NASA Facts

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A Dispatch From Planet Mercury: The Messenger Mission

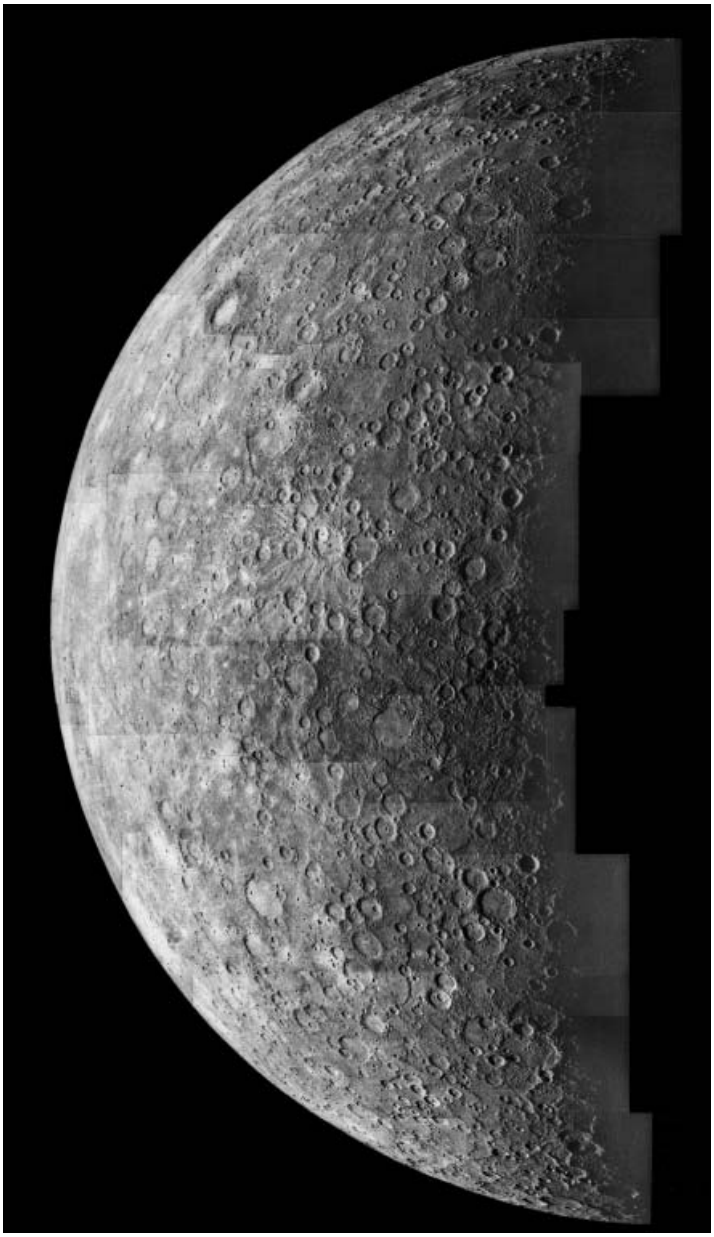
In Roman mythology, Mercury was the messenger of the gods. And though no god clad in winged shoes and helmet will be relaying important messages to an awaiting Zeus, a similar exchange of information will take place between Mercury (the planet) and awaiting scientists on Earth via the MErcury Surface Space ENvironment GEochemistry and Ranging (MESSENGER) mission.

The mission will help scientists solve the many mysteries associated with this terrestrial planet, forcing Mercury to resign its rank as one of the least explored planets in our solar system and ultimately leading to a better understanding of the evolution of the solar system.

What We Know

Mercury, the closest planet to the Sun, is a world of extremes. With an equatorial diameter of about 3,031 miles (4,879 km), it is the smallest of the inner rocky planets that include Mars, Earth and Venus. Of these four, it has the thinnest atmosphere.

Mercury is also the only terrestrial planet besides Earth to have a global magnetic field,



Mariner 10 image mosaic of Mercury from 125,000 miles (about 200,000 kilometers) away.

NASA/JPL

although 100 times weaker than Earth. Because scientists believe that Earth's magnetic field is generated by swirling motions in the molten outer portion of its core, and because of Mercury's high density, scientists have concluded that Mercury contains a large metallic core about 3/4 of the planet's radius.

