

Journey into the Night Sky

A composite image of the Solar System. In the center is Jupiter, showing its characteristic bands of orange, red, and white. To the right is Saturn, with its prominent rings. Above Saturn are Uranus and Neptune, both appearing as blue spheres. The background is black, with a few small, distant stars visible.

The Solar System

Mercury



Mercury

In Roman mythology *Mercury* is the god of commerce and travel

It was most likely given this name because Mercury moves so quickly through the night sky.



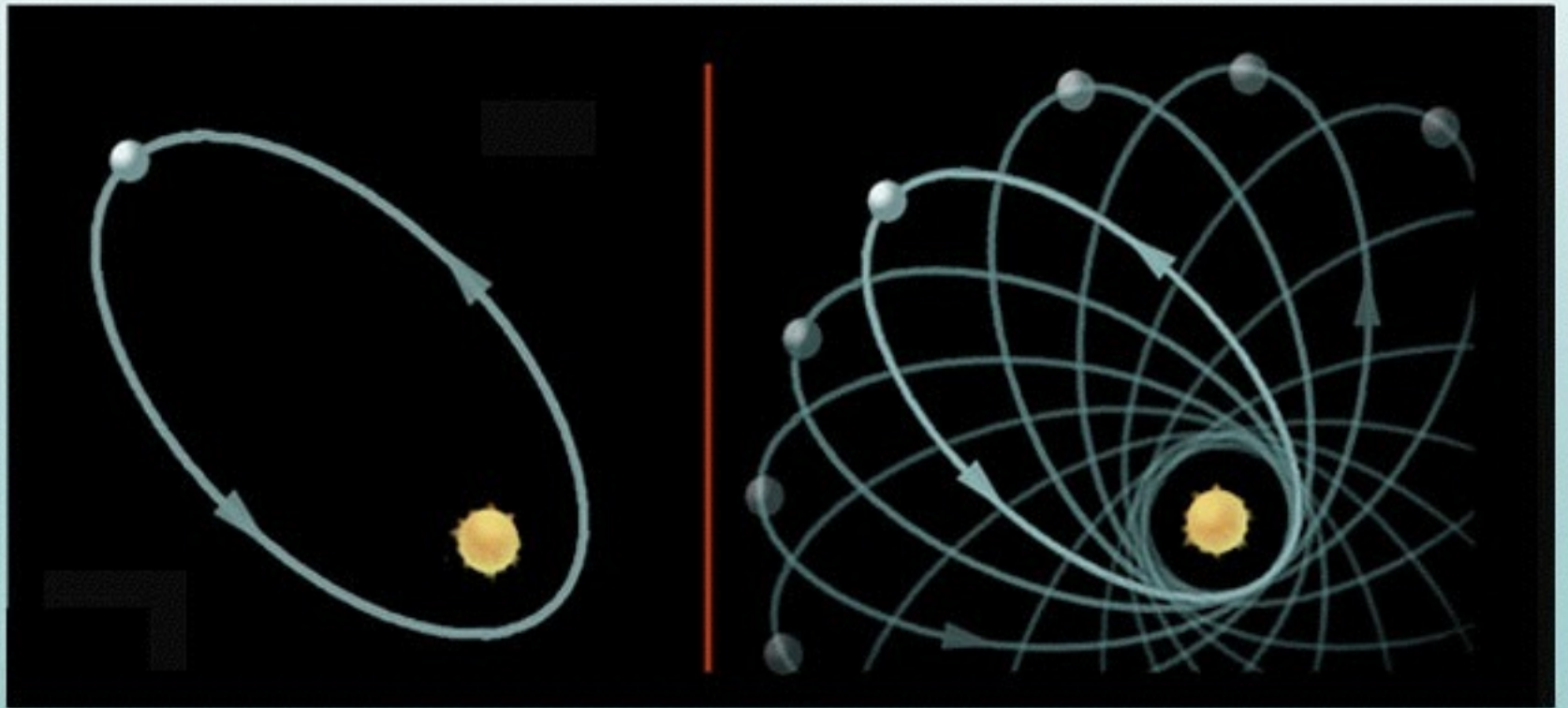
Mercury

- Rotates 3 times for every 2 revolutions
- Extreme Temp. Variations
 - 90K to 700K
- Highly eccentric orbit
 - 46 mil km to 70 mil km



