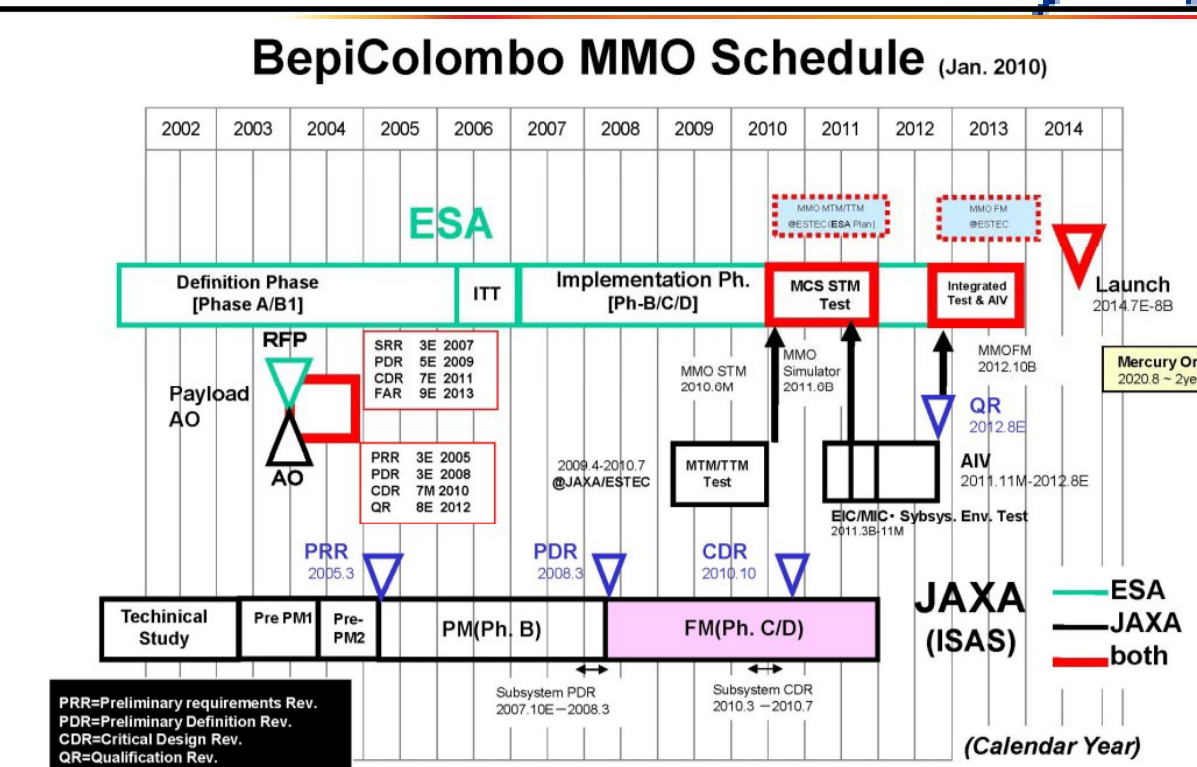


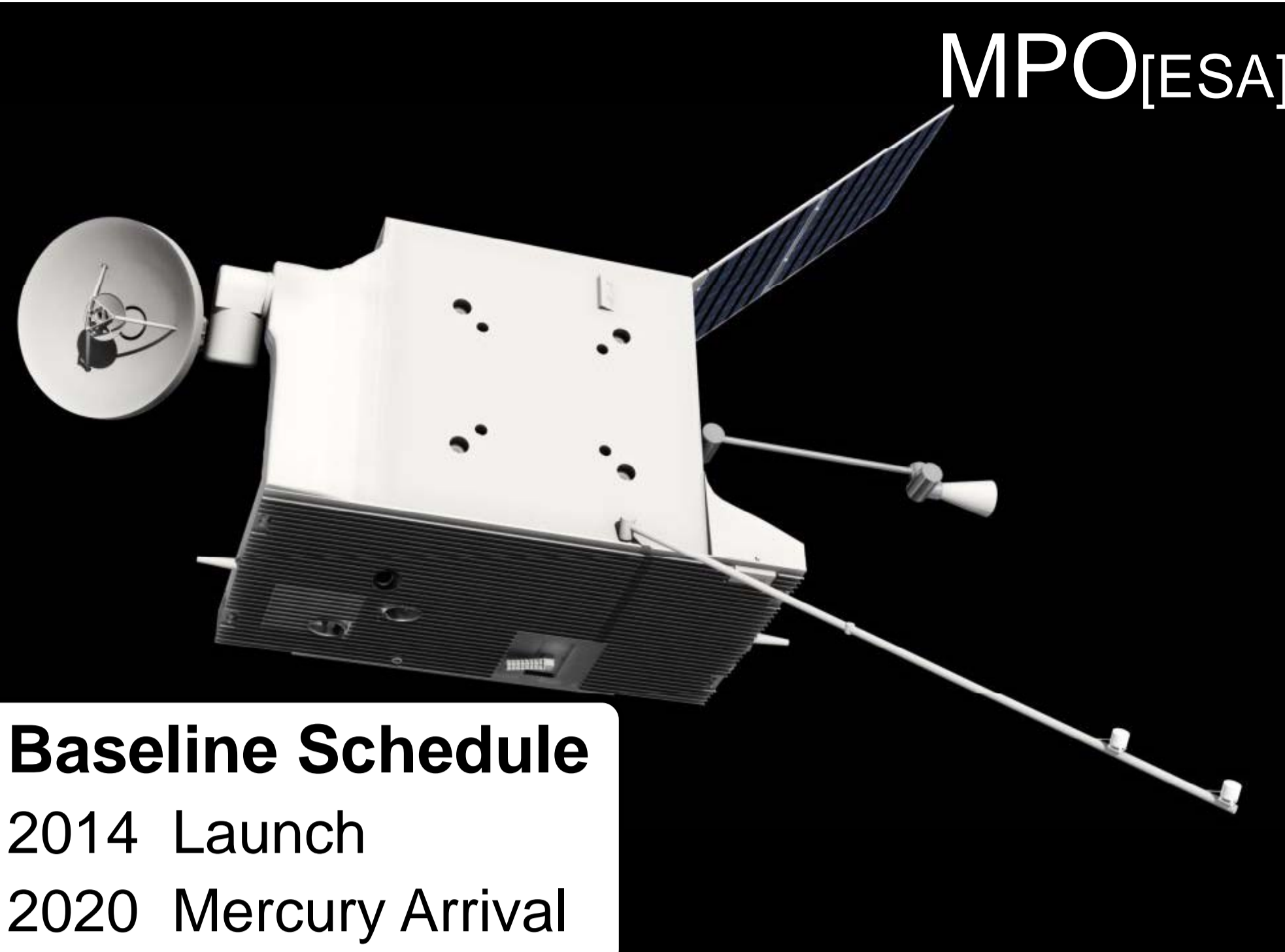
Hajime HAYAKAWA (ISAS/JAXA)
Hironori MAEJIMA (ISAS/JAXA)
BepiColombo Project Team

