

A detailed illustration of the MESSENGER spacecraft in orbit around the planet Mercury. The spacecraft is shown from a side-on perspective, featuring a central body with various instruments and two large, rectangular solar panel arrays extending outwards. The planet Mercury is a large, brownish, cratered sphere on the right side of the frame. The background is a dark, star-filled space with a bright light source in the upper left corner. The text "What We Learnt About Mercury: From MESSENGER to BEPI-COLOMBO" is overlaid in the center in a white, serif font.

# What We Learnt About Mercury: From MESSENGER to BEPI-COLOMBO

# A Little About Myself

- Went to U.S after NS in 2010 for college
- Graduated from University of Colorado in Physics and Astronomy
  - First MESSENGER research project with Prof. Daniel Baker at CU LASP
- Started PhD program (space science/plasma physics) at University of Michigan in 2012
  - Finished my dissertation on Mercury's magnetosphere with Prof. James Slavin and Prof. Xianzhe Jia in 2017
- Postdoctoral position in the Planetary Magnetosphere Lab at NASA GSFC since 2018.
- Research Topics: Data Analysis, Space Plasma Physics, Planetary Science, Space Weather, Earth's (and planetary) magnetosphere, Heliophysics



# Mercury

- Internal Structure:

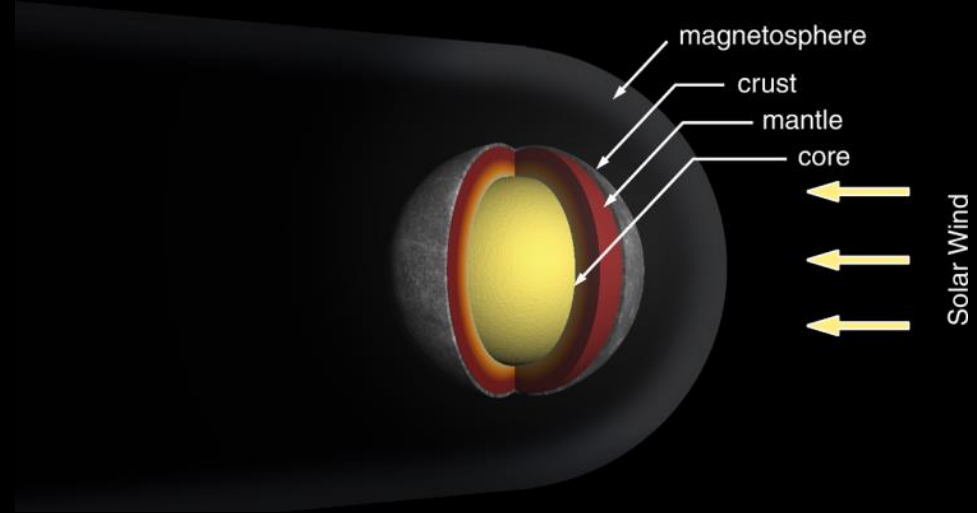
- Radius ~ 2440 km.
- Iron core radius ~ 2000 km

- Celestial Mechanics

- Mercury has the most eccentric orbit in the Solar System ( $e \sim 0.21$ ) with perihelion and aphelion ~ 0.31 and 0.46 AU, respectively.
- Slow rotator with a 59-days rotation period.
- Full orbit around the Sun every 88 Earth days

- Discovery of a global dipole magnetic field by **Mariner 10**.

- Dipole tilt relative to spin axis ~ zero degrees.
- Southward pointing dipole moment (similar to Earth) that is  $1/100^{\text{th}}$  intensity of Earth's.
- The center of dipole field has a northward offset of ~ 484 km.
- Interaction of Mercury's weak dipole field with intense solar wind conditions creates a small, intrinsic and dynamic Earth-like magnetosphere.

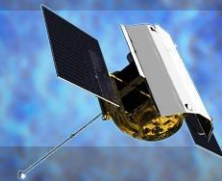




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# MESSENGER

MErcury Surface, Space ENvironment, GEochemistry, and Ranging



- **ME**rcury, **S**urface, **S**pace **EN**vironment, **GE**ochemistry and **R**anging (**MESSENGER**)
- ~\$300 million Discovery-Class NASA mission
- Launched on a Delta II rocket from Cape Canaveral Air Force Station on 3<sup>rd</sup> August 2004.
- Begin its 6.6 years long journey to Mercury with multiple Earth, Venus and Mercury flybys.
  - Went into orbital insertion on 18<sup>th</sup> March 2011 and become the first spacecraft to orbit Mercury.
- Put into a near polar (~ 80 degrees), highly elliptical, 12-hour orbit during the primary mission.
  - Periapsis ~ 200 km & Apoapsis ~ 15,000 km.
  - Orbit was changed into a 8-hour orbit during the extended phase of mission.
- Mission ended with MESSENGER crashing into Mercury's surface on 30<sup>th</sup> April 2015.