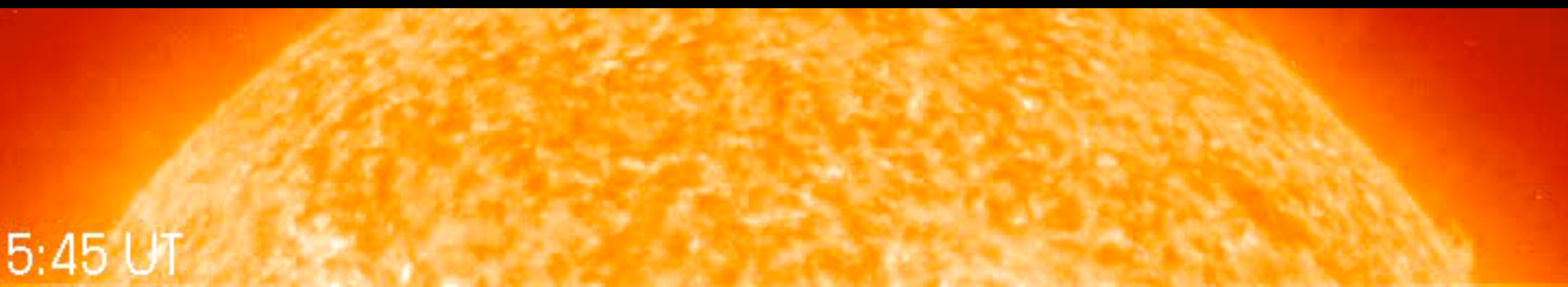
Mercury

MERCURY'S ORBIT



Mercury

Transit



5:45 UT

Mercury

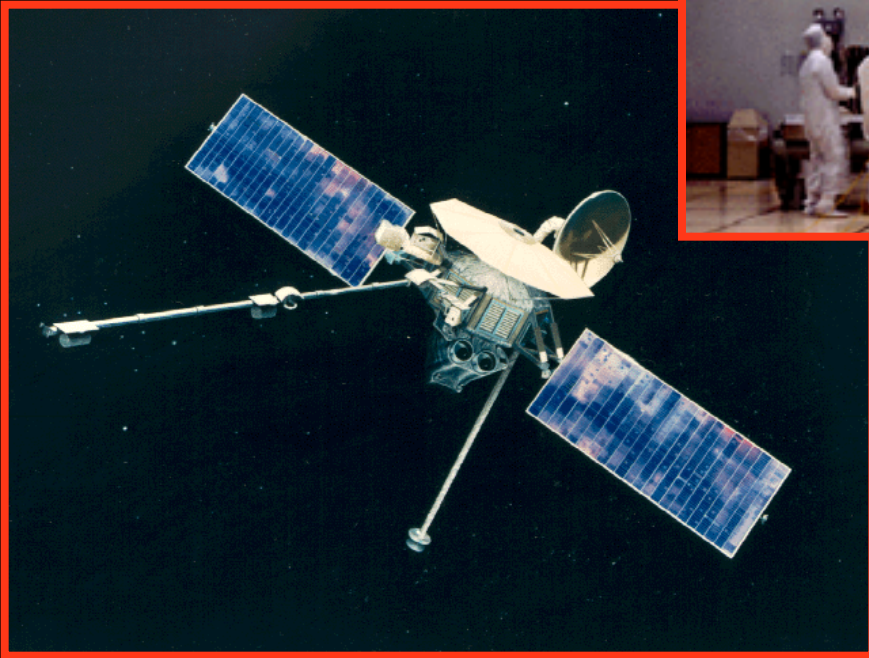
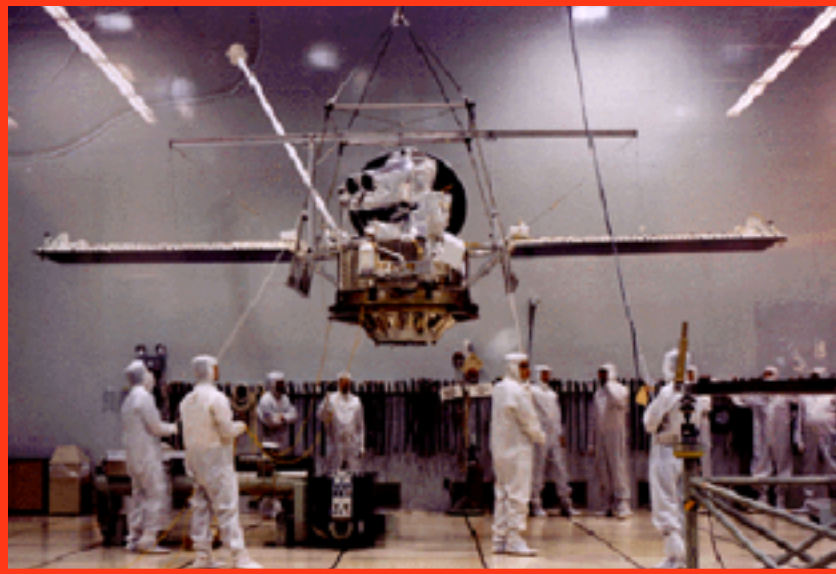
Transit