First full-scale Euro-Japan joint mission

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



MMO_[JAXA]



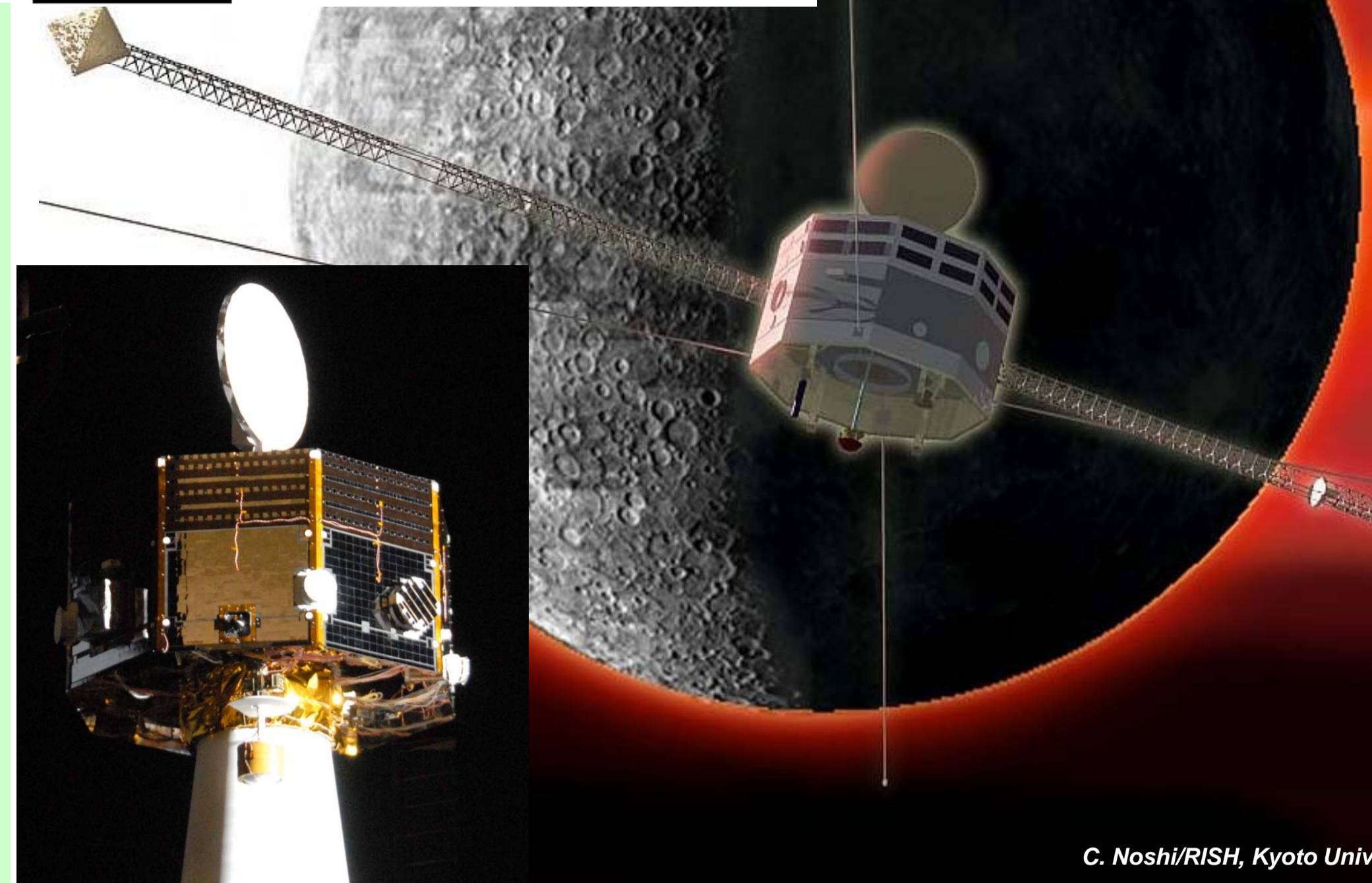
Baseline Schedule
2014 Launch
2020 Mercury Arrival

MMO (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.