The surface of Mercury is heavily cratered, similar to the surface of the Earth's moon. Huge scarps, some a mile high, spread for hundreds of miles. Between the craters lie extensive plains with smooth surfaces, perhaps indicating early volcanic activity. Radar images of its polar regions indicate the permanently shadowed interiors of large craters on Mercury are highly reflective at radar wavelengths — a behavior that may indicate the presence of ice.

Mercury has an unusual orbit with a rather high eccentricity (deviation from a circular orbit), causing what is known as libration, or a slight wobble in the planet's motion. The planet makes three complete rotations on its axis (one rotation takes a little more than 58 Earth days) for every two complete orbits about the Sun (one orbit is 88 Earth days). Temperatures here vary from a scorching 870 degrees Fahrenheit (465 degrees Celsius) on the daytime side to a frigid minus 300 degrees Fahrenheit (minus 184 degrees Celsius) on the nighttime side.

What We Want to Know

Scientists made many discoveries about Mercury from data and images returned by the Mariner 10 mission, which flew by the planet three times in 1974 and 1975. But since Mariner 10 was the sole spacecraft to visit Mercury, the mission left scientists asking numerous questions. The MESSENGER mission is intended to help answer the following questions:

1) Why is Mercury so dense?

2) What is the geological history of Mercury? Has Mercury experienced volcanism? What are the composition and structure of its crust?

3) What is the structure of Mercury's core?

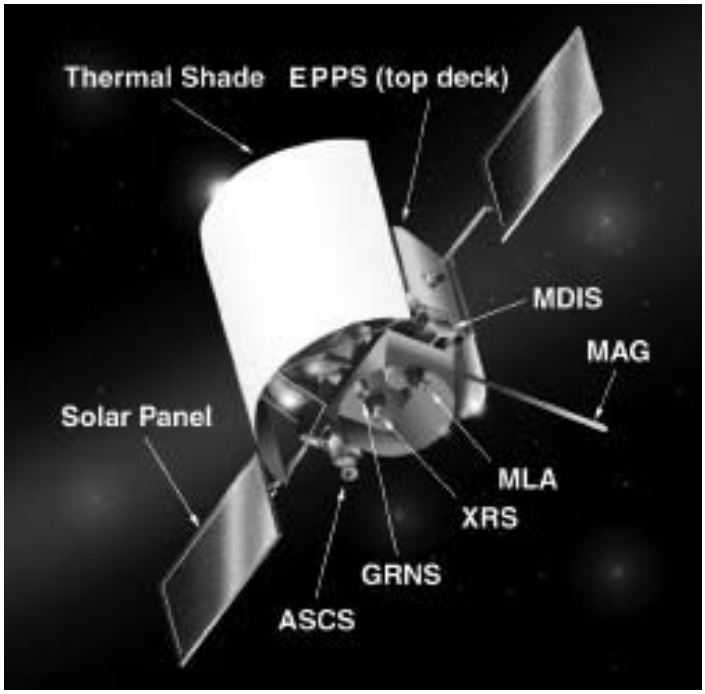
4) What is the nature of Mercury's magnetic field? Is a liquid outer core responsible for generating its magnetic field?

5) Do magnetic storms take place in Mercury's magnetosphere (a region around a planet where the movement of electrically charged particles is dominated by the planet's magnetic field)?

6) How does Mercury's magnetosphere respond to violent solar events like coronal mass ejections?

7) What are the unusual radar-reflective materials at Mercury's poles?

8) What volatiles (materials like water that readily evaporate) are important at Mercury? What are the nature and dynamics of its thin atmosphere?



NASA JHU/APL

Artist concept of the MESSENGER spacecraft.