MDI Continuum Filtergram 7-May-2003 07:45 UT ; Focus Setting 5



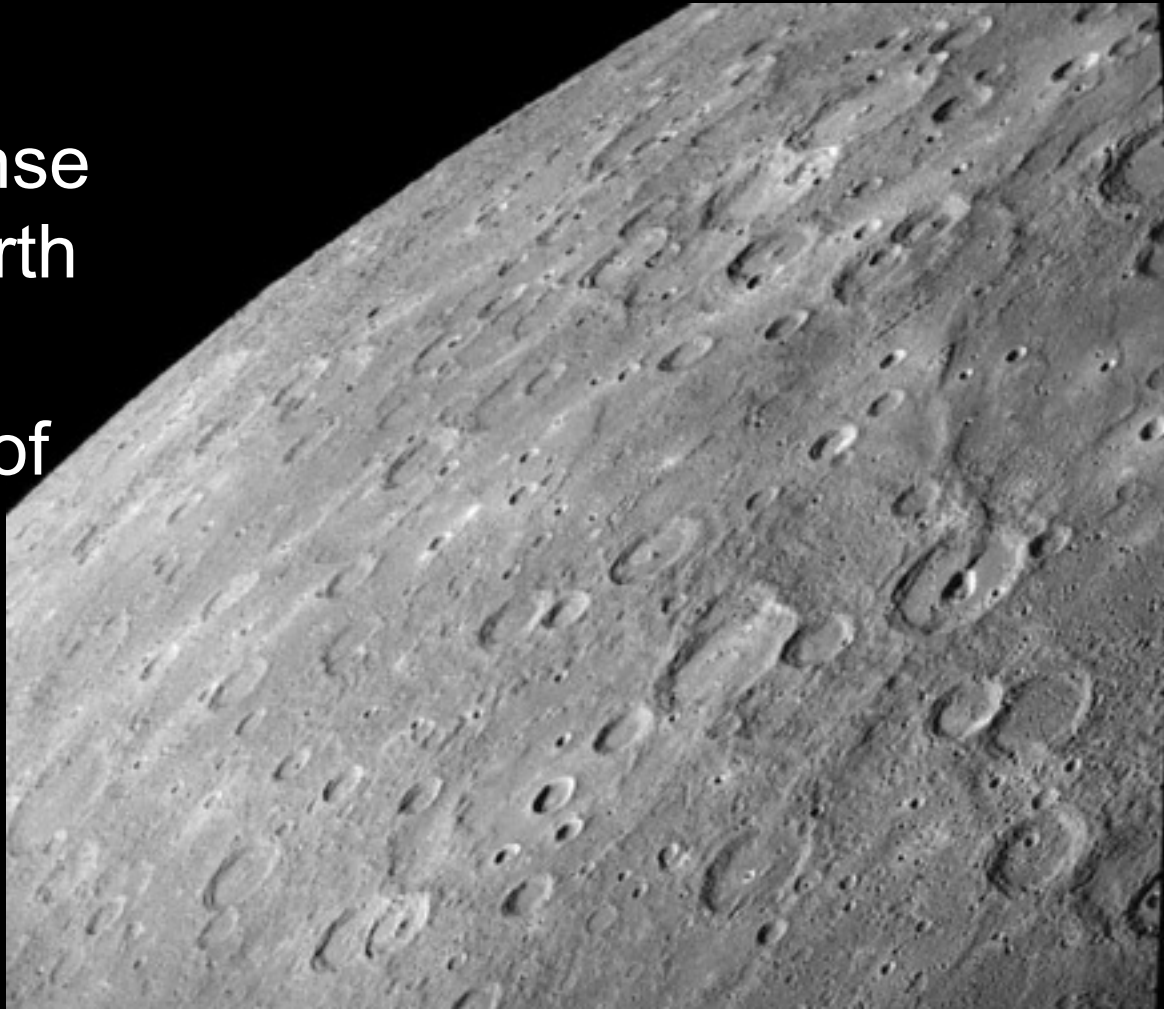
Mercury

Mercury has been visited by Mariner 10



Mercury

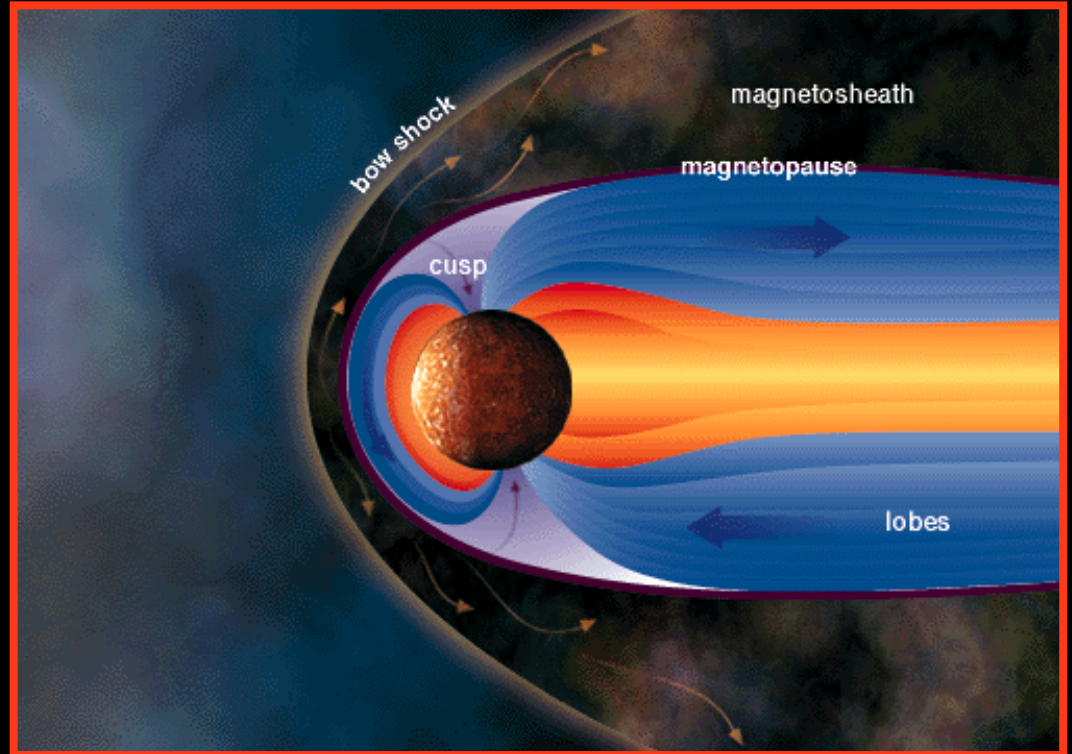
- Surface is heavily cratered
- Second most dense planet behind Earth
- Iron core that represents most of the planet



Mercury

Mercury has its own magnetic field, only %1 as strong as Earth's.

Venus, Mars, and the Moon have none.