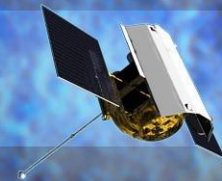




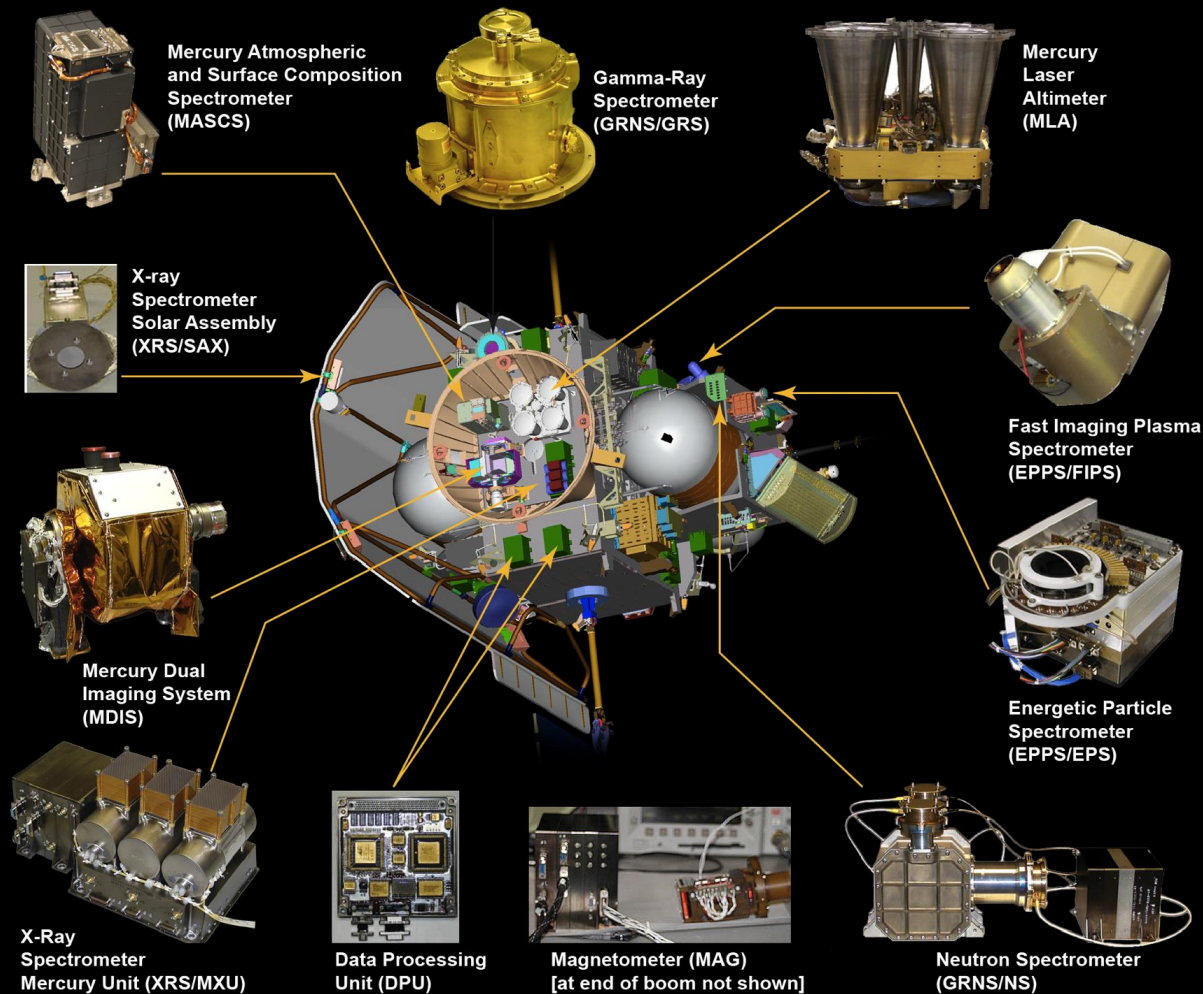
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## MESSENGER Instrument Suites