C. Noshi/RISH, Kyoto Univ.

BepiColombo Science Team

Project Scientist: J. Benkhoff (ESA/ESTEC)

MPO Science Sub-Group

[Altimeter]

BELA (Laser Altimeter)
Co-PI: N. Thomas (U. Bern, Switzerland)
T. Spohn (DLR, Germany)

[Radio Science]

ISA (Accelerometer)
PI: V. Iafolla (CNR-IFSI, Italy)

MORE (Ka-band trans.)
PI: L. Iess (Univ. Rome, Italy)
Co-PI: S. Asmar (JPL, USA)

[Magnetic field]

MERMAG (Magnetometer)
PI: K.H. Glassmeier (TU-BS, Germany)
Deputy PI: C.M. Carr (ICL, UK)

[Image & V-NIR Spectrum]

SIMBIO-SYS
PI: E. Flamini (ISA, Italy)
Co-PI: F. Capaccioni (INAF-IASF, Italy)
L. Colangeli (INAF-OAdC, Italy)
G. Cremonese (INAF-OAdP, Italy)
A. Doressoundiram (LESIA, France)
O. Fornari (IAS, France)
J. L. Josset (SPACE-X, Switzerland)

[IR]

MERTIS-TIS
PI: E.K. Jessberger (U. Munster, Germany)

[γ & neutron]

MGNS
PI: I. Mitrofanov (IKI, Russia)

[X-ray]

MIXS (spectrometer)
PI: G. Fraser (Univ. Leicester, UK)
Co-PI: K. Muinonen (U. Helsinki, Finland)

[SIXS (Solar monitor)]

PI: J. Huovelin (Univ. Helsinki, Finland)
Co-PI: M. Grande (RAL, UK)

[UV]

PHEBUS (spectrometer)
PI: E. Chassefiere (SA/PSL, France)
Co-PI: S. Okano (Tohoku Univ.)
O. Korabely (IKI, Russia)

[Neutral / Ion particles]

SERENA
PI: S. Orsini (CNR-IFSI, Italy)
Co-PI: S. A. Livi (JHU, USA)
S. Barabash (IRF, Sweden)
K. Torkar (SRI, Graz, Austria)

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 Science Sub-Group

Project Scientist: M. Fujimoto (ISAS/JAXA, Japan)
(Deputy) Y. Kasaba (Tohoku Univ. Japan),
T. Takashima (ISAS/JAXA, Japan)

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

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

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

PI: Y. Saito (ISAS/JAXA, Japan)
Co-PI: J.-A. Sauvaud (CESR-CNRS, France), M. Hirahara (Rikkyo Univ., Japan),
S. Barabash (IRF, Sweden)
Members: Japan, France, Sweden, UK, 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.

PI: Y. Kasaba (Tohoku Univ., Japan)
Co-PI: 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 Sodium Atmosphere Spectral Imager
studies thin sodium atmosphere of Mercury.

PI: I. Yoshikawa (Univ. Tokyo, Japan)
Co-PI: O. Korabely (IKI, Russia)
Members: Japan, Russia, Italy, USA

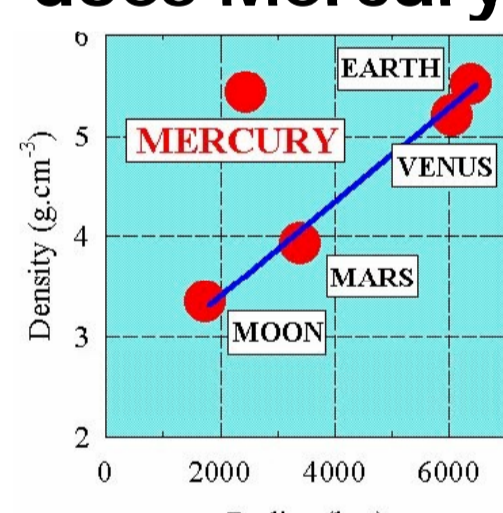
MDM Mercury Dust Monitor
studies dust from the planet and interplanetary & interstellar space.
PI: K. Nogami (Dokkyo Univ., Japan)
Members: Japan, Germany

