ATOMIC AND MOLECULAR PHYSICS

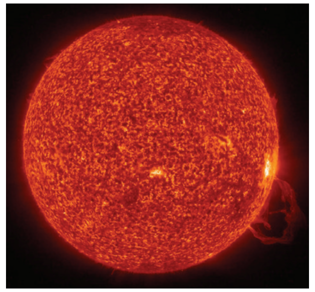
JPL scientists in atomic and molecular physics engage in laboratory experiments that explore new phenomena and provide basic atomic collision data for understanding solar and stellar plasmas as well as interstellar and interplanetary regions. We perform experiments using highly charged ions to understand processes such as electron excitation, charge exchange, and level lifetimes. We study fast hydrogen and oxygen atom collisions with grain-adsorbed molecules to form polyatomic molecules — the building blocks of life. We have developed a compact quadrupole ion-trap/gas chromatograph mass spectrometer system for monitoring astronaut air quality for human spaceflight. The Vehicle Cabin Atmosphere Monitor was installed aboard the international Space Station to monitor trace species and major atmospheric constituents.

RESEARCH AREAS

- Measuring the excitation cross sections of highly charged ions (HCIs)
- Measuring excitation cross sections and metastable lifetimes of HCIs for coronal equilibrium
- Measuring charge-exchange cross sections for HCI-comet and planet exosphere studies
- Measuring polyatomic molecule formation on interstellar dust-grain analogs
- Developing compact mass spectrometer systems for human and robotic planetary flight

SPACE PHYSICS AND HELIOPHYSICS

Research in space physics and heliophysics at JPL spans a wide range of topics, including the study of the tenuous plasmas that fill interplanetary space, the violent upheavals on the Sun that drive solar flares and coronal mass ejections, and the plasma environments of Earth and the planets and their interactions with the solar wind. Heliophysics encompasses all the processes involved in the interactions between the Sun and the other solar system bodies and with the surrounding interstellar medium. JPL scientists are involved in space missions including the joint ESA–NASA Cassini and Cluster missions, and the NASA missions Advanced Composition Explorer (ACE), Solar Terrestrial Relations Observatory (STEREO), and Juno. JPL research focus includes theoretical plasma physics, the development of instrumentation, and the analysis and interpretation of data.



A prominence eruption on the Sun captured in ultraviolet light by one of the twin spacecraft of NASA's STEREO mission.

RESEARCH AREAS

- Investigating the physics of the solar photosphere, chromosphere, and corona
- Modeling solar wind acceleration and heating
- Measuring and analyzing the structure and dynamics of the heliospheric magnetic field
- Exploring planetary magnetic fields and magnetospheres
- Studying physical processes in auroras and the ionosphere
- Studying the effects of solar variability on climate

RELATIVISTIC ASTROPHYSICS

Research on relativistic astrophysics at JPL is principally concerned with the emerging field of gravitational-wave astronomy. Gravitational waves, which are ripples in the fabric of spacetime, are emitted by accelerating masses, such as two stars in a binary system. Future space missions will be able to detect gravitational waves from short-period white-dwarf binaries in our own galaxy, as well as from mergers of million-solar-mass black holes throughout the Universe. We are also involved in current and planned solar system tests of General Relativity (Einstein's theory of gravitation), such as laser ranging to the Moon and Mars.

RESEARCH AREAS

- Investigating the astrophysics of gravitational-wave sources
- Developing techniques for gravitational-wave data analysis
- Study of future gravitational-wave missions
- Testing General Relativity via lunar laser ranging
- Developing new satellite tests of General Relativity

Two supermassive black holes emitting radio jets in 3C 75, at a distance of 300 million light-years. When pairs of supermassive black holes eventually merge, they emit a phenomenally powerful burst of gravitational waves that would be detectable by a space mission.

CONTACT US

JPL Science Division, M/S 183-335
Jet Propulsion Laboratory, 4800 Oak Grove Drive
Pasadena, CA 91109-8099

Tel: 818-354-2884

JET PROPULSION LABORATORY

Astrophysics and Space Sciences

Visit our website at science.jpl.nasa.gov

JPL
Jet Propulsion Laboratory
California Institute of Technology

JPL 400-1486 8/12

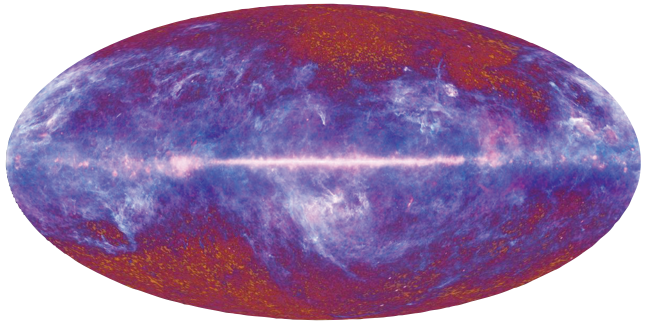
Astrophysics and Space Sciences research at JPL covers a broad spectrum of topics including the Sun, the formation of stars and planetary systems, the evolution of galaxies, and the structure and evolution of the Universe. Our scientists engage in theoretical studies, data analysis, and advanced instrument development, all generally focused on existing or future NASA missions. A world of possibilities awaits you at JPL. As a scientist here, you'll have opportunities for research not possible anywhere else.

