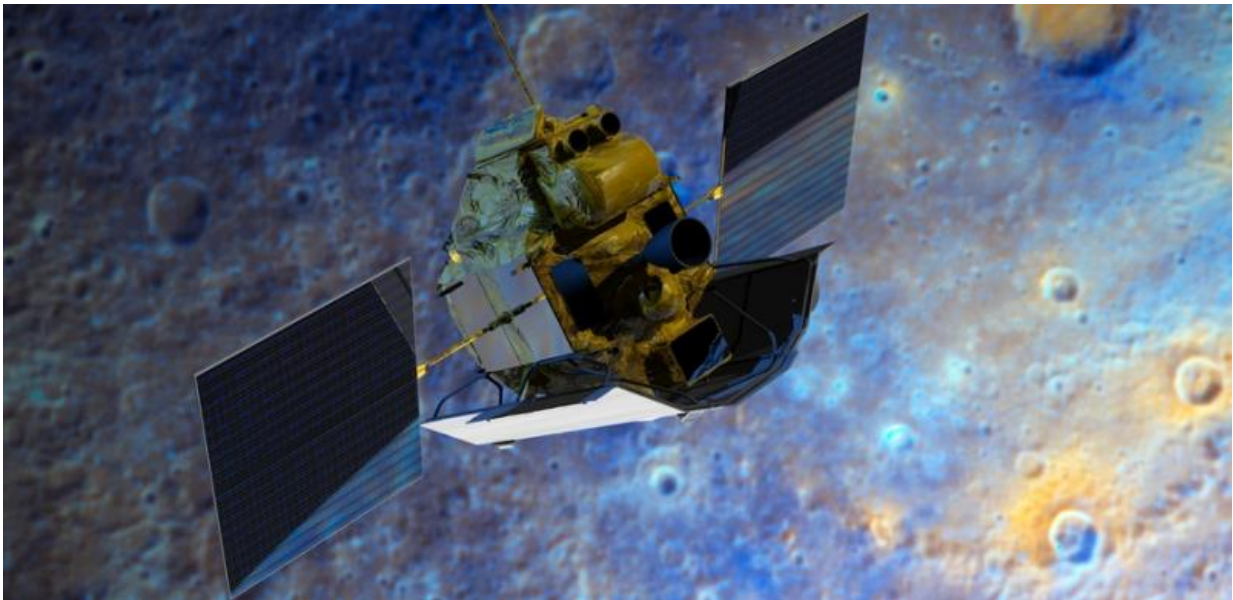


# Mercury's MESSENGER mission comes to a crashing climax

April 29 2015, by Donna Burton

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An artist's impression: MESSENGER flying over a colourful Mercury. Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington

More than a decade after it left Earth, the space probe MESSENGER is in the dying days of its exploration of the planet Mercury.

The spacecraft is about to run out of fuel, and after a planned final manoeuvre on April 30, it will plummet into the surface of Mercury out of view of watchers on Earth but will remain in contact until 10 to 15

minutes prior to its demise.

[Mercury](#) is the smallest of the eight current [solar system](#) planets and the one nearest to our star. ([Pluto](#) was relegated to being a mere dwarf planet in 2006.)

Unlike the other well studied and photographed planets, Mercury has until recent times remained mostly unexplored.

The planet – just 57.9 million km from the sun – was first visited by NASA's [Mariner 10](#) probe which undertook three flybys of Mercury between March 1974 and March 1975.

The planet had to wait for more than 30 years before MESSENGER ([MErcury Surface, Space ENvironment, GEOchemistry and Ranging](#)) completed its first flyby in January 2008.

Today you can even study its craters and other surface features using the [Google Earth interface](#).

## **The MESSENGER spacecraft**

MESSENGER was launched on August 3, 2004, weighing 507.9kg, 1.42m tall, 1.85m wide, and 1.27m deep. It is powered by two body-mounted gallium arsenide solar panels and a nickel-hydrogen battery.

The probe carries a number of [science instruments](#) to map the surface of the planet and its [magnetic field](#), detect atmospheric gases and various elements of Mercury's crust, and much more.

After its launch, the spacecraft flew by Earth once (in 2005), Venus twice (in 2006 and 2007) and Mercury three times (twice in 2008 and once in 2009).