Science

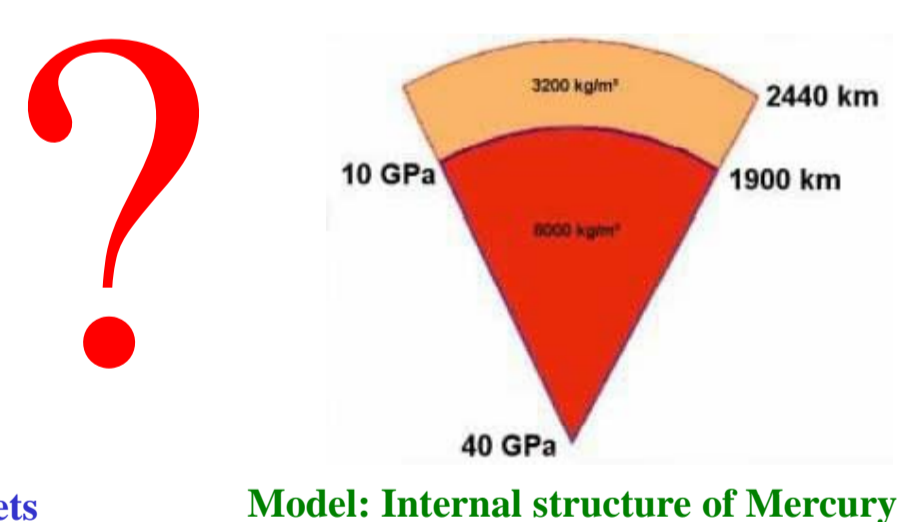
Magnetic Field & Internal structure

Internal structure

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



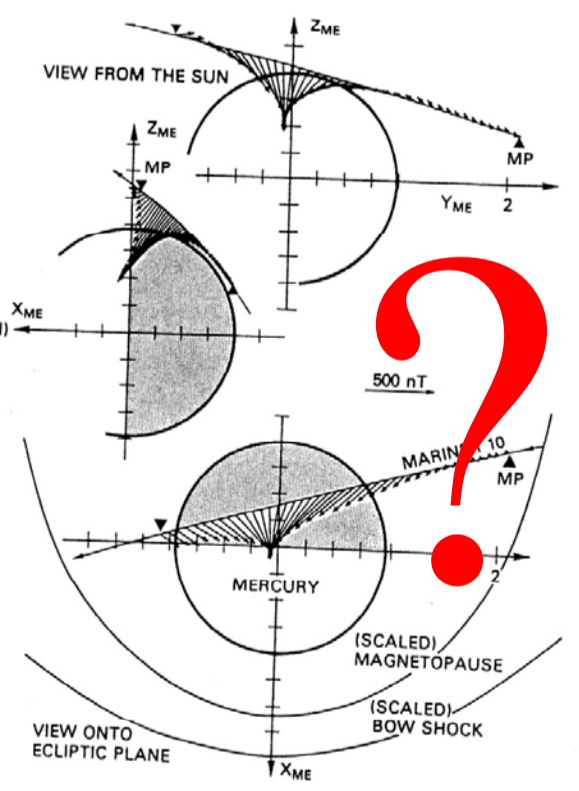
Fact: Radius-Density relation of terrestrial-type planets