Mercury

Bow Shock

One Solar Day =
176 Earth Days

Thin Mantle

Large Core

2439 km

Caloris Basin

Craters

Ray Crater

Temperature
up to 360°C

SUN

Heat up to 10 times
more intense than at Earth

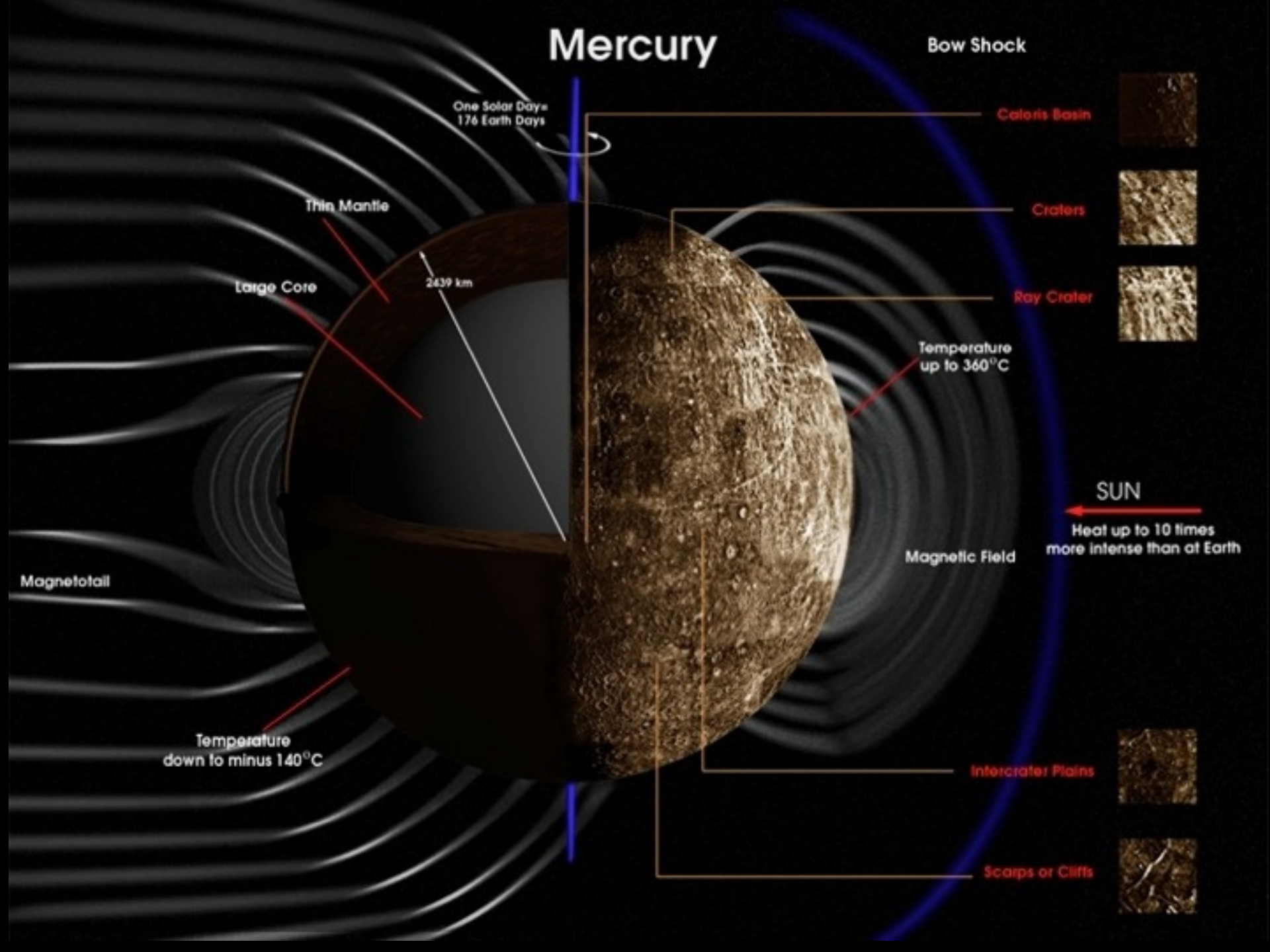
Magnetic Field

Magnetotail

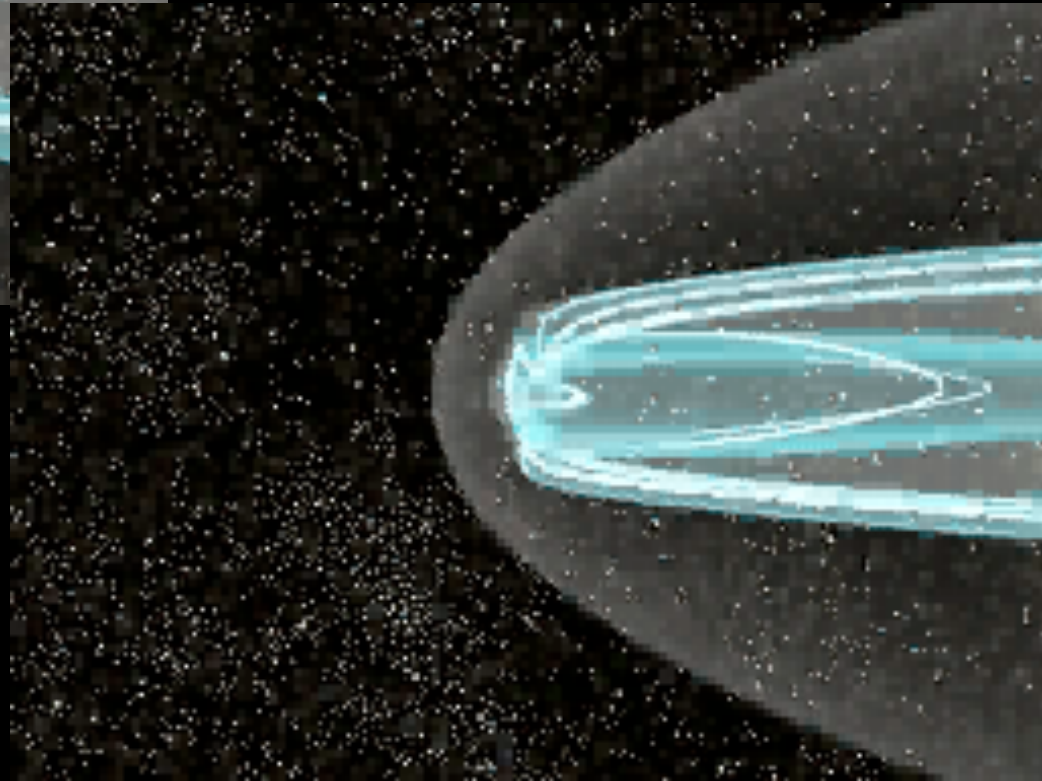
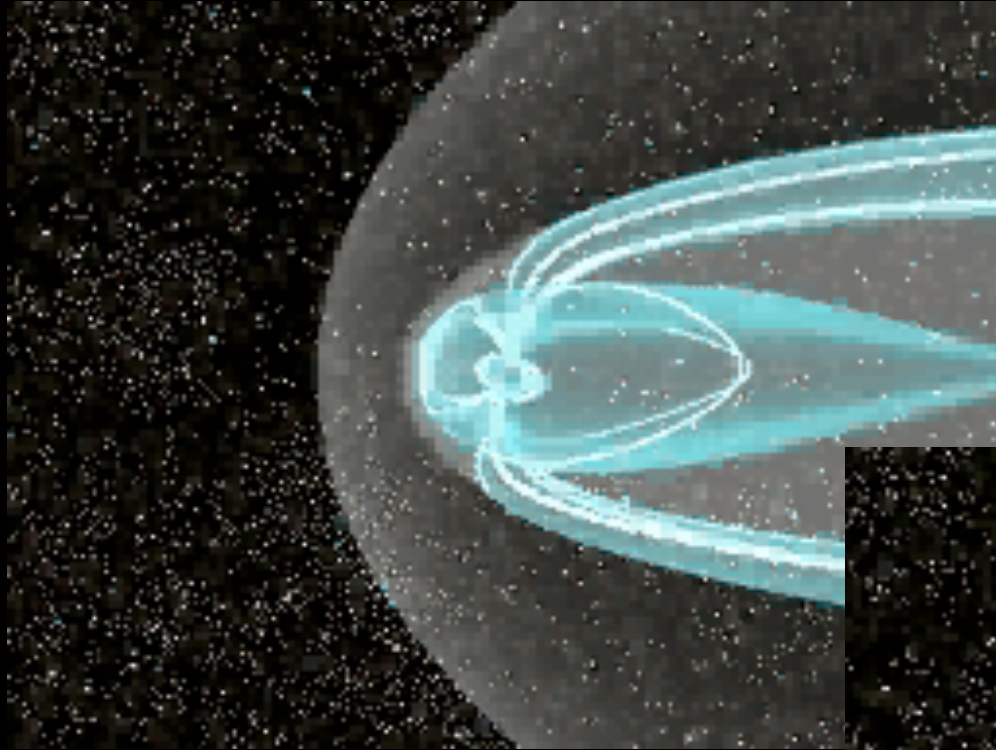
Temperature
down to minus 140°C

Intercrater Plains

Scarps or Cliffs