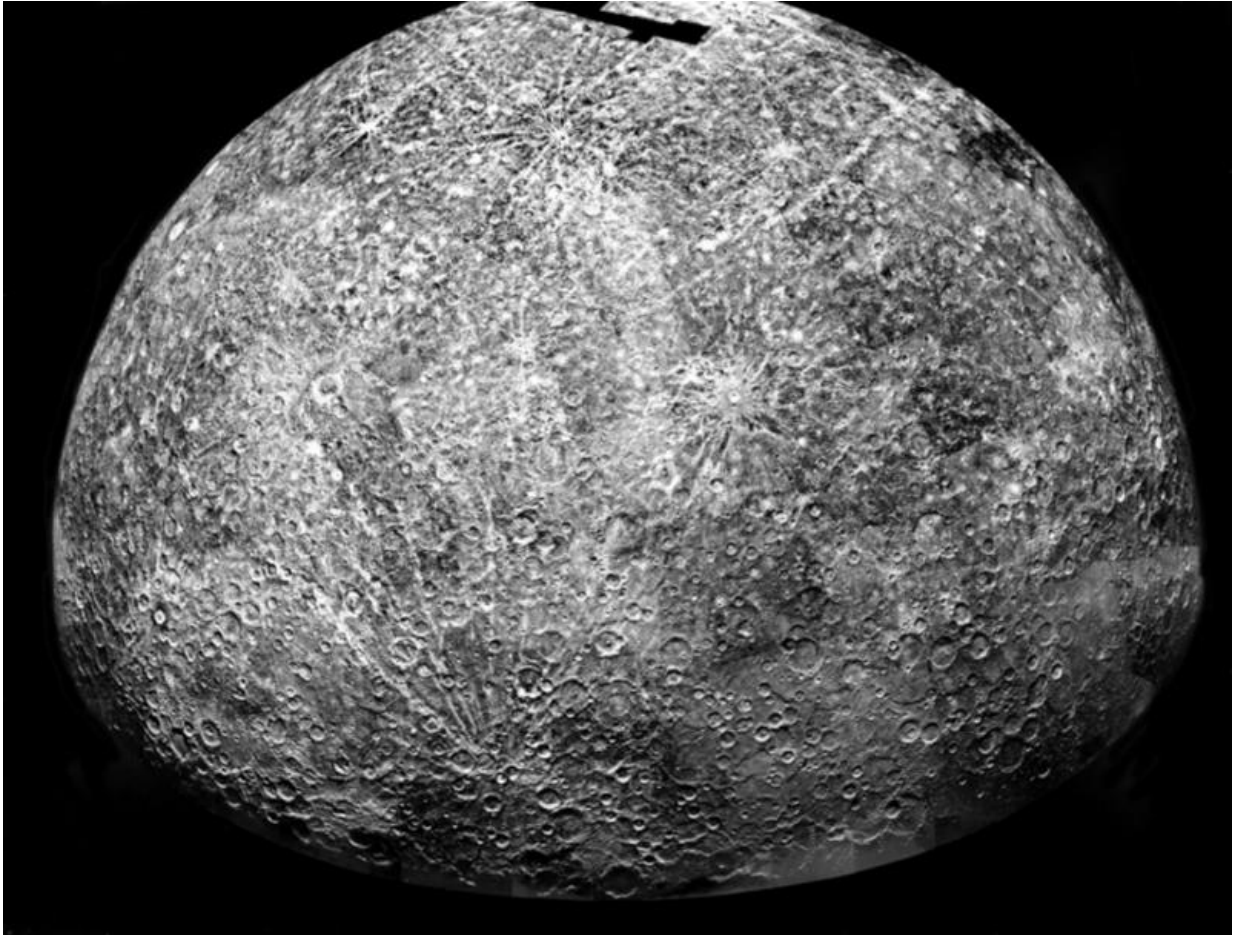
This multi-flyby process greatly reduced the amount of fuel needed to decelerate, although at the cost of increasing both travel time and distance.

Planets such as Venus and Mars have atmospheres that enable the minimisation of fuel by utilising atmospheric friction to enter orbit.

But Mercury's atmosphere is far too thin for such manoeuvres. Using gravity assist manoeuvres at Earth, Venus and Mercury provided the necessary reduction in velocity enabling it to use its rocket engine when entering its elliptical orbit around Mercury.