The Payload

MESSENGER will consist of the following instruments:

Magnetometer (MAG): A shared development between NASA Goddard Space Flight Center and The Johns Hopkins University Applied Physics Laboratory (JHU/APL), MAG will

- Map Mercury's global magnetic field and determine its origin
- Determine the nature of any crustal magnetic field anomalies
- Map the structure of Mercury's magnetosphere
- Ascertain whether terrestrial-style magnetic storms occur on Mercury
- Help discover how Mercury's magnetosphere responds to large solar events

The MAG can measure magnetic fields up to 10 million times weaker than the Earth's field. Scientists will use the maps and analyze the data mathematically to make inferences about the nature of the field and its source. Results from MAG will assist in determining if the magnetic field is, indeed, generated by a partly fluid core. This information would explain a great deal about how terrestrial planets like Earth can generate a magnetic field. In addition, understanding how the magnetic field is constantly changing in response to activity on the Sun will help scientists understand the Earth's own field.

Gamma-Ray Neutron Spectrometer (GRNS) and X-ray Spectrometer (XRS): Developed by JHU/APL, GRNS and XRS will help Goddard scientists -

- Measure emissions from gamma-ray fluorescence (light emitted during absorption of radiation) stimulated by cosmic rays (energetic particles traveling through the Universe at practically the speed of light) and radioactive elements (GRNS specific)
- Measure fluorescence in low-energy X-rays stimulated by solar gamma rays and high-energy X-rays (XRS specific)
- Map the abundance of elements on the surface, revealing chemical provinces within Mercury's crust
- Determine whether Mercury's polar caps contain hydrogen in water ice (GRNS specific)

GRNS can take measurements up to almost 4 inches (10 centimeters) below the surface, while the XRS can measure the very top of the surface. Data from the two instruments will indicate what has happened on Mercury's surface since its formation, allowing scientists to better understand the development of the inner solar system and the volatile materials in it.

Mercury Laser Altimeter (MLA): Developed by Goddard, MLA will -

- Produce highly accurate measurements of Mercury's topography (surface features)
- Map the topography and thickness of the polar caps
- Measure the planet's libration to determine the presence or absence of a liquid outer core
- Determine the size of the core and how much of it is solid (when MLA data is combined with the measurement of the gravity field)
- Provide distance measurements from the spacecraft to the planet

MLA is the fourth laser altimeter to visit a planet and it is a quarter the size and mass 15.4 pounds (7 kilograms) of the one flown to Mars.

Not only will MLA help determine the sequence of processes, which have shaped Mercury's surface, it will help scientists understand the state of its core. If the interior of Mercury is entirely frozen, the MLA's libration measurement will be smaller than it would be if the outer core is molten. The topographical map will provide information critical to understanding the sequence of tectonic deformation (the structure and movement of a planet's crust), volcanism, and cratering, which has shaped Mercury's surface.

- Mercury Dual Imaging System (MDIS): Provided by JHU/APL, MDIS will map the landforms, surface variations, and topography from stereo imaging.
- Mercury Atmospheric and Surface Composition Spectrometer (MASCS): Provided by the University of Colorado Laboratory for Atmospheric and Space Physics, MASCS will measure abundances of atmospheric gasses and detect minerals in surface materials.
- Energetic Particle and Plasma Spectrometer (EPPS): Provided by JHU/APL, EPPS will measure the composition, spatial distribution, energy and time-variability of charged particles within and surrounding Mercury's magnetosphere. In addition, the University of Michigan is providing the Fast Imaging Plasma Spectrometer (FIPS) head for the EPPS.
- Radio Science (RS): Built and designed by JHU/APL, RS will measure Mercury's mass distribution.

Mission design

- Class: NASA's Discovery program
- Mission: Solar System Exploration
- Launch vehicle: Delta II 7925H
- Proposed Launch date: March 2004, Cape Canaveral Air Force Station, Fla.
- Venus flyby: June 2004, March 2006 (gravity assists will help get MESSENGER into Mercury's orbital plane and closer to Mercury's orbital period)
- Mercury flyby: July 2007, April 2008 (gravity assists and science measurements of Mercury)
- Mercury orbit: April 2009 – April 2010

Spacecraft design

- Passive thermal design requires no high-temperature electronics
- Dual-sided high temperature solar array reduces cell temperatures
- Lightweight thermal shade protects instruments on science deck facing Mercury
- Fixed phased-array antennas
- Low-mass, integrated propulsion and composite structure

MESSENGER Mission web site

For more information about this mission, visit: http://messenger.jhuapl.edu/

For more information about NASA's Discovery missions, visit: http://discovery.nasa.gov