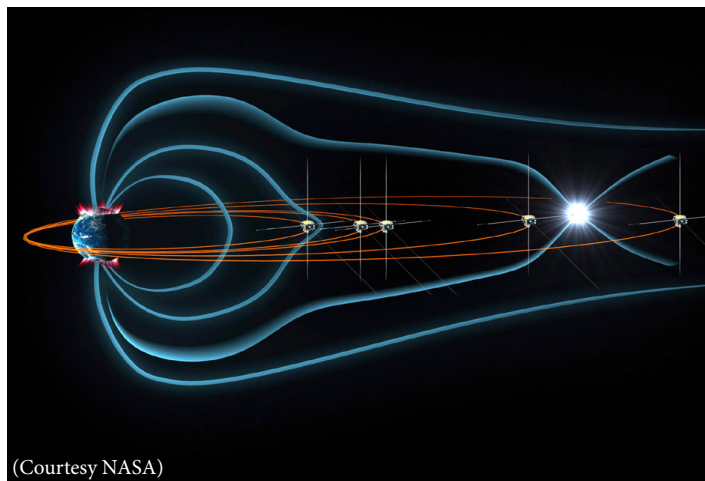
Analyzing different plasma conditions is important to understanding space plasma, and different instruments are used depending on condition and location. LASP scientists are frequently involved in developing new space plasma missions and instrumentation. Our space plasma researchers have many different interests and skills, providing opportunities for both scientists and students to help develop new mission concepts.

LASP space plasma researchers build electric field and waves instruments, Langmuir probes, and high-energy particle detectors. These instruments can fly on missions that LASP has designed or on missions designed by partner organizations that specifically requested these instruments. When building instruments, there is often close collaboration among LASP scientists and engineers to optimize the science return from each one-of-a-kind instrument.

Instrument quality verification testing is often led by our graduate students. To create a state-of-the-art instrument, LASP students must understand the instrument, the specific plasma environment the instrument will measure, and the fundamental scientific questions driving it. This understanding is often acquired by analyzing data from ongoing operations. Designing and building flight hardware is a rare opportunity for students, and LASP students are in high demand for industry-related jobs after graduation.

## Data Analysis

LASP space plasma researchers analyze multiple kinds of data from different space plasma instruments and spacecraft, and design and code software to address specific scientific questions. LASP space plasma researchers are involved in a variety of satellite missions that use LASP-built instruments,

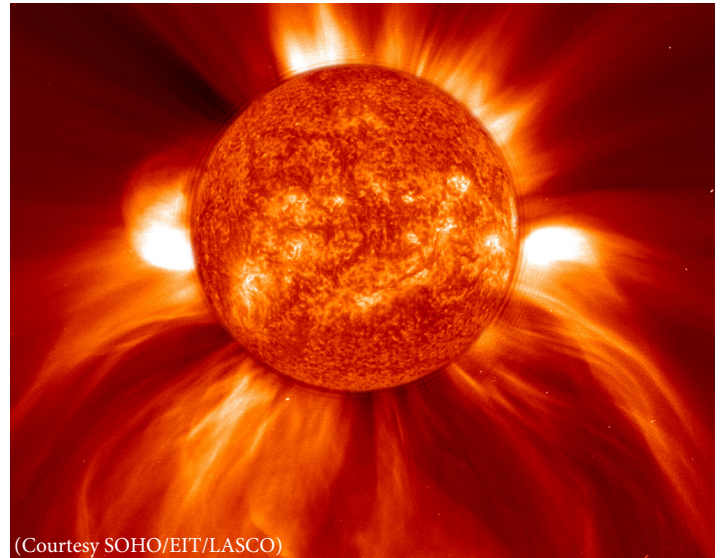


(Courtesy NASA)

*The Space Weather group at LASP researches the dynamics of the space environment and how strong disturbances can be predicted.*

giving most of our graduate students and recent graduates the unique opportunity to work on these missions. Such student work includes monitoring instrument status and suggesting operational modes.

LASP research often begins with a prediction, which is then either verified or rejected by analyzing data. The results lead to additional theoretical modeling and further data analysis. LASP space plasma researchers represent a diverse set of scientific interests, often applying Earth-based research to places such as Jupiter, Io, Enceladus, Saturn, Mercury, Mars, the Moon, and the Sun. This research diversity requires large-scale collaboration with other groups in a variety of science fields.



(Courtesy SOHO/EIT/LASCO)

*The Space Plasma group at LASP studies fundamental plasma processes throughout our Solar System, such as reconnection, shocks, Alfvén waves, and ion heating.*

## Modeling and Simulations

Space plasmas span vast regions, but satellites provide information from only specific points. LASP scientists use large-scale simulations, such as magnetohydrodynamics (MHD) simulations of the interaction between the solar wind and the Earth's magnetosphere, to enhance satellite data. These types of large-scale simulations are complex and often derived from a community code. LASP specialists determine how to use and improve these codes in order to meet the needs of end-users. We use large-scale simulations to set up well-tested problems, and then compare the results with existing satellite observations. In turn, we use the large-scale simulations to see if interesting satellite observations can be reproduced by code.

To read more about Space Physics at LASP, visit:  
<http://lasp.colorado.edu/home/science/space-physics>.

*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>.*