The insertion into a highly elliptical orbit minimised the amount of fuel necessary and allowed time for the probe to cool down after passing between the planet and the sun.

It also allowed measurement of the effects of solar wind and Mercury's magnetic field at varying distances, as well as capturing close-up measurements and photographs of the surface and exosphere.



A photo-mosaic of images collected by Mariner 10 as it flew past Mercury showing the planet's southern hemisphere. Credit: NASA

After travelling 7.9 billion km and orbiting the sun 15 times MESSENGER entered Mercury's orbit on March 18, 2011. The science instruments were reactivated on March 24 and the first photo from orbit was returned to Earth a few days later on March 29.

## **Discoveries and science**

The MESSENGER flybys of Mercury in 2008 and 2009 were able to

confirm the earlier Mariner 10 results that Mercury had an internal magnetic field and also to show that its magnetic dipole – which is just like a large bar magnet – is aligned to within  $5^\circ$  of the planet's spin axis.

In an early flyby in 2008 there was a totally unexpected discovery that there were large amounts of water present in Mercury's thin atmosphere. Visual evidence of past volcanic activity on the surface of Mercury and evidence for a liquid iron planetary core added to the incredible discoveries.

in November 2012, NASA announced, [evidence of water ice](#) and carbon-containing tar-like organic compounds molecules at both of Mercury's poles. In these areas the deepest parts of the craters are always in shadow with temperatures reaching as low as  $-200\text{C}$ .

This discovery lends weight to the idea that Mercury, like the Earth, was bombarded by water-laden comets and mineral rich asteroids during the early years of the solar system.

## **Mission extended**

The original mission was initially for a year and then extended to allow for observations of the predicted 2012 solar maximum.

The solar maximum is the period during the normal 11 year solar-cycle where the number of sunspots, solar flares and Coronal Mass Ejections are the highest. These are the major indicators of solar activity and MESSENGER was in a prime position to get information about the effects of increased solar activity.

In November 2013, Messenger was one of a number of spacecraft used to observe and photograph both Comet Encke (2P/Encke) and Comet ISON (C/2012 S1).

A second extended mission was scheduled to last through to March this year and has taken advantage of the probe's orbital decay to obtain highly detailed close-up photographs of ice-filled craters and other landforms at Mercury's north pole.

And so after a mission lasting almost 11 years the tiny robotic probe MESSENGER will end its mission on 30 April by crashing into the surface of the planet. Even then data will be gathered: the new man made crater the probe crash makes will hopefully provide new information for the NASA scientists. On its final orbit the probe will be only around 250 - 500 m above the surface at around 14,500km/hr.

NASA scientists will continue to gather data from MESSENGER until it finally succumbs to Mercury's gravity.

### **A question of ethics?**

This raises a question: just as comet and asteroid impactors may have delivered organic matter to their targets, what possible contaminants will this human-made visitor introduce?

