EPSC Abstracts
Vol. 10, EPSC2015-184, 2015
European Planetary Science Congress 2015

BepiColombo – a joint ESA/JAXA mission to explore Mercury

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Abstract

BepiColombo is a joint project between ESA and the Japanese Aerospace Exploration Agency (JAXA). The Mission consists of two orbiters, the Mercury Planetary Orbiter (MPO) and the Mercury Magnetospheric Orbiter (MMO). The mission scenario foresees a launch of both spacecraft with an ARIANE V in January 2017 and an arrival at Mercury in the first half of 2024. From their dedicated orbits the two spacecraft will be studying the planet and its environment. The MPO scientific payload comprises eleven instruments/instrument packages; the MMO scientific payload consists of five instruments/instrument packages. Together, the scientific payload of both spacecraft will perform measurements to find clues to the origin and evolution of a planet close to its parent star. The MPO on BepiColombo will focus on a global characterization of Mercury through the investigation of its interior, surface, exosphere and magnetosphere. In addition, it will be testing Einstein's theory of general relativity. The MMO provided by JAXA focuses on investigating the wave and particle environment of the planet from an eccentric orbit. Together, the scientific payload of both spacecraft will provide the detailed information necessary to understand the process of planetary formation and evolution in the hottest part of the proto-planetary nebula as well as the similarities and differences between the magnetospheres of Mercury and the Earth.

1. Introduction

A suite of state-of-art scientific instruments allow a wide range of scientific questions to be addressed like understanding of the origin and evolution of a planet close to its parent star, the detailed study of Mercury's figure, its interior structure and composition, the investigation of the interior dynamics and origin of Mercury's magnetic field. Further science goals are trying to understand exo- and endogenic surface modifications, cratering, tectonics, and volcanism. The composition, origin and dynamics of Mercury's exosphere and Mercury's magnetosphere will be addressed by combined measurements of both spacecraft. Last but not least scientist believe that they can use BepiColombo also as a laboratory to test Einstein's theory of general relativity, by performing high accurate positioning measurements of the spacecraft. All in all measurements performed by the instruments on BepiColombo will provide clues on the origin and formation of terrestrial planets and help to answer fundamental questions like: "How do Earth-like planets form and evolve in the Universe?"

Mercury is a small planet compared to the Earth and difficult to observe from the Earth, due to its close proximity to the bright Sun. For an in-depth study ofthe planet and its environment, it is therefore necessary to operate a spacecraft equipped with scientific instrumentation around the planet. On the other hand the thermal and radiation environment close to the Sun and close to the hottest planet in the solar system is extremely aggressive, which makes this mission technically very challenging.

The BepiColombo mission will provide a rare opportunity to collect multi-point measurements in a planetary environment. This will be particularly important at Mercury because of short temporal and spatial scales in the Mercury's environment. It is foreseen that the orbits of MPO and MMO are selected in a way to allow close encounters of the two spacecraft throughout the mission. Such intervals are very important for the inter-calibration of similar instruments on the two spacecraft. They also provide scientifically valuable intervals to collect multi-point measurements in an environment where both spatial and temporal scales can be very short.

In order to ensure the science and technical performance of the spacecraft intense on-ground testing has to be performed. The environment around Mercury imposes strong requirements on the

spacecraft design, particularly to all elements that are exposed to Sun and Mercury.

Recently acceptance testing of the Proto Flight Models (PFM) of the two BepiColombo spacecraft and the Mercury Transfer Module (MTM) are ongoing.

The MTM provides the acceleration and braking required during Cruise to reach the eventual capture by Mercury and the large amount of power required by the solar electric propulsion system. The MTM also constitutes the bottom element in the overall spacecraft structure. The MTM holds 2 solar array wings totaling over 40 m^2, which provide the power for the SEPS (Solar Electric Propulsion System) during the Cruise

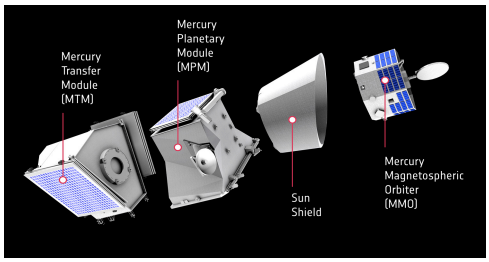

Figure 1: Spacecraft configuration of BepiColombo...

1.1 Science Goals

The main scientific objectives of the BepiColombo mission are to study:

- the origin and evolution of a planet close to its parent star,

- Mercury's figure, interior structure, and composition,

- Interior dynamics and origin of its magnetic field

- Exogenic and endogenic surface modifications, cratering, tectonics, volcanism

- Composition, origin and dynamics of Mercury's exosphere and polar deposits

- Structure and dynamics of Mercury's magnetosphere

- Test of Einstein's theory of general relativity

These questions can be related to five major topical areas, namely interior, surface, exosphere, magnetosphere and fundamental physics.

2. Summary and Conclusions

BepiColombo is the planetary Cornerstone of ESA's Cosmic Vision Programme, and is devoted to the thorough exploration of Mercury and its environment. It will be carried out as a joint project between ESA and the Japanese Aerospace Exploration Agency. The mission consists of two orbiters, the Mercury Planetary Orbiter (MPO), which is 3-axis-stabilised and nadir pointing, and the Mercury Magnetospheric Orbiter (MMO), a spinning spacecraft. With its two-spacecraft, interdisciplinary approach, the BepiColombo mission will provide the detailed information necessary to understand the processes of planetary formation and evolution in the hottest part of the proto-planetary nebula, as well as the similarities and differences between the magnetospheres of Mercury and Earth. To accomplish this, a global characterisation of Mercury is required, which will be achieved with a thorough investigation of its interior, surface, exosphere and magnetosphere. In addition, the mission offers unique possibilities for testing Einstein's theory of general relativity.

The BepiColombo mission to Mercury has a large scientific interest in Europe and Japan and will expand our knowledge of planetary formation in close proximity to its parent star. BepiColombo will provide comprehensive, high-resolution global coverage of the planet, infrared images, surface composition, and global temperature maps. It aims for a global 3-dimensional (stereo) coverage of the surface, accurate measurements of Mercury's gravity field (planet interior, test of Einstein's theory) and high-detailed measurements of the plasma and particle environment
Last but not least BepiColombo will follow up on MESSENGER results and will to close the gaps in the southern hemisphere

References

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