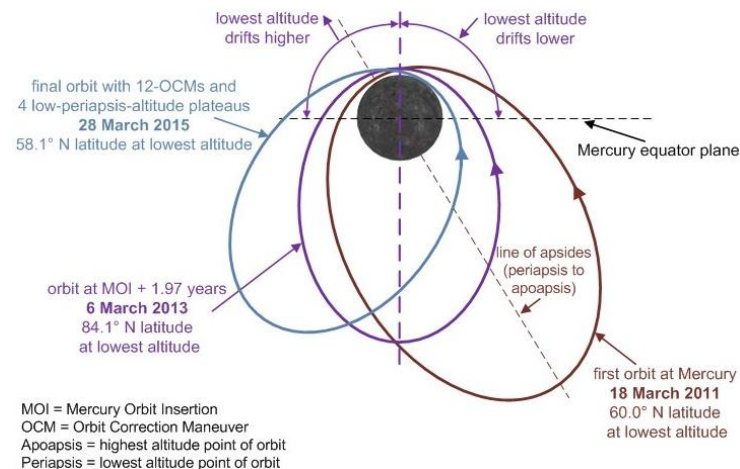
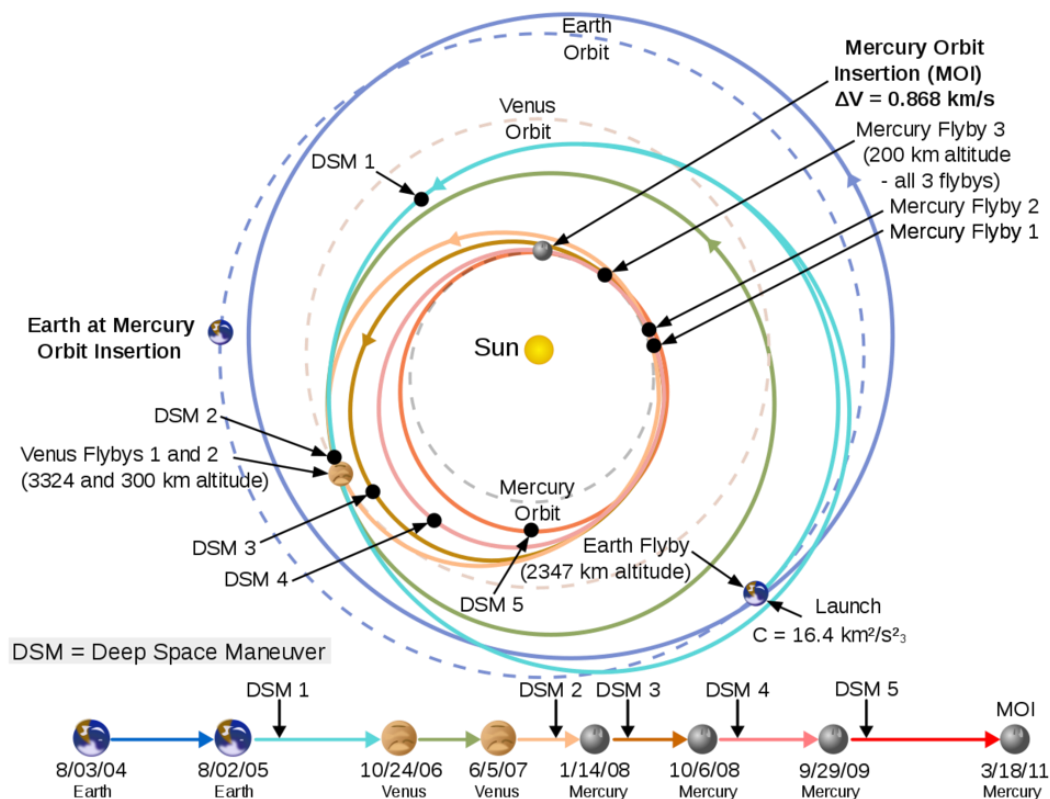
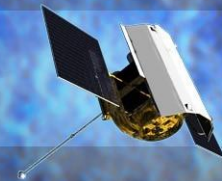
<http://messenger.jhuapl.edu/About/Spacecraft-and-Instruments.html>



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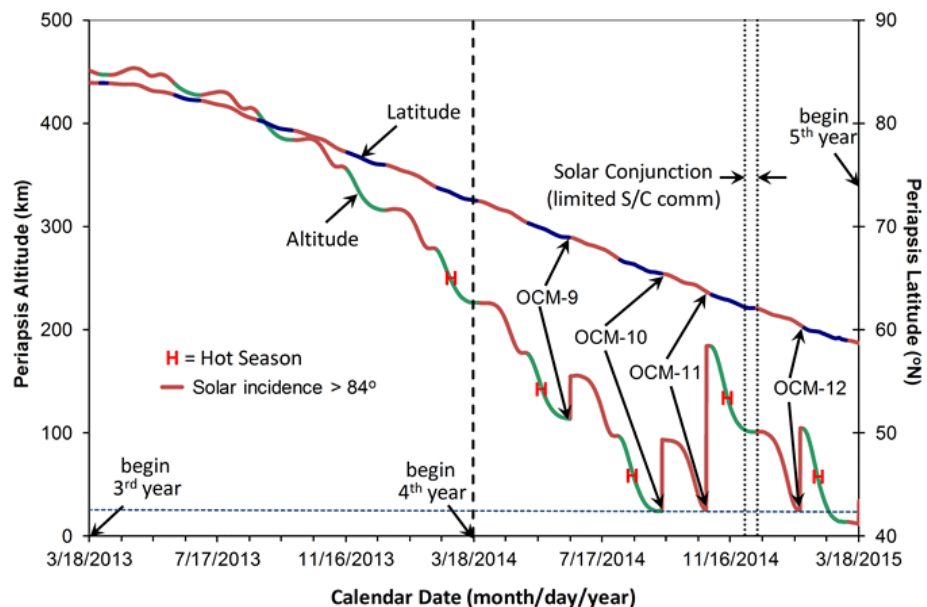
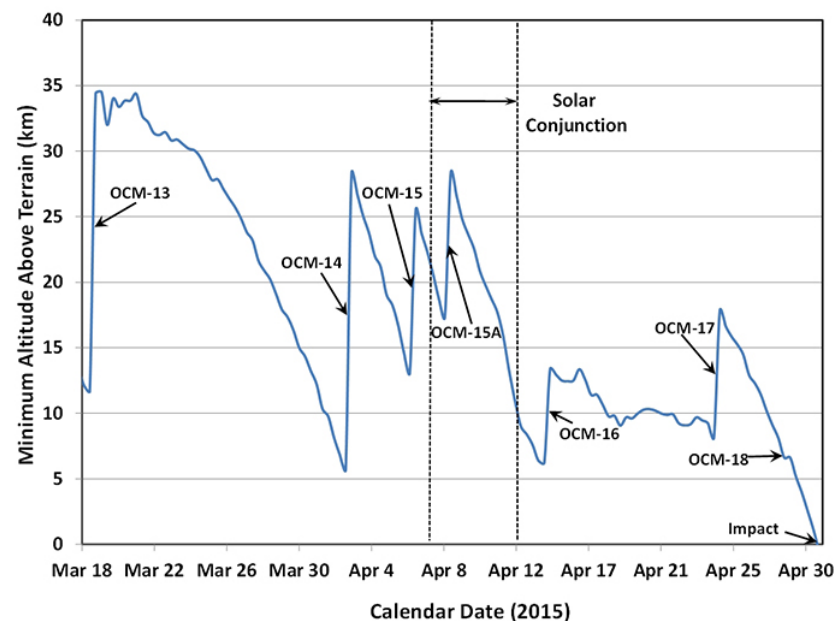
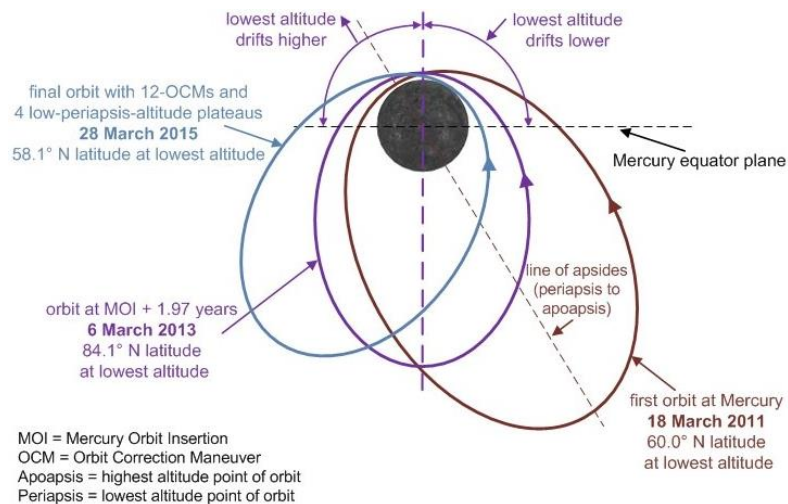
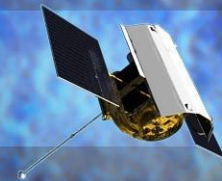
Figures from <http://messenger.jhuapl.edu>



