

BepiColombo: Mission to Mercury - MMO project



MMO Science Sub-Group

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MGF Magnetic Field Investigation (2 sub instruments) studies magnetic field from the planet, magnetosphere, and interplanetary solar wind.

W. Baumjohann (IWF, Austria) Co-PI: A. Matsuoka (ISAS/JAXA, Japan) Members: Japan, Austria, Germany, UK, USA

MPPE Mercury Plasma Particle Experiment (7 sub-instruments) studies plasma & neutral particles from the planet, magnetosphere, and interplanetary solar wind.

Y. Saito (ISAS/JAXA, Japan) J.-A. Sauvaud (CESR-CNRS, France), M. Hirahara (Rikkyo Univ., Japan),

S. Barabash (IRF, Sweden) Members: Japan, France, Sweden, ÚK, Italy, Czech, Belgium, Germany, Switzerland, USA, Taiwan

PWI Plasma Wave Investigation (7 sub-instruments)

studies electric field, electromagnetic waves, and radio waves from magnetosphere and solar wind. H. Matsumoto (Kyoto Univ., Japan) J.-L. Bougeret (LESIA, France)

L. Blomberg (KTH, Sweden) H. Kojima (RISH, Kyoto Univ.). S. Yagitani (Kanazawa Univ.) Members: Japan, France, Sweden, Norway, Finland, Hungary, ESA

MSASI Mercury Sodium Atmosphere Spectral Imager

studies thin sodium atmosphere of Mercury.

PI: I. Yoshikawa (Univ. Tokyo, Japan) Co-PI: O. Korablev (IKI, Russia)

Mercury Dust Monitor

Members: Japan, Russia, Italy, USA

studies dust from the planet and interplanetary & interstellar space. PI: K. Nogami (Dokkyo Univ., Japan) Members: Japan, Germany

First full-scale Euro-Japan joint mission

Two orbiters (MPO & MMO) will observe Mercury simultaneously with instruments developed by Euro-Japan joint research teams.

Mercury Magnetospheric Orbiter)

is a spin-stabilized spacecraft. The MMO will study magnetic field, atmosphere, magnetosphere, and inner interplanetary space. Comparison of magnetic field & Magnetosphere with Earth will provide the new vision for space physics.

MPO Mercury Planetary Orbiter)

is a three-axis stabilized spacecraft. The MPO will study geology, composition, inner structure and the exosphere. Abnormal structure and composition of Mercury will provide the keys for the planetary formation in the inner solar system.

Complete study of 'unknown planet' near the Sun

The innermost planet Mercury was already known in the ancient days, but it was visited only by the Mariner 10 spacecraft 3 decades ago. Mercury is still "unknown" and provides important keys to the solar system sciences.

History of Inner Solar System

Mercury's high density and composition tell us the initial stage of the innermost solar system.