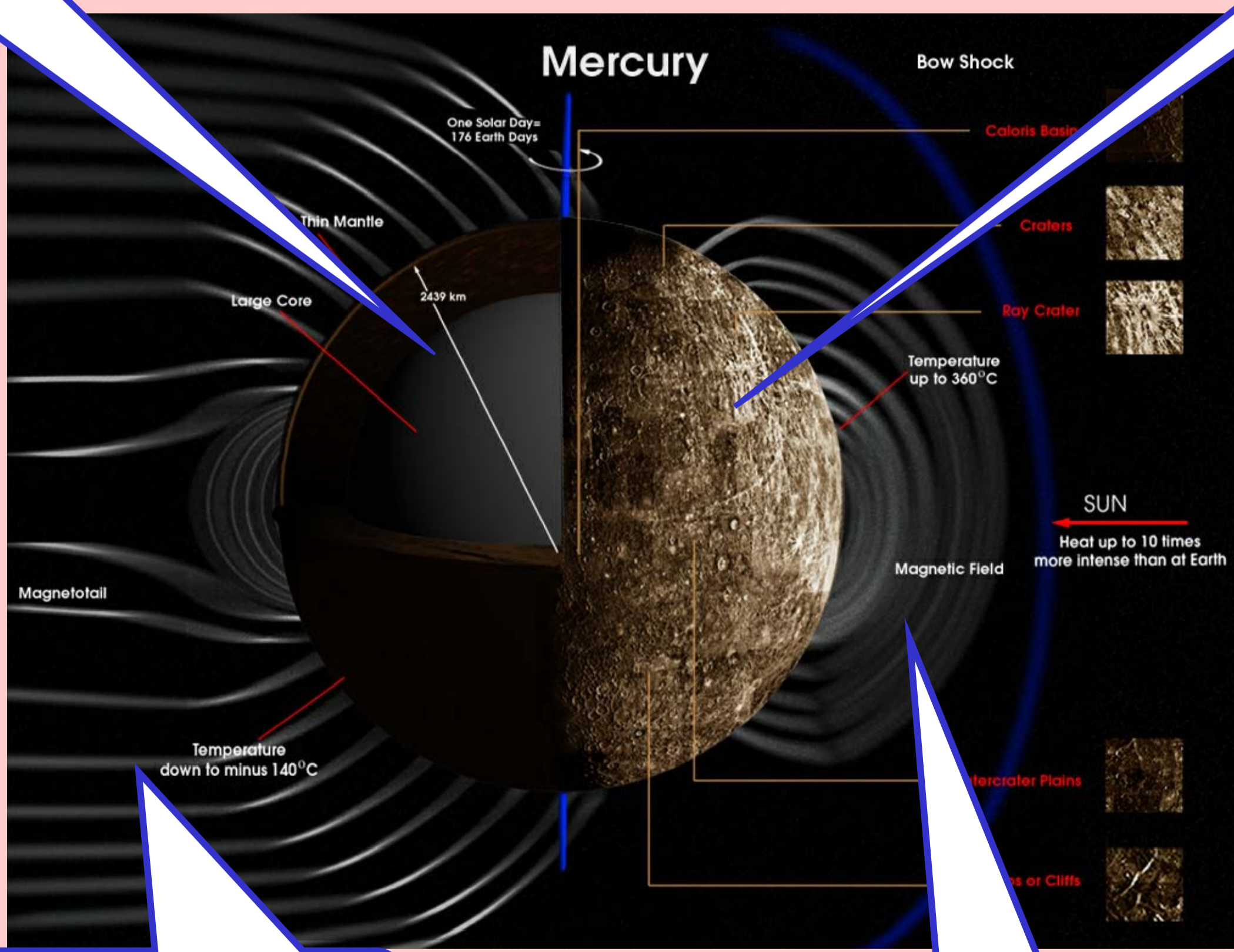
Model: Internal structure of Mercury

Magnetic field

Structure: Dipole or Multi-pole?
Origin: Dynamo or Crust?



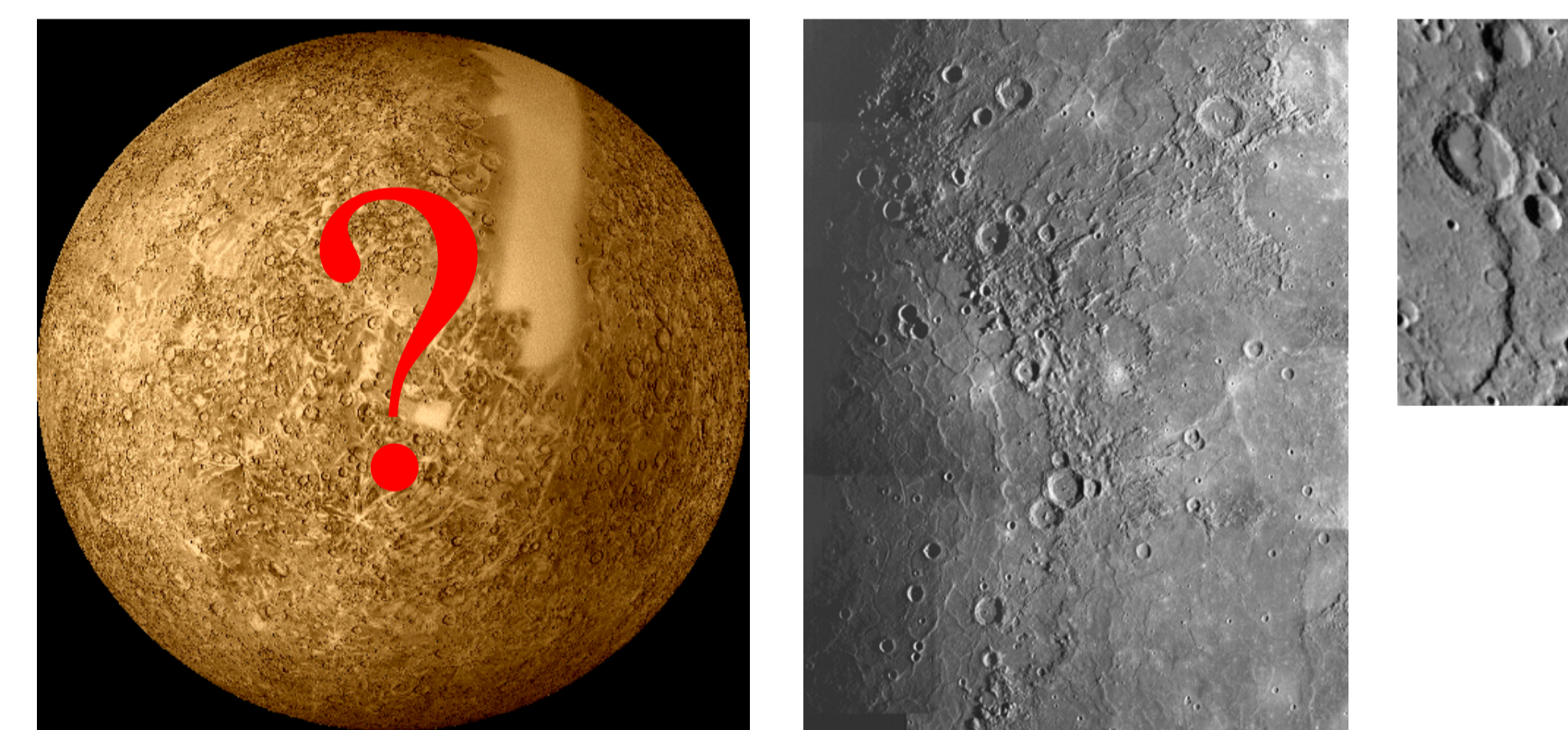
Fact: Magnetic field observation at 3rd Flyby of Mariner 10 [Connerney and Ness, 1988]