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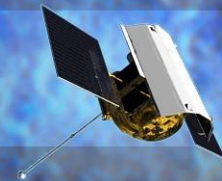




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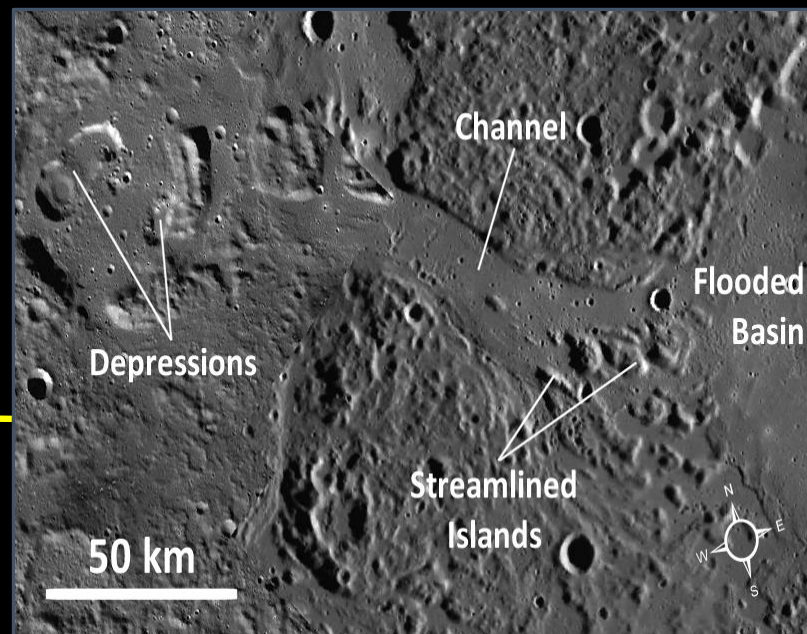
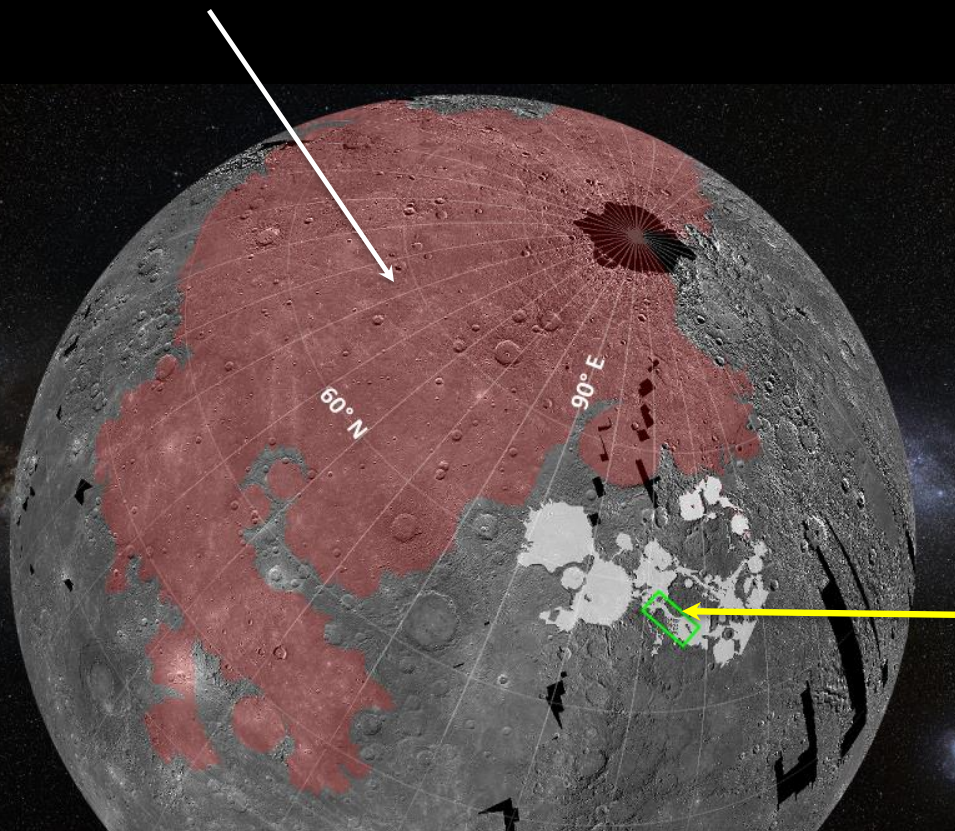
# MESSENGER