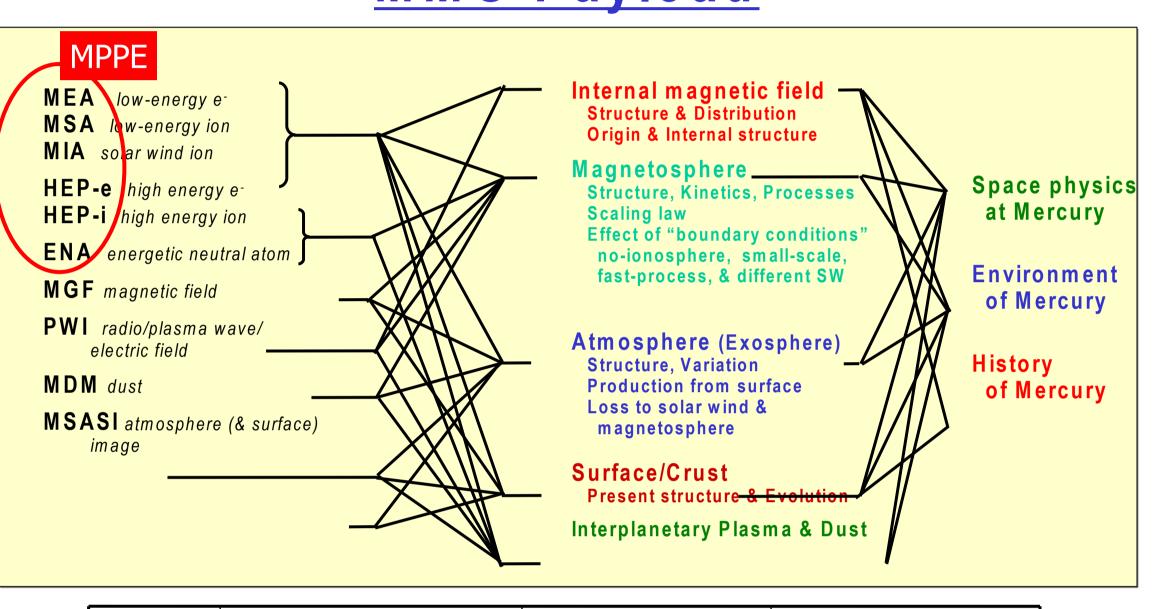
Origin & Structure of Magnetic Field

Why do planets have magnetic field? Mercury provides the first chance to compare the magnetic field with Earth.

Magnetosphere: Similar or Different?

Mercury's special magnetosphere without thick atmosphere will provide another view of the planetary magnetosphere.