COSMOLOGY

"Where did we come from? What powered the Big Bang? What is the nature of dark matter and dark energy?" These are among the deepest questions faced by astronomers and cosmologists today. Cosmologists at JPL are leading efforts to develop the advanced technologies and sophisticated techniques to directly address these questions. We develop new detector technology, instruments, and concepts, providing new capabilities for sensitive photometric, polarimetric, and spectroscopic observations. In addition, we develop the analysis tools necessary to study a rich and diverse set of astrophysical data. These data are acquired with telescopes located in Antarctica, the Atacama Desert of Chile and Mauna Kea volcano on the big island of Hawaii, and NASA spaceborne observatories, including Hubble and Spitzer. JPL developed instrumentation for the European Space Agency (ESA)–NASA Planck and Herschel missions. We are now analyzing data from these missions, which launched in 2009.

RESEARCH AREAS

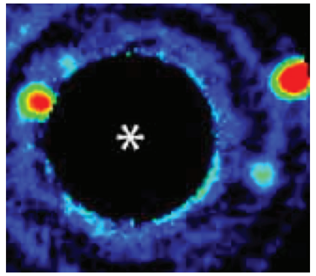
- Developing cryogenic superconducting detectors and instrumentation for studies of the polarization anisotropy of the Cosmic Microwave Background (CMB)
- Analyzing CMB data to reveal the early history of the Universe
- Developing techniques for studying the distribution of dark matter using gravitational lensing



A false-color image of the whole sky as seen by Planck. The dust throughout the Galaxy is shown in blue, hot gas appears as red regions across the center of the image. The mottled yellow features in the background are relic radiation, called the Cosmic Microwave Background, containing information about the very early Universe. Image credit: ESA / LFI and HFI Consortia.

ORIGINS OF STARS AND PLANETS

JPL scientists are studying the origins of stars and planets using telescopes and advanced models to study the formation and death of stars and the physical and chemical processes in the spinning clouds of gas and dust where these stars are born. We also develop technologies, instruments, and mission concepts for the direct detection, imaging, and characterization of exoplanets — planets orbiting the nearby stars in our galaxy. We use these same techniques to image and study the planet-forming disks around stars. We are also using eclipse techniques to probe exoplanet atmospheres, and pursuing a space-based mission, Fast Infrared Exoplanet Survey Explorer (FINESSE), for this purpose.



Simulated image of a nearby planetary system, as would be taken using an advanced coronagraph demonstrated at JPL. The white asterisk denotes the position of the central star, whose light has been blocked using the coronagraph.

RESEARCH AREAS

- Developing high-contrast imaging technologies for future space telescope mission concepts
- Studying planet formation in young stars' circumstellar disks using ground-based, suborbital and space observatories as well as numerical modeling
- Characterizing the atmospheres of Jupiter-class planets around other stars using spectroscopic observations from ground-based and space telescopes
- Observing and analyzing outflows from young stars and dying stars

STRUCTURE AND EVOLUTION OF GALAXIES

Galactic structure and evolution researchers study whole galaxies as coherent, self-contained systems of dark matter, stars, and gas, changing billion year time scales. A galaxy's history is shaped by its internal processes (star formation and death, gravitational interactions among its components, and sometimes by an active black hole engine at its core) as well as by interactions with its environment (other galaxies and the Universe itself). Current research at JPL in this area employs radio, infrared, optical, and X-ray observations using space missions such as NASA's Spitzer Space Telescope, Wide-Field Infrared Survey Explorer (WISE), Nuclear Spectroscopic Telescope Array (NuSTAR), and the ESA–NASA Herschel and Planck missions.

RESEARCH AREAS

- Mapping star-forming molecular clouds using submillimeter astronomy
- Modeling the gas and dust in debris disks around protostars
- Studying the formation and evolution of galaxies in the early Universe using infrared observations
- Modeling relativistic jet outflows ejected by black holes in active galaxies and quasars
- Developing instrumentation for NASA missions such as the Mid-Infrared Instrument (MIRI) on the James Webb Space Telescope (JWST), the High Angular Resolution Widefield camera (HAWC) polarimeter on the Stratospheric Observatory for Infrared Astronomy (SOFIA), and for the Deep Space Network and the Square Kilometer Array (SKA).
- Data reduction and scientific analysis of data from missions such as NuSTAR, WISE, Spitzer, Herschel, and Planck.

Explore the Possibilities