NASA Planetary Science

The observation and discovery of our solar system's planetary objects is one of the oldest scientific pursuits, and NASA's planetary science program is engaged in it. This project is being undertaken in order to gain a better understanding of our solar system's history and the distribution of life within it.

NASA's planetary science program has pushed the boundaries of spacecraft and robotic engineering design and operations for decades, advancing scientific understanding of the solar system in extraordinary ways. NASA spacecraft have visited every planet and a variety of tiny bodies to yet, and some of our ongoing missions will return new samples from interesting new locations, allowing further comprehensive study and analysis here on Earth. The NRC's planetary science decadal survey, Vision and Voyages for Planetary Science in the Decade 2013-2022, lays out the scientific framework for this endeavor (NRC, 2011).

Planetary scientific missions and research, guided by the decadal recommendations, provide information about our surroundings as well as our own origins and evolution, and they are essential precursors to humanity's extension beyond Earth. Humans will return to the Moon, Mars, and maybe other solar system bodies in the future to study them after robotic expeditions have explored and understood them.

Current Missions

NASA's Planetary Science missions continue to transform our understanding of the Solar System's origins and history. NASA missions are still exploring the Solar System, from the innermost planet, Mercury, to the farthest reaches of the Kuiper Belt, where Pluto is one of several Kuiper Belt Objects. We've orbited Mars and traveled across its surface, discovering signs of liquid water and old livable ecosystems. Closer to home, the Planetary Science Division collaborates with other institutions such as the National Science Foundation and the United States Air Force to use Earth-orbiting telescopes and ground-based sensors.

These telescopes and sensors are used to explore the volume of near-Earth space for near-Earth objects (NEOs) that may represent a threat to Earth or provide destinations and resources for future exploration, as well as to investigate our planetary counterparts through comparative planetology.

NASA's robotic explorers collect data to aid scientists in their understanding of how planets formed, what sparked distinct evolutionary routes among planets, what processes have occurred and are ongoing, and how Earth became habitable among the planets. Scientists utilize these data to map zones of habitability, analyze the chemistry of alien worlds, and uncover the mechanisms that lead to the circumstances required for life in the quest for life beyond Earth. NASA is using this expertise to enable safe and effective human missions beyond low Earth orbit.

What We Study

Understanding the planets and tiny bodies that make up our solar system aids scientists in answering questions regarding its formation, how it came to be so diverse, how life developed on Earth and presumably elsewhere in the solar system, and what features of the solar system lead to life's origins.

Unlike the outer solar system's gas and water giant planets, the inner solar system's bodies are rocky. Mercury, Venus, Earth, and Mars are believed to have developed through the accretion of dust into "planetismals," planetismals into proto-planets, and proto-planets into planets. Many elements about this sequence remain a mystery. The histories of the planets in the inner solar system are also murky: while Venus, Earth, and Mars are similar, they have evolved in various ways. We already know that Mars had water on its surface at one time, and there are suggestions that Venus may have had it as well. Currently, only the Earth is known to be habitable.

Jupiter, Saturn, Uranus, and Neptune are the four "gas giants" of the outer solar system. These four planets do not have a definite surface; Jupiter and Saturn are primarily hydrogen and helium, while Uranus and Neptune are largely water, methane, and ammonia, and are known as the "water giants." The gas changes or condenses to a liquid state at a specific depth in these planets' atmospheres (or at a point closer to the core). The rocky cores of Jupiter and Saturn are most likely ringed by metallic hydrogen. Uranus and Neptune differ from the other planets in that they are made up of rock, water, methane, and ammonia.

Their outer atmospheres, on the other hand, are hydrogen-rich, similar to Jupiter and Saturn's. There are nearly a hundred moons orbiting these planets, and Saturn's ring system is assumed to be a crushed moonlet.

Comets, asteroids, Kuiper Belt and Oort cloud objects, minor planetary satellites, Triton, Pluto, Charon, and interplanetary dust are examples of small bodies in the solar system. Because some of these objects are thought to have only minor changes from their original state in the young solar nebula from which the planets formed, they could reveal information about planet Earth as well as the genesis and evolution of the solar system.

Programs

Discovery

Discovery is a long-running initiative that allows scientists to form a team and create fascinating, specific research to supplement NASA's bigger planetary science endeavors.

Lunar Discovery and Exploration

The Vision for Space Exploration is encouraging a lunar science renaissance, as the return of people to the Moon necessitates and enables increased scientific understanding of Earth's natural satellite.

Mars Exploration

The Mars Exploration Program is a science-based mission to determine if Mars was, is, or can be a habitable planet.

New Frontiers

The New Frontiers Program is an important step forward in the exploration of the solar system.

Outer Planets & Ocean Worlds

The Galileo and Cassini missions to Jupiter and Saturn have helped us learn a lot more about those massive planets and their fascinating moons.

Planetary Defense Coordination Office

Asteroids and comets known as Near-Earth Objects (NEOs) orbit the Sun like planets, but their trajectories can bring them within 30 million miles of Earth's orbit. To counter the NEO impact hazard, planetary defense uses "applied planetary science."