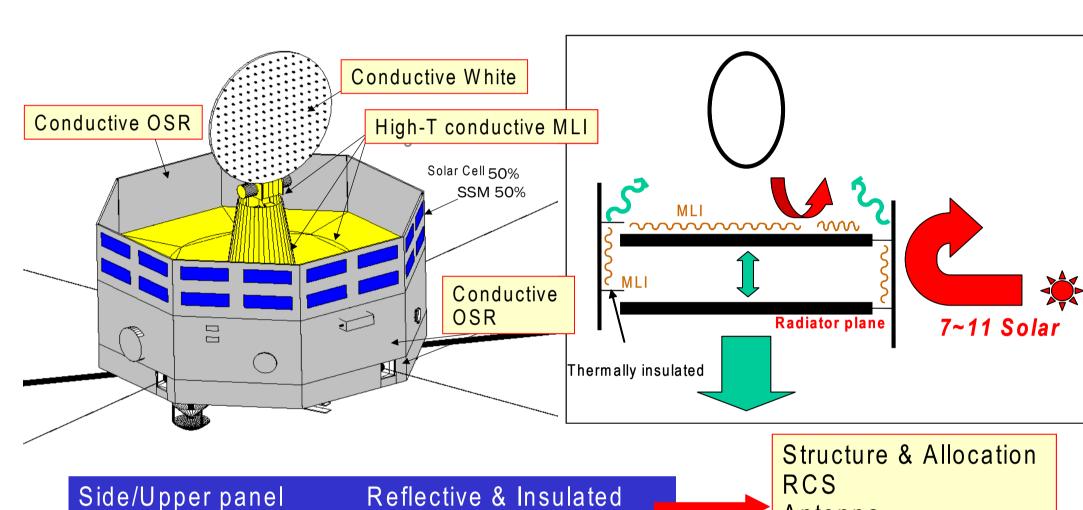
MMO Payload



MPPE	Mercury Electron Analyzer (MEA)	Low-energy electrons	3eV ~ 30keV, dt=1sec
	Mercury Ion Analyzer (MIA)	Low-energy ions	5eV ~ 30keV、dt=2sec
	Ion Mass Spectrometer (MSA)	Ion mass spectroscopy	5eV ~ 40keV \ dt=2sec m/dm=40/15
	High-Energy Ions (HEP-ion)	High-energy ions	30keV ~ 1MeV, dt=4sec
	High-Energy Electrons (HEP-ele)	High-energy electrons	30keV ~ 700keV, dt=4sec
	Energetic Neutral Atmos (ENA)	Plasma imaging	<25eV ~ 3.3keV, dt=80sec
Mermag-M	Magnetic Field Investigation (MGF)	Magnetic field	DC ~ 64Hz [MAST:5m]
PWI	Plasma Wave Investigation (PWI)	Electric field, Plasma wave, Radio wave	DC ~ 10MHz (E) [probe:15m x 4] few ~ 640kHz (B) [MAST:5m]
MSASI	Mercury Imaging Camera (MIC)	Na-atmosphere image	FOV ~8°
MDM	Mercury Dust Moniter (MDM)	Interplanetary Dust	PZT

Thermal Design: The most critical area

~Endurance in "7-11 Solar" ~

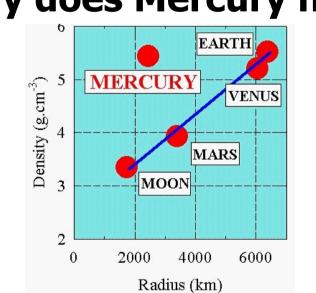


Magnetic Field & Internal structure

Science

Mercury

Internal structure What does internal structure look like? Why does Mercury have large core?



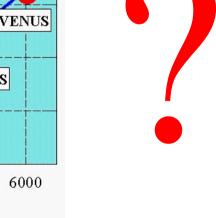
Magnetic field

Origin:

Global view

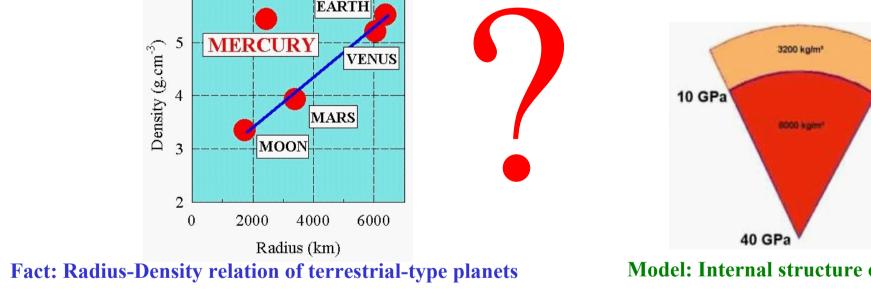
Is "analogical view" true?

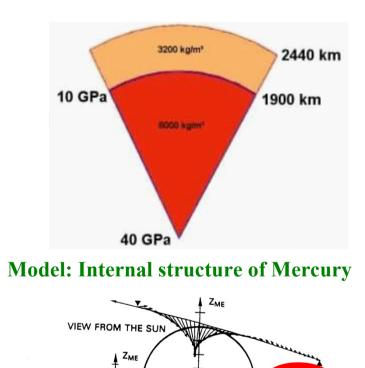
Expectation: Model of Herman magnetosphere

