



**APL**  
The Johns Hopkins University  
APPLIED PHYSICS LABORATORY



# 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) spacecraft 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.

## 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.

## 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 education and public outreach program to produce exhibits, plain-language books, educational modules, and teacher training through partnerships.

## Mission Summary

Launch:	3 August 2004	Mercury flybys (3):	14 January 2008,
Launch vehicle:	Delta II 7925H-9.5		6 October 2008,
Earth flyby:	2 August 2005		29 September 2009
Venus flybys (2):	24 October 2006,	Mercury orbit insertion:	17 March 2011 (EDT)
	5 June 2007		18 March 2001 (UTC)

# MESSENGER — Mercury, the Last Frontier of the Terrestrial Planets

Understanding Mercury is fundamental to understanding terrestrial planet evolution.

## Discoveries from MESSENGER's Mercury Flybys:

In addition to providing key gravity assists that enable orbit insertion as well as opportunities to test scientific operations and command sequences for all payload instruments, MESSENGER's three flybys of Mercury yielded a number of discoveries that have markedly changed our view of Mercury and influenced our preparations for orbital operations. These include:

### Geology

- Volcanism was widespread on Mercury and extended from before the end of heavy bombardment to the second half of solar system history.
- Mercury experienced explosive volcanism, indicating that interior volatile contents were at least locally much higher than thought.
- Contraction spanned much of Mercury's geologic history.

### Composition and surface-derived exosphere

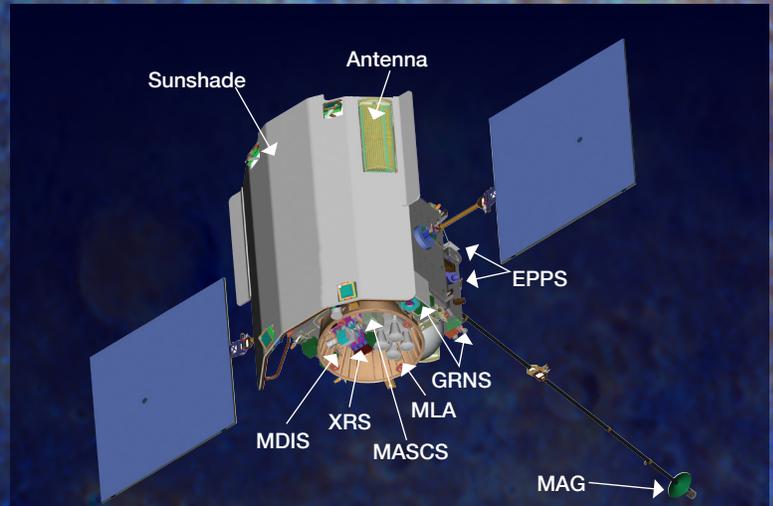
- Mercury's surface silicates, even in fresh crater ejecta, contain little or no ferrous oxide.
- Mercury's thermal neutron flux matches that of several lunar maria, indicating that iron and titanium are present in comparable collective abundances, perhaps as oxides.
- Magnesium and ionized calcium are present in Mercury's exosphere.

### Internal structure and dynamics

- The equatorial topographic relief of Mercury, in agreement with earlier radar results, is at least 5.5 km.
- The case for a liquid outer core on Mercury is greatly strengthened.
- Mercury's internal magnetic field is dominantly dipolar with a vector moment closely aligned with the spin axis.

### Magnetospheric dynamics

- Mercury's magnetosphere is more responsive to interplanetary magnetic field (IMF) fluctuations than those of other planets.
- Under southward IMF, rates of magnetic reconnection are ~10 times that typical at Earth.
- Loading of magnetic flux in Mercury's magnetic tail can be so intense that much of Mercury's dayside could be exposed to the shocked solar wind of the magnetosheath during such episodes.



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

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

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

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

## Mission Management

<b>Principal Investigator:</b>	Sean C. Solomon, Carnegie Institution of Washington
<b>Project Management:</b>	The Johns Hopkins University Applied Physics Laboratory (JHU/APL)
<b>Spacecraft Integration and Operation:</b>	JHU/APL

<b>Instruments:</b>	JHU/APL, NASA Goddard Space Flight Center, University of Colorado, University of Michigan
<b>Structure:</b>	Composite Optics, Inc.
<b>Propulsion:</b>	GenCorp Aerojet
<b>Navigation:</b>	KinetX, Inc.

## On the Web

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

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