



MESSENGER

MErcury Surface, Space ENvironment, GEochemistry, and Ranging

Mission Overview

MESSENGER is a scientific investigation of the planet Mercury. Understanding Mercury, and the forces that have shaped it, is fundamental to understanding the terrestrial planets and their evolution.

The MESSENGER (MErcury Surface, Space ENvironment, GEochemistry, and Ranging) mission will orbit Mercury following three flybys of that planet. The orbital phase will use the flyby data as an initial guide to perform a focused scientific investigation of this enigmatic world.

MESSENGER will investigate key scientific questions regarding Mercury's characteristics and environment during these two complementary mission phases. Data are provided by an optimized set of miniaturized space instruments and the spacecraft telecommunications system.

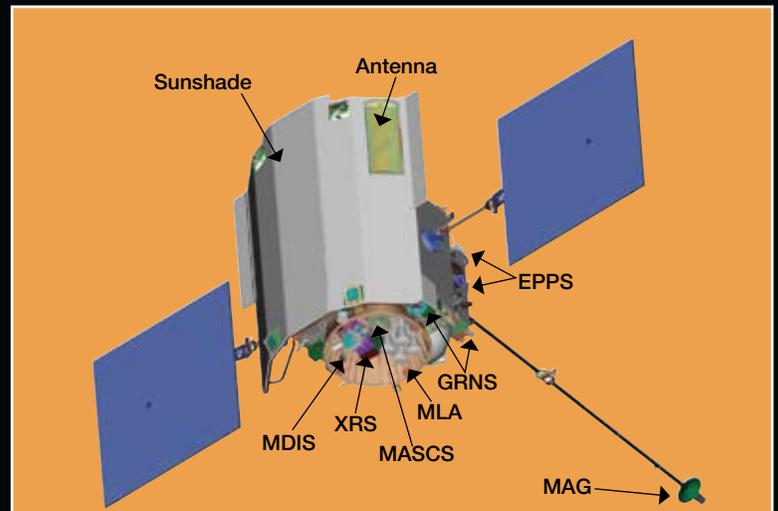
MESSENGER will enter orbit about Mercury in March 2011 and carry out comprehensive measurements for one Earth year. Orbital data collection concludes in March 2012.

Mission Summary

- Launch:** 3 August 2004
- Launch vehicle:** Delta II 7925H-9.5
- Earth flyby:** 2 August 2005
- Venus flybys (2):** 24 October 2006, 5 June 2007
- Mercury flybys (3):** 14 January 2008, 6 October 2008, 29 September 2009
- Mercury orbit insertion:** 18 March 2011

Key Spacecraft Characteristics

- Redundant major systems provide critical backup
- Passive thermal design utilizing ceramic-cloth sunshade requires no high-temperature electronics
- Fixed phased-array antennas replace a deployable high-gain antenna
- Custom solar arrays produce power at safe operating temperatures near Mercury



Science Payload

Mercury Dual Imaging System (MDIS) takes detailed color and monochrome images of Mercury's surface.

Gamma-Ray and Neutron Spectrometer (GRNS) measures surface elements (including polar materials).

X-Ray Spectrometer (XRS) maps elements in Mercury's crust.

Magnetometer (MAG) maps Mercury's magnetic field.

Mercury Laser Altimeter (MLA) measures topography of surface features; determines whether Mercury has a fluid core.

Mercury Atmospheric and Surface Composition Spectrometer (MASCS) measures atmospheric species and surface minerals.

Energetic Particle and Plasma Spectrometer (EPPS) measures charged particles in Mercury's magnetosphere.

Radio Science uses Doppler tracking to determine Mercury's mass distribution.

MESSENGER – to Mercury, the Last Frontier of the Terrestrial Planets

Understanding Mercury is fundamental to understanding terrestrial planet evolution.