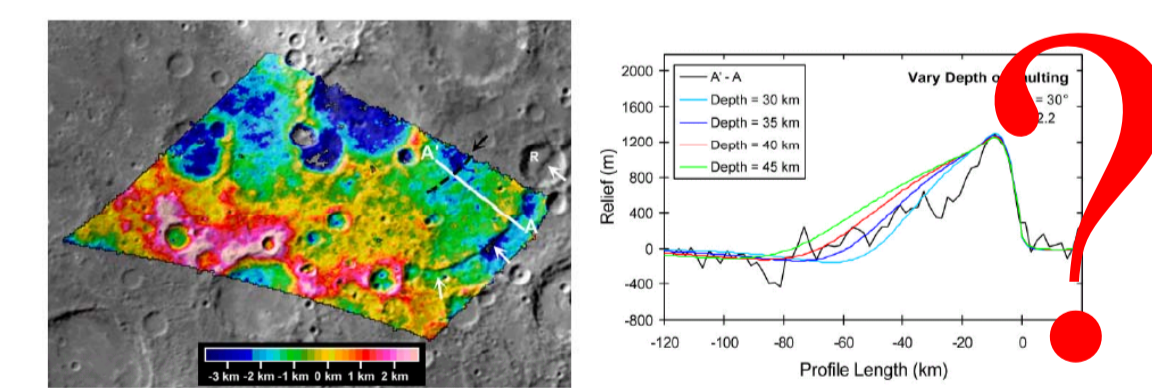
Surface

Structure & Composition

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



Fact: Image taken by Mariner 10



Expectation: Spectroscopy of Lunar surface

Surface / Exosphere / Magnetosphere / Heliosphere interactions

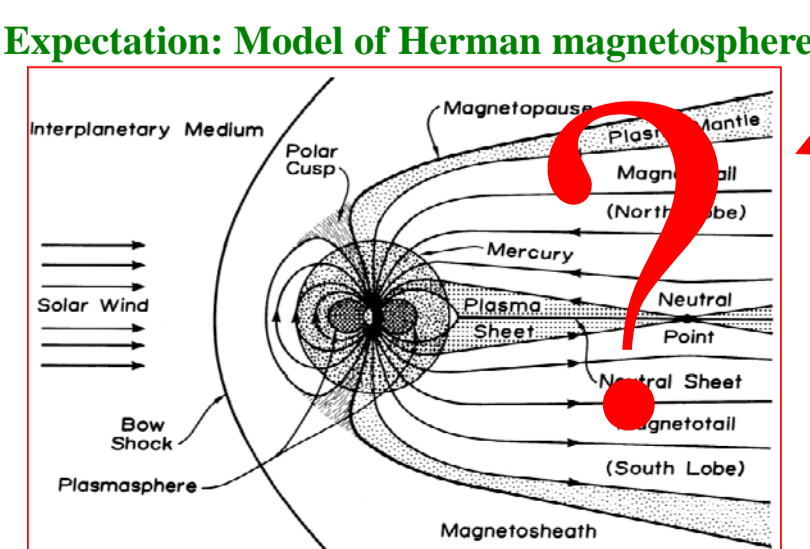
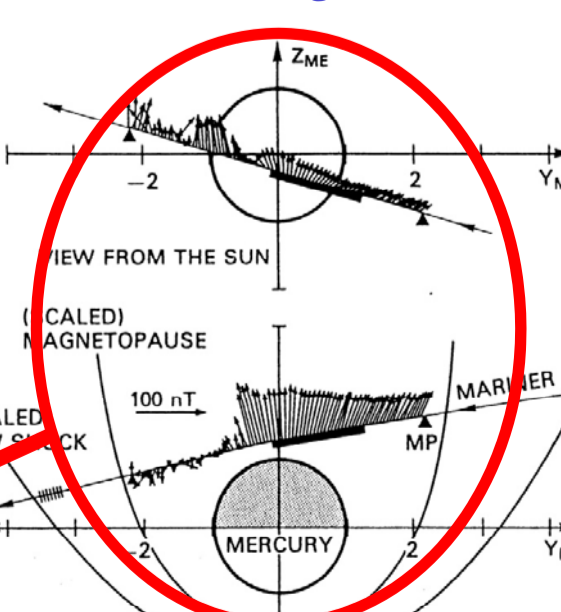
How are the relationship between them through photon, fields, particles, dusts, etc.?

Global view

Is "analogical view" true ?

- How is "the small-scale magnetosphere" ?
- How is "the current system" without ionosphere ?