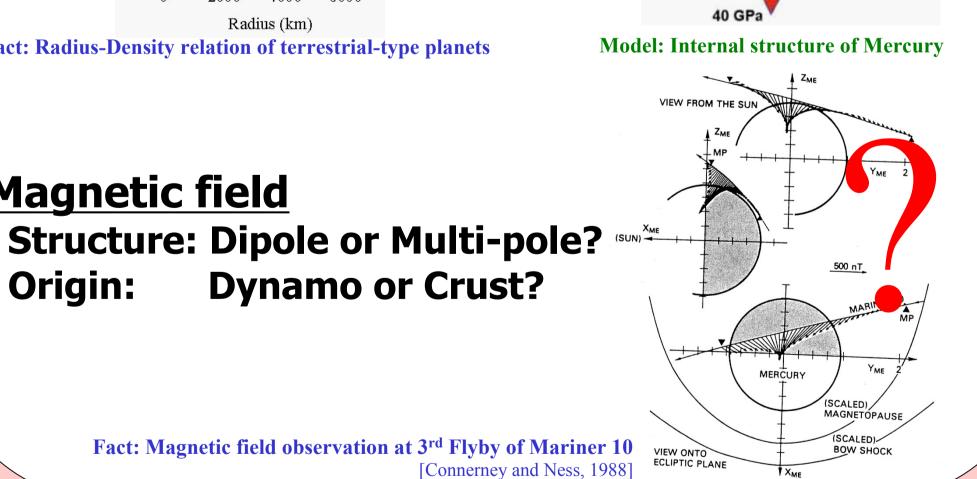


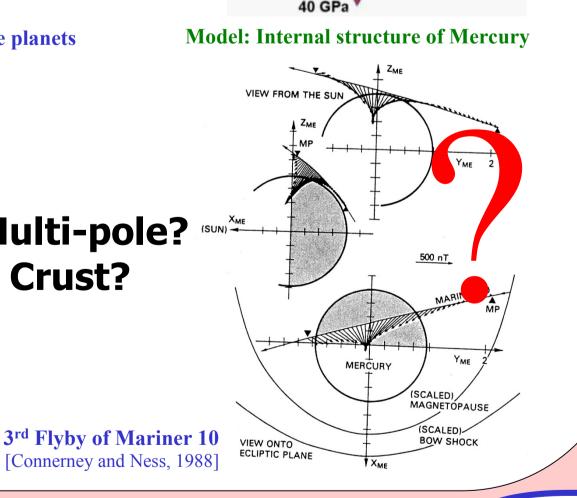
Dynamo or Crust?

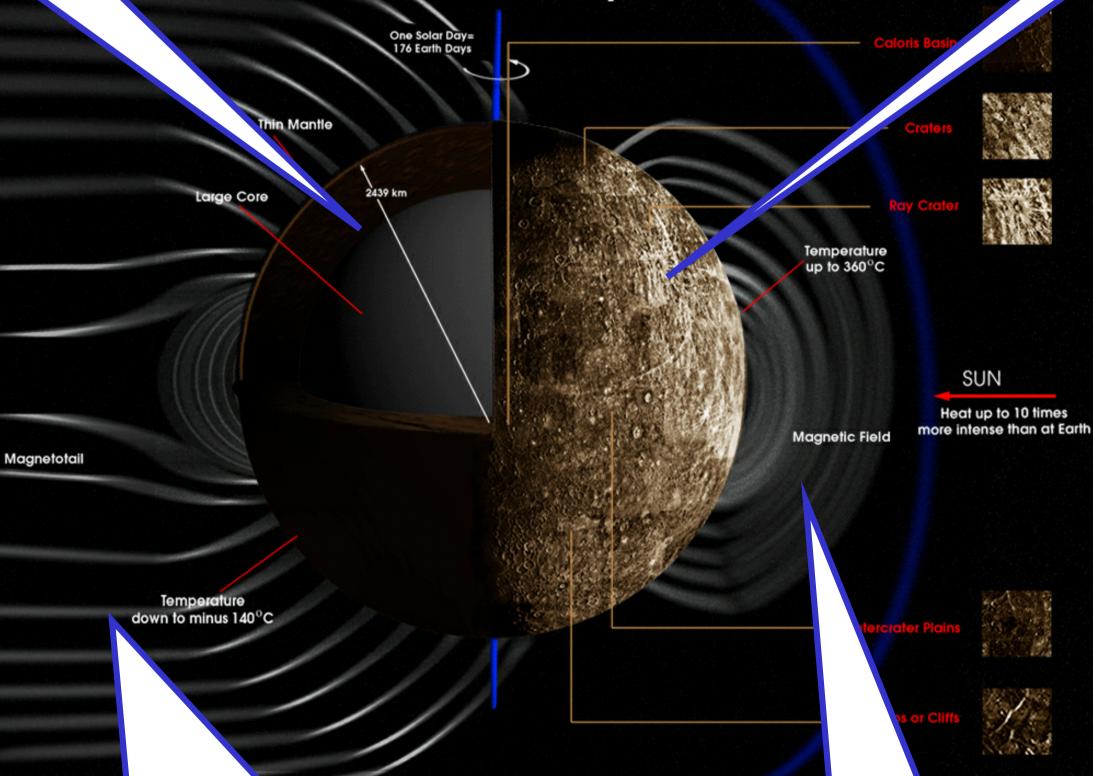
- How is "the small-scale magnetosphere"?