MErcury Surface, Space ENvironment, GEochemistry, and Ranging



## Geologic History: Widespread Volcanism

Northern Plains



*Head et al. [ 2011]*

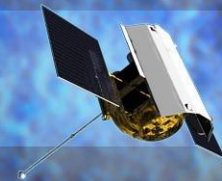




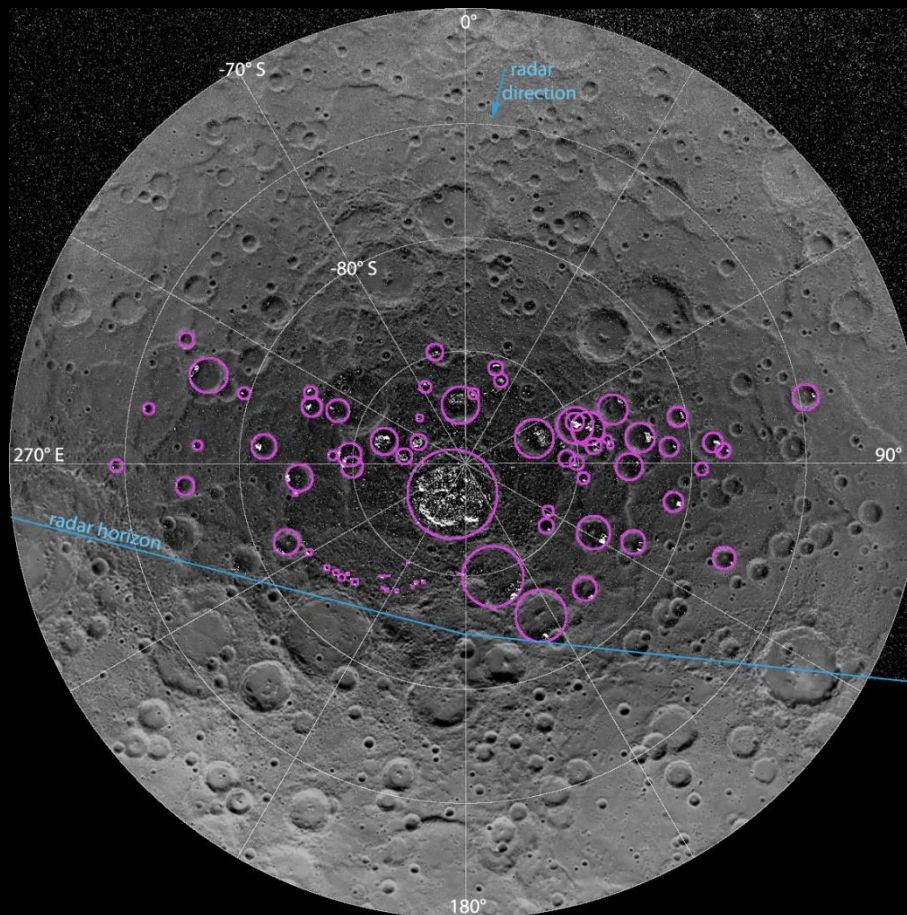
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## Ice in Permanently Shadowed Craters