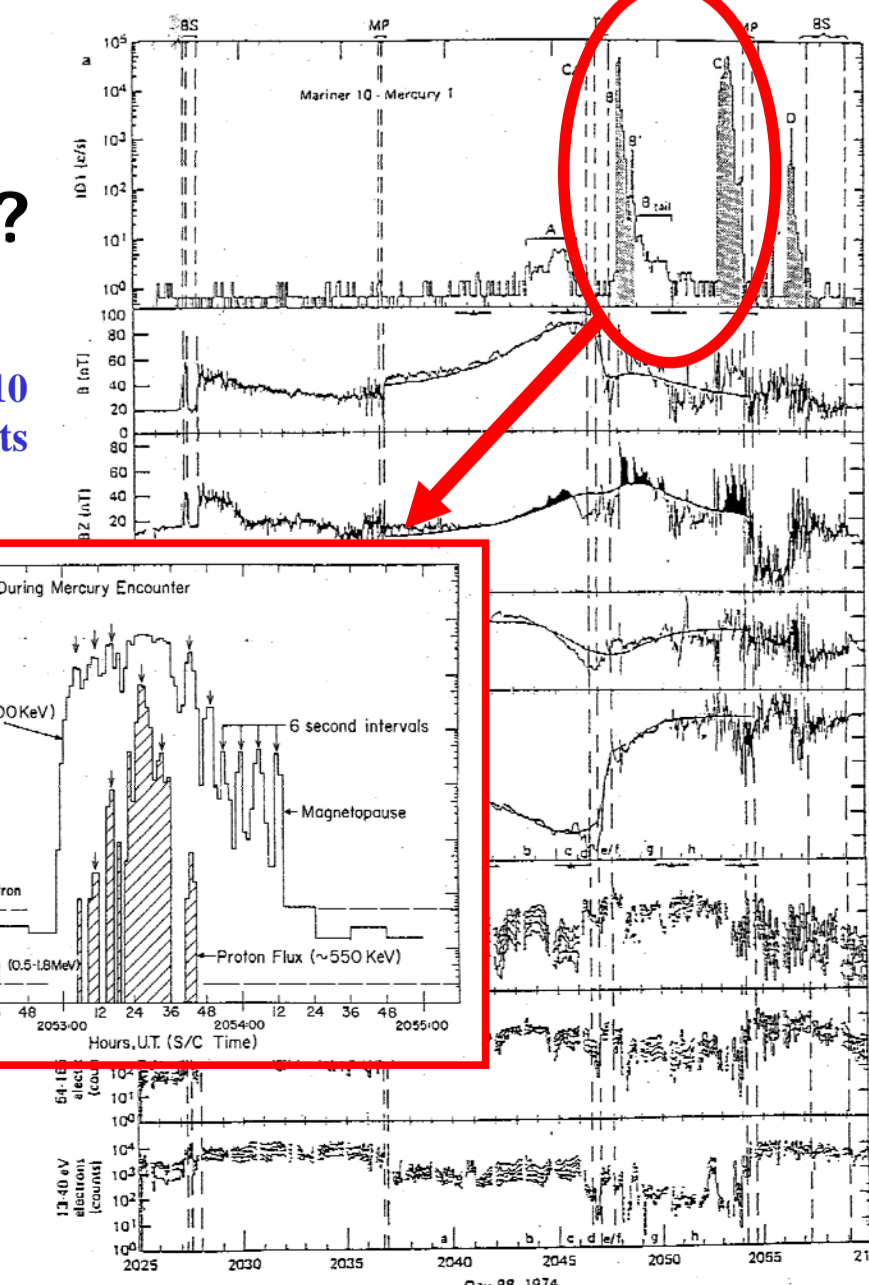
Fact: "Magnetosphere" (?) observed in 1st Flyby of Mariner 10
Variation of magnetic field & Unique energetic events