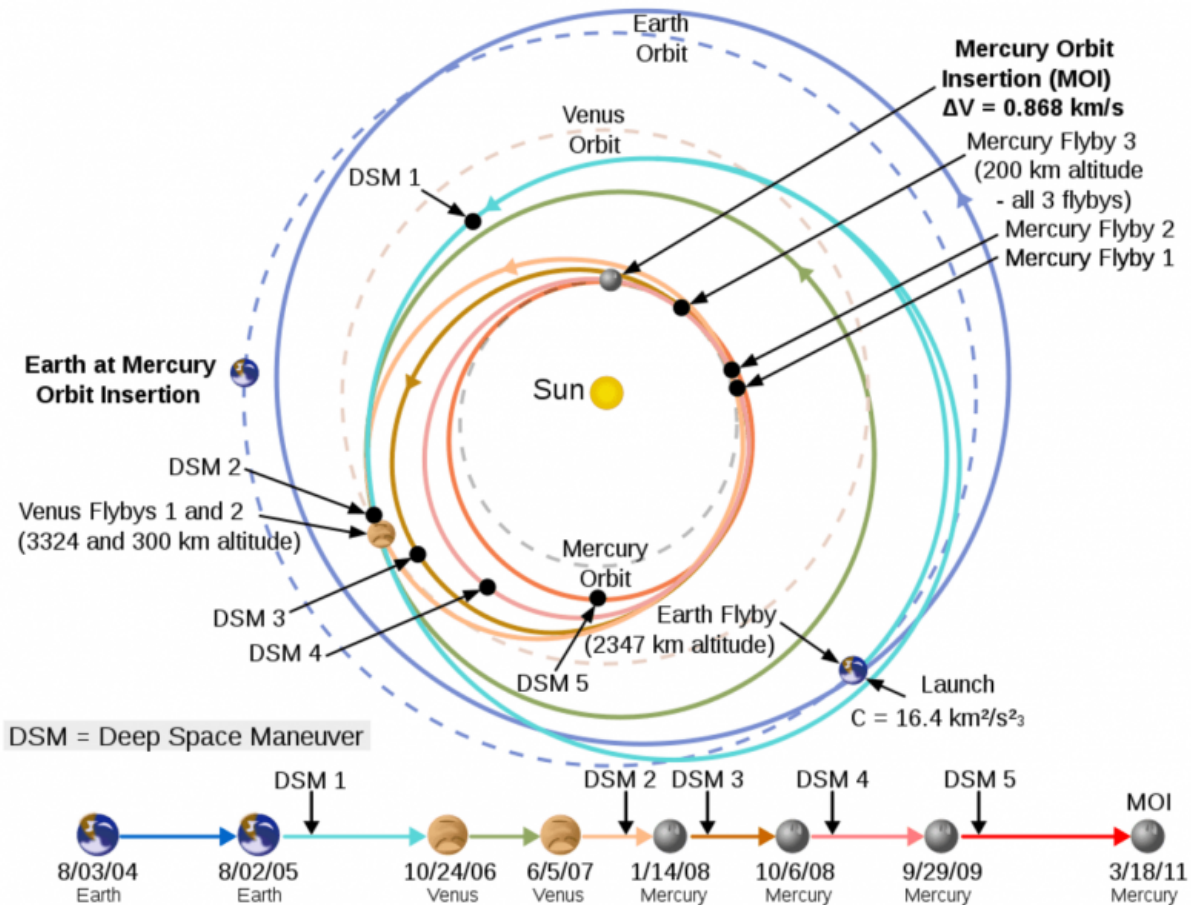
Since 1958, with the increasing potential of discovering extraterrestrial life, there have been groups of scientists such as Committee on Space Research ([COSPAR](#)) examining the foundational ethical principles involved in the exploration of space.

In 2010, a workshop was convened to consider whether planetary protection measures and practices should be extended to protect planetary environments within an ethical framework that goes beyond "science protection".

Previous planetary protection policy had been aimed at avoiding the contamination of planetary environments by biological contaminants or

terrestrial microbes that could compromise current or future scientific investigations, particularly those searching for indigenous life.

Spacecraft have been crashed into a number of planets as well as our moon. So as we continue to send probes to the very edge of our solar system, perhaps we are seeding these worlds with the basic volatile elements that could in a distant future lead to the evolution of more advanced life forming.



Interplanetary trajectory of the MESSENGER orbiter. Credit: NASA

Or perhaps as early settlers to foreign shores on Earth introduced diseases with devastating consequences, what effect could any nasty little hitchhikers have on the destiny of whatever life may already exist.

## **Mercury – so much known yet so much to learn!**

We now have detailed high-resolution maps of Mercury created from the hundreds of thousands of images taken by MESSENGER.



The globe on the left was created from the MDIS monochrome surface morphology base map campaign. The globe on the right was produced from the MDIS colour base map campaign. Each map is composed of thousands of images, and the colour view was created by using three of the eight colour filters



acquired. Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington

The launch of the European Space Agency's [BepiColombo](#) planned mission to Mercury is planned to take place during a one-month long window from January 27, 2017.

This is a joint mission with the Japan Aerospace Exploration Agency (JAXA) and should enter Mercury orbit in January 2024 carrying two separate orbiters, the Mercury Planetary Orbiter (MPO) operated by ESA and the JAXA designed Mercury Magnetospheric Orbiter (MMO) carried by the Mercury Transfer Module (MTM).

One of its tasks will be to observe the 16m crater made by MESSENGER when it impacts at around 3.9 km/s (about 14,040 km/h). Scientists will be monitoring this fresh crater in order to identify the process of space weathering—the erosive effect of radiation and tiny meteorite strikes—in action.

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