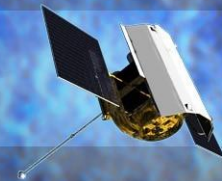
*Chabot et al. [2012]*



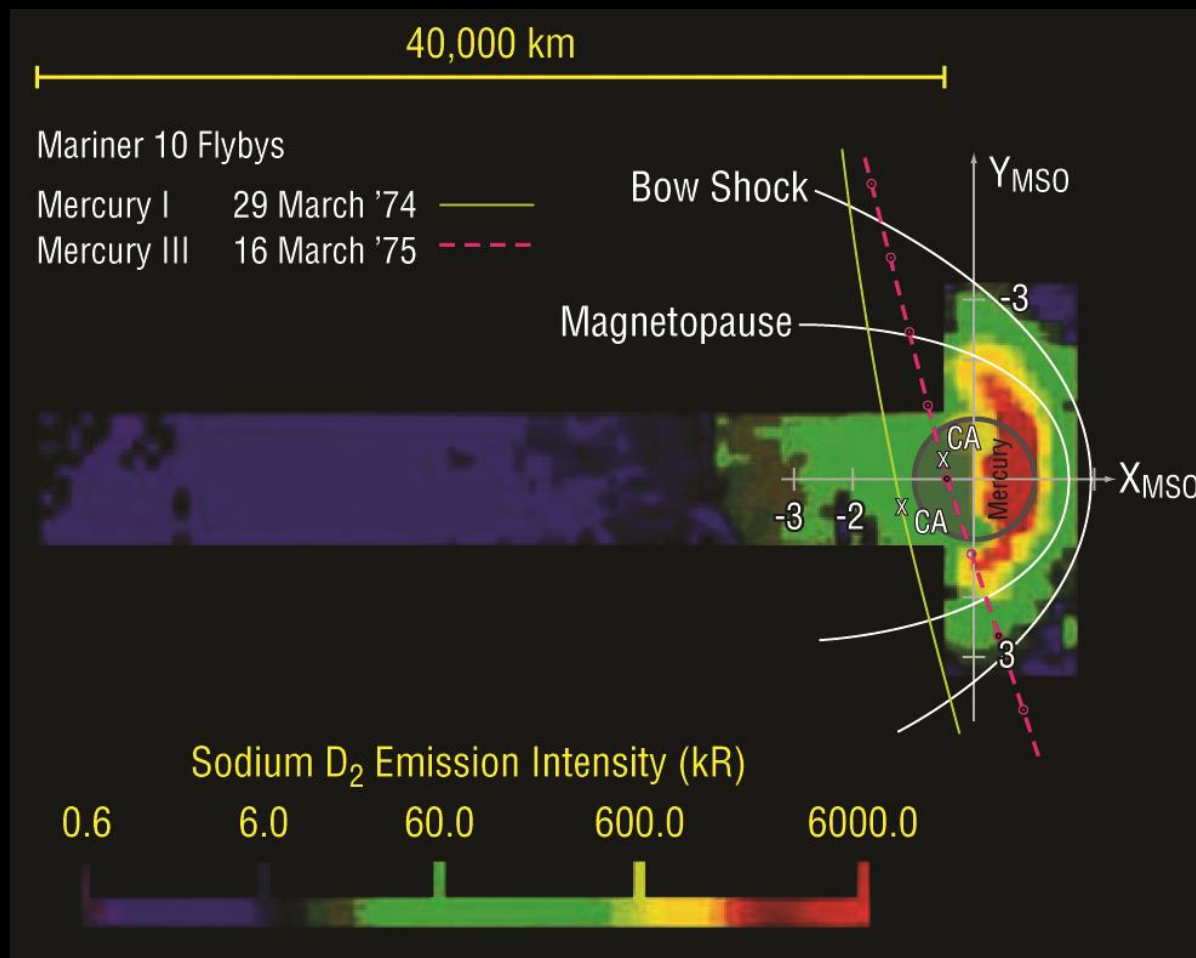
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## Mercury's Sodium Exosphere and Tail