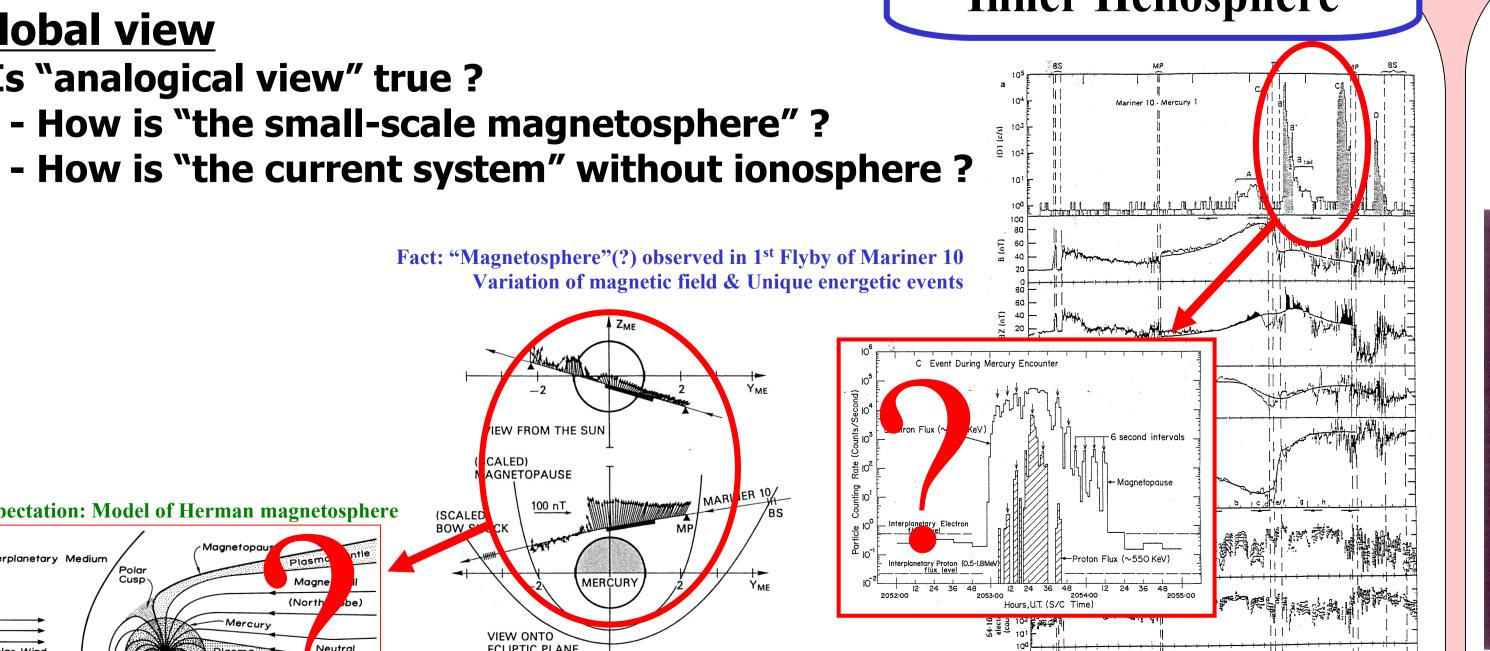






Magnetosphere &

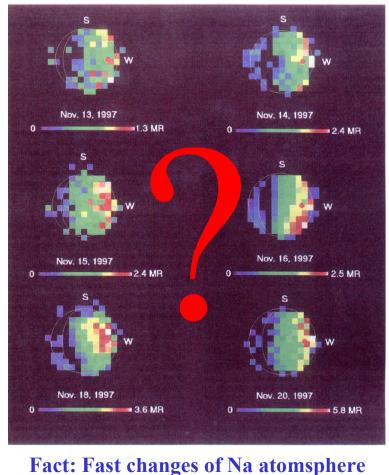
Inner Heliosphere

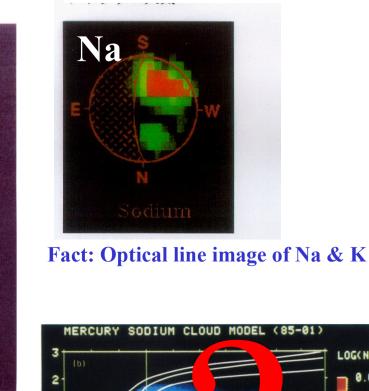


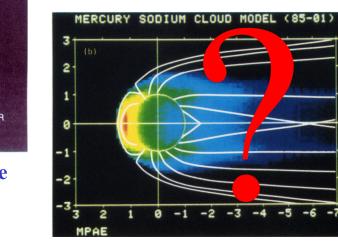
Energetic process How is the acceleration / heating process? How is the scale effects?

Exosphere

Structure & Composition What is the origin? How and why is the fast variability?







Expectation: Spatial distribution of Na

Surface

Structure & Composition

When and how did the crust form? **Unknown region: Ice on the pole? Volcano?**





Antenna

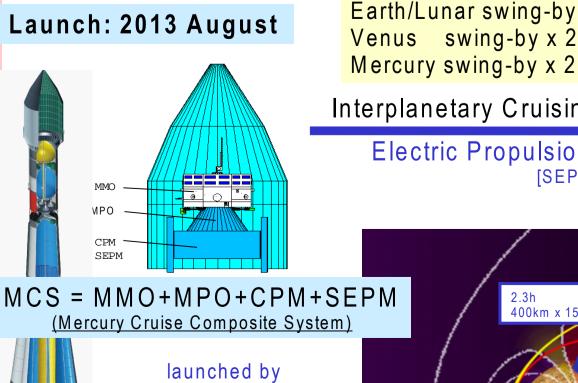