MESSENGER is designed to answer six broad scientific questions:

- Why is Mercury so dense?
- What is the geologic history of Mercury?
- What is the nature of Mercury's magnetic field?
- What is the structure of Mercury's core?
- What are the unusual materials at Mercury's poles?
- What volatiles are important at Mercury?

MESSENGER provides:

- Multiple flybys for global mapping, detailed study of high-priority targets, and probing of the atmosphere and magnetosphere
- An orbiter for detailed characterization of the surface, interior, atmosphere, and magnetosphere
- An aggressive education and public outreach program to produce exhibits, plain-language books, educational modules, and teacher training through strong partnerships

MESSENGER Science Objectives

MESSENGER's instruments will explore Mercury's:

Polar deposits – The gamma-ray and neutron spectrometer will determine if Mercury's polar deposits contain hydrogen in water ice, and the laser altimeter will map the topography of the craters in which the deposits are located. The particle, plasma, and ultraviolet spectrometers will detect effluent from the frozen volatiles, even if the deposits are formed of elemental sulfur.

Core and magnetic dynamo – Accurate measurement of Mercury's libration by the laser altimeter and radio science experiments will reveal whether Mercury still possesses a liquid outer core.

Crust and mantle – Altimetric mapping by the laser altimeter and gravity mapping by the radio science experiment will probe for spatial variations in the structure of the lithosphere, evidence for early impact stripping of the crust, and evidence for ongoing mantle convection.

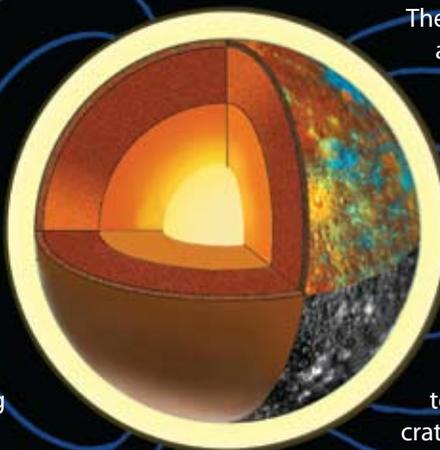
Magnetosphere – While the magnetometer maps the configuration and time-variability of Mercury's magnetic field, the combined plasma and energetic-particle spectrometer will determine the types, abundances, energetics, and dynamical characteristics of ions trapped within it.

Crustal composition – Global elemental abundance mapping by the X-ray, gamma-ray, and neutron spectrometers will reveal the chemical provinces within Mercury's crust. Multicolor imaging and infrared spectroscopy will detect and map variations in mineral abundances to scales of 1 kilometer or less.

These data will allow determination of the abundance and distribution of volcanic materials and the testing of models for the origin of Mercury's high bulk density.

Geologic evolution – Global imaging coverage at 250 meters/pixel, acquired at stereo geometries and with elevation "ground truth" from the laser altimeter, will provide morphologic information critical to understanding the sequence of tectonic deformation, volcanism, and cratering that shaped Mercury's surface.

Exosphere – The ultraviolet spectrometer will measure the composition and structure of Mercury's tenuous atmosphere and determine how it varies with local solar time, solar activity, and the planet's distance from the Sun. The energetic particle spectrometer will measure the exchange of species between the exosphere and magnetosphere, and the plasma spectrometer will observe pick-up ions in the solar wind.



Mission Management

Principal Investigator: Sean C. Solomon,
Carnegie Institution of Washington

Project management: The Johns Hopkins University
Applied Physics Laboratory (JHU/APL)

**Spacecraft integration
and operation:** JHU/APL

Instruments: JHU/APL,
NASA Goddard Space Flight Center,
University of Colorado,
University of Michigan
Composite Optics, Inc.

Structure: GenCorp Aerojet

Propulsion: KinetX, Inc.

Navigation: KinetX, Inc.

On the Web

MESSENGER mission: <http://messenger.jhuapl.edu>

NASA Discovery Program: <http://discovery.nasa.gov>