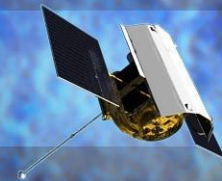




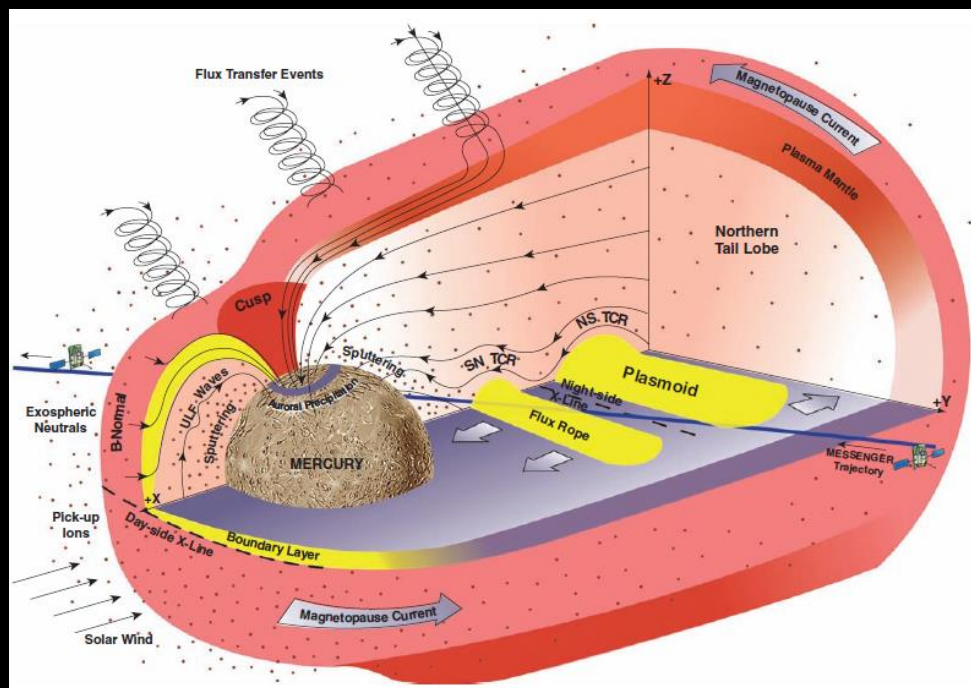
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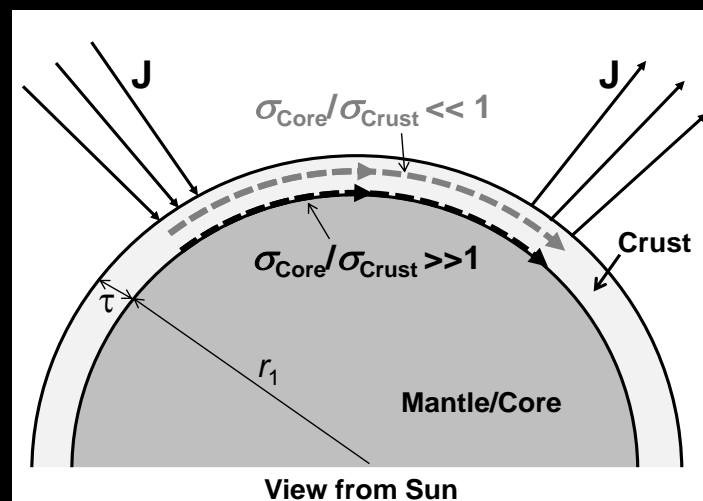
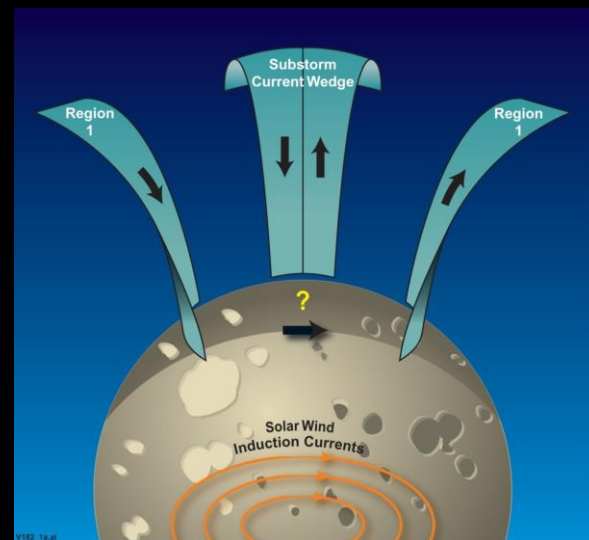
MErcury Surface, Space ENvironment, GEochemistry, and Ranging