SmallSats

Small satellites and spacecraft assist NASA in advancing scientific and human exploration, lowering the cost of new space missions, and increasing access to space. Small satellites provide whole new designs for a wide range of activities in space, with the potential for exponential leaps in transformative research, thanks to technical innovation.

Solar System Exploration Research Virtual Institute

Recognizing that science and human exploration are mutually beneficial, NASA established the Solar System Exploration Research Virtual Institute (SSERVI) to address fundamental and applied scientific questions related to the Moon, Near Earth Asteroids, the Martian moons Phobos and Deimos, and their near-space environments.

Science Questions

NASA's Planetary Science program attempts to answer a variety of issues about the solar system, including how life began and how it is evolving. The solar system is a world of immense diversity, severe environments, and constant change, as well as beauty and mystery. The solar system is also a large-scale natural laboratory in which we try to figure out the secrets of the cosmos and our place in it.

[How did life begin and evolve on Earth, and has it evolved elsewhere in the Solar System?]

On Earth, microbial life forms have been identified that can live and even thrive at extremes of high and low temperature and pressure, as well as in environments of acidity, salinity, alkalinity, and heavy metal concentrations that would have been considered lethal only a few years ago.

[How did the solar system evolve to its current diverse state?]

Many additional solar systems have huge Jupiter-like planets orbiting their stars, sometimes much closer than Mercury. These gas giants, according to many scientists, could not have evolved there. Rather, they must have started where our Jupiter is now and worked their way inwards, scattering the smaller planets with their enormous gravity.

[How did the sun's family of planets and minor bodies originate?]

For the first time in human history, scientists have discovered planets orbiting other stars, many of which are very different from our own. Many people have a planet similar to Jupiter, or even larger, orbiting the sun. We need a deeper understanding of how planets develop if we are to comprehend why this is the case and how likely it is that Earth-like planets exist elsewhere.

[What are the characteristics of the Solar System that lead to the origins of life?]

For many individuals, the chance of discovering life elsewhere is the most compelling motivation for humanity to travel beyond the Earth. We believe that liquid water and carbon, as well as a source of energy, are essential for life to emerge and develop. Many regions in the solar system, including planets, moons, and even comets, furnish these, at least for a period. However, we assume that a friendly environment must be more than just temporary in order for life to emerge.

Documents

Committees

[Planetary Science Advisory Committee]

The Planetary Science Advisory Committee (PAC) is a new FACA committee of NASA, and replaces the Planetary Science Subcommittee of the NAC SC.

- Materials from the predecessor Subcommittee
- PAC Charter
- PAC Designated Federal Officer and Appointments
- Meeting Documents

Strategic Planning

Planetary Missions Concept Studies Reports

- Mercury Lander
- Venus Flagship Mission

- Lunar Geophysical Network
- Lunar Intrepid
- Geochronology Report
- Mars MORIE
- Mars MOSAIC
- Exploration of Ceres Habitability
- Enceladus Orbilander
- Neptune Odyssey
- Pluto Persephone Study

Planetary Decadal Documents

- PSD Response to Decadal Midterm
- 2018 NRC Decadal Survey Midterm Review
- 2013-2022 NRC Decadal Survey
- Visions into Voyages for Planetary Science in the Decade 2013-2022 (2011)
- Vision and Voyages for Planetary Science in the Decade 2013-2022 (A Mid-term Review - 2018)

White Papers

- Community White Paper on Landed Mercury Science
- Value of NASA Participating Scientist programs to NASA PSD
- High-priority science questions about Mercury

NAS Reports

- Signed Curation Facilities Response Final
- Finding Hazardous Asteroids Using Infrared and Visible Wavelength Telescopes
- Report Series: Committee on Astrobiology and Planetary Science (Commercial Aspects)
- Report Series: Committee on Astrobiology and Planetary Science (Planetary Science Aspects)
- Review of the Restructured Research and Analysis Programs of NASA's Planetary Science Division
- Strategic Investments in Instrumentation and Facilities for Extraterrestrial Sample Curation and Analysis
- Report Series: Committee on Astrobiology and Planetary Science: Getting Ready for the Next Planetary Science Decadal Survey
- Grading NASA's Solar System Exploration Program
- Report Series: Committee on Astrobiology and Planetary Science
- Extending Science: NASA's Space Science Mission Extensions and the Senior Review Process (2016)
- Near-Earth Object Surveys and Hazard Mitigation Strategies
- Achieving Science with CubeSats

Senior Reviews

- Senior Review Subcommittee Report on Proposals for Mission Extensions for 2019

- 2016 PMSR - Final Report
- 2014 Senior Review - Report
- 2012 PMSR Chair letter July 5th

Town Hall Presentations

LPSC

- PSD Virtual Town Hall -- Lori Glaze, PSD Director
- R&A Virtual Town Hall -- Stephen Rinehart, Planetary R&A Director
- LPSC 2019 - Lori Glaze, PSD Director

DPS

- DPS 2018 – Lori Glaze, PSD Director

AGU

- AGU 2019 – Lori Glaze, PSD Director
- AGU 2018 – Lori Glaze, PSD Director

- AGU 2017 - NASA PSD Townhall Presentation

Science-funded Nuggets

- What is a Nugget?
- Lunar and Planetary Institute Nuggets