Energetic process

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

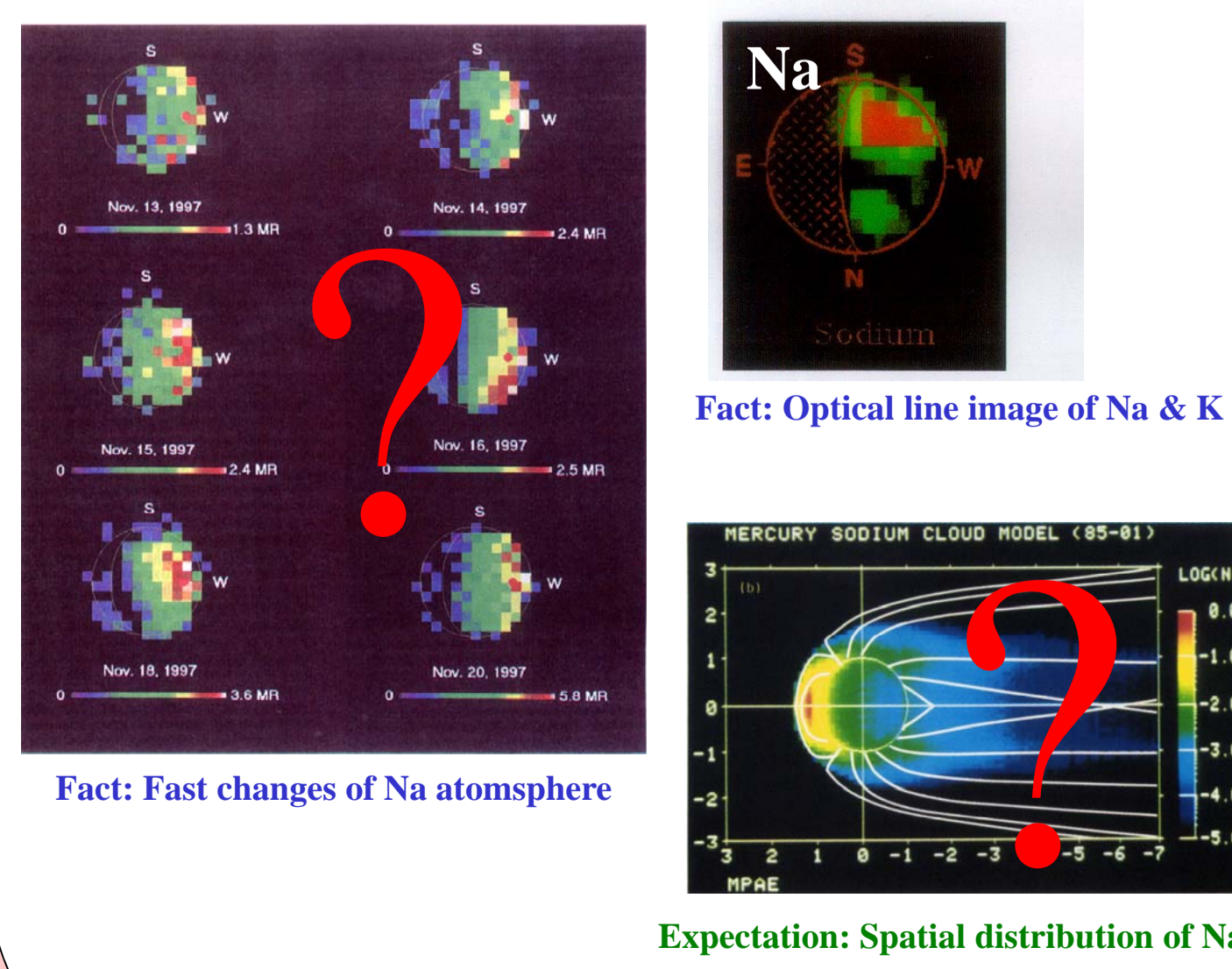
Magnetosphere & Inner Heliosphere



Exosphere

Structure & Composition

What is the origin ?
How and why is the fast variability ?

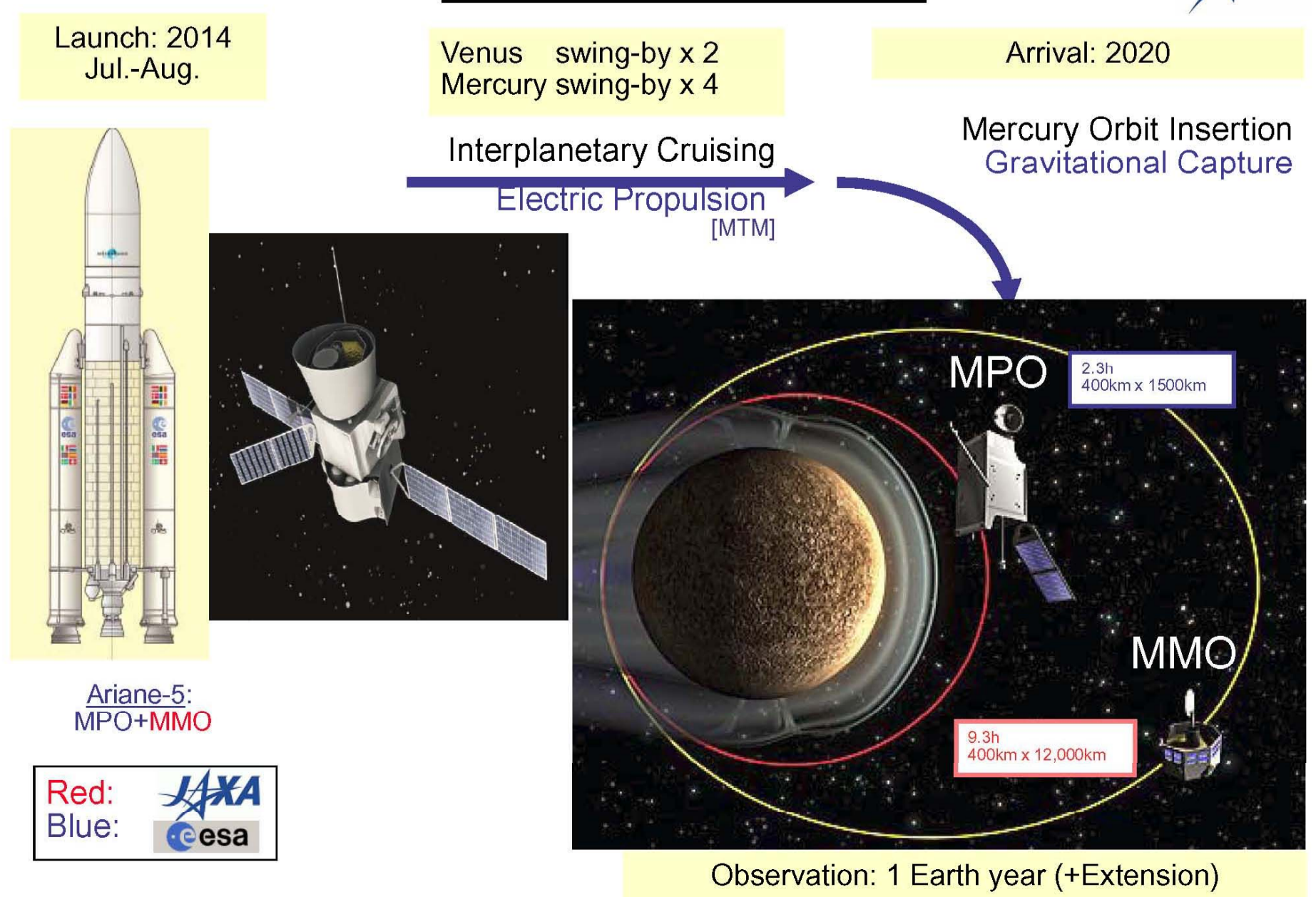


Fact: Optical line image of Na & K

Fact: Fast changes of Na atmosphere

Expectation: Spatial distribution of Na

Mission Scenario



Launch: 2014 Jul.-Aug.
Venus swing-by x 2
Mercury swing-by x 4
Interplanetary Cruising
Electric Propulsion [MTM]
Mercury Orbit Insertion
Gravitational Capture
Arrival: 2020
MPO: 2.3h, 400km x 1500km
MMO: 9.3h, 400km x 12,000km
Observation: 1 Earth year (+Extension)