## Most Dynamic Magnetosphere in the Solar System



*Slavin et al. [2007; 2009]*  
*Anderson et al. [2014]*







**bepicolombo**

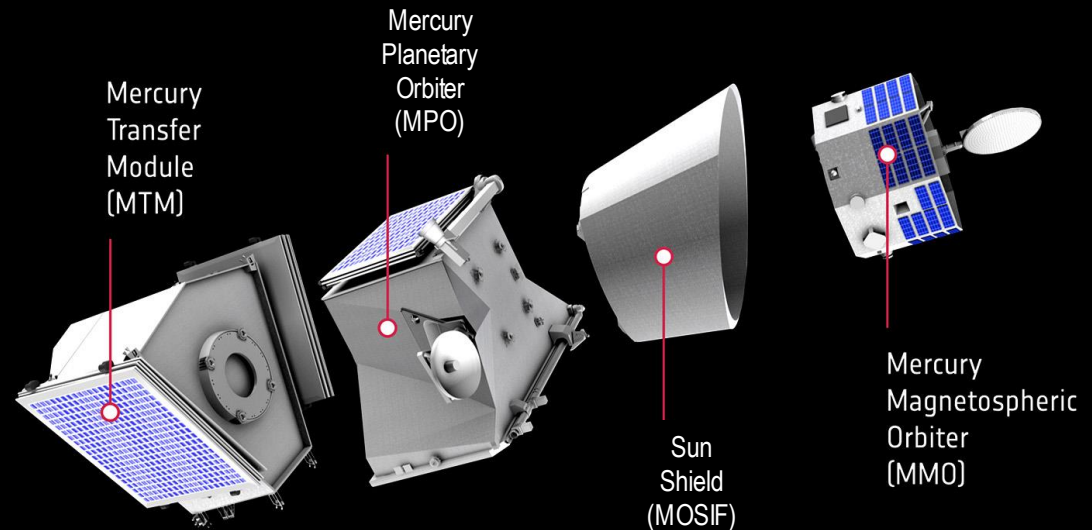
# ESA & JAXA Flagship

**Launched From ESA  
Spaceport at French  
Guiana on October  
20<sup>th</sup> 2018 on a  
Ariane 5 rocket**

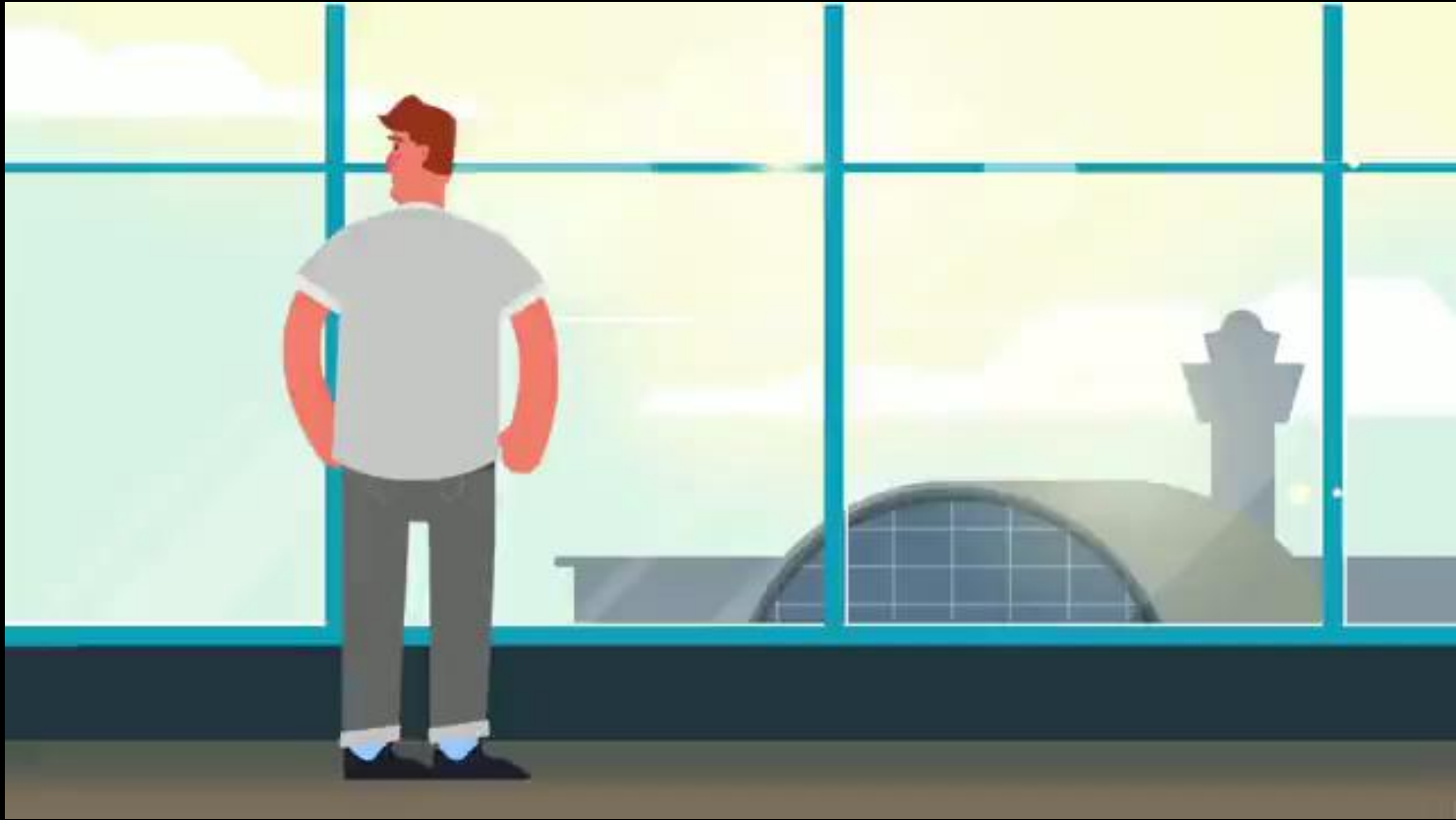


**Currently on a 7 year  
journey to Mercury. Set  
to arrive around 2026.**

**First Mercury Flyby  
coming up in October  
2021.**



Mercury Composite Spacecraft (MCS)



Credit: <http://www.airbus.com/space/space-exploration/bepicolombo.html>

# What's after Bepi-Colombo?

National Aeronautics and Space Administration



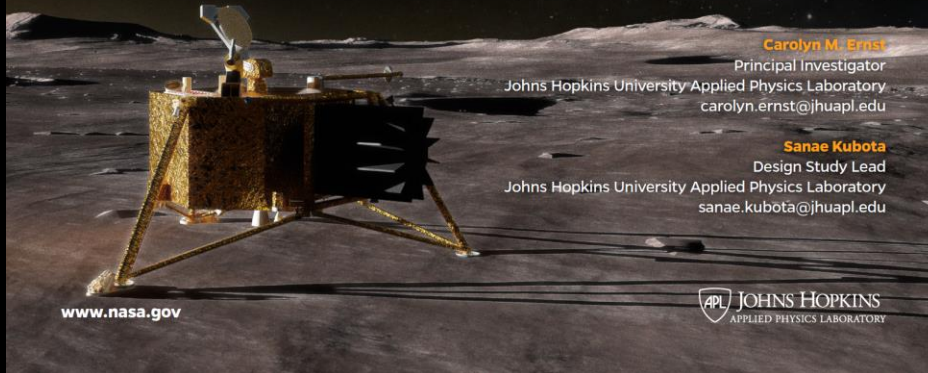
PLANETARY MISSION CONCEPT STUDY FOR THE 2023-2032 DECADAL SURVEY

## Mercury Lander

Transformative science from the surface of the innermost planet

August 08, 2020

Or Even a Sample Return?



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[www.nasa.gov](http://www.nasa.gov)

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<http://science.nasa.gov/science-red/s3fs-public/atoms/files/Mercury%20Lander.pdf>