Separation mechanics

Fact: Image taken by Mariner 10 **Expectation: Spectroscopy of Lunar surface**

Surface / Exosphere / Magnetosphere / **Heliosphere interactions** How are the relationship between them

through photon, fields, particles, dusts, etc.?

Mission Scenario



Soyuz Fregat 2B

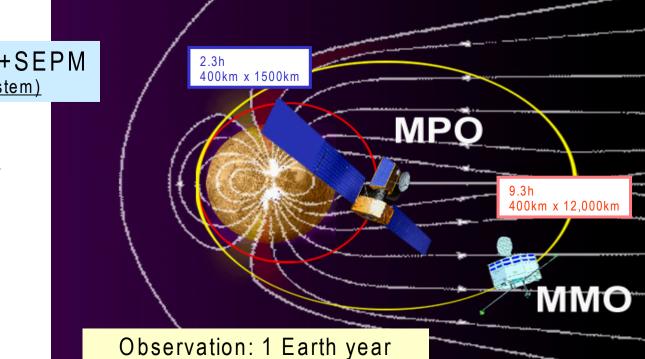
from Kourou

Red:

Blue:

Mercury swing-by x 2 Interplanetary Cruising **Electric Propulsion**

Arrival: 2019 August Mercury Orbit Insertion Chemical Propulsion



JAXA/BepiColombo Project Office: http://www.stp.isas.jaxa.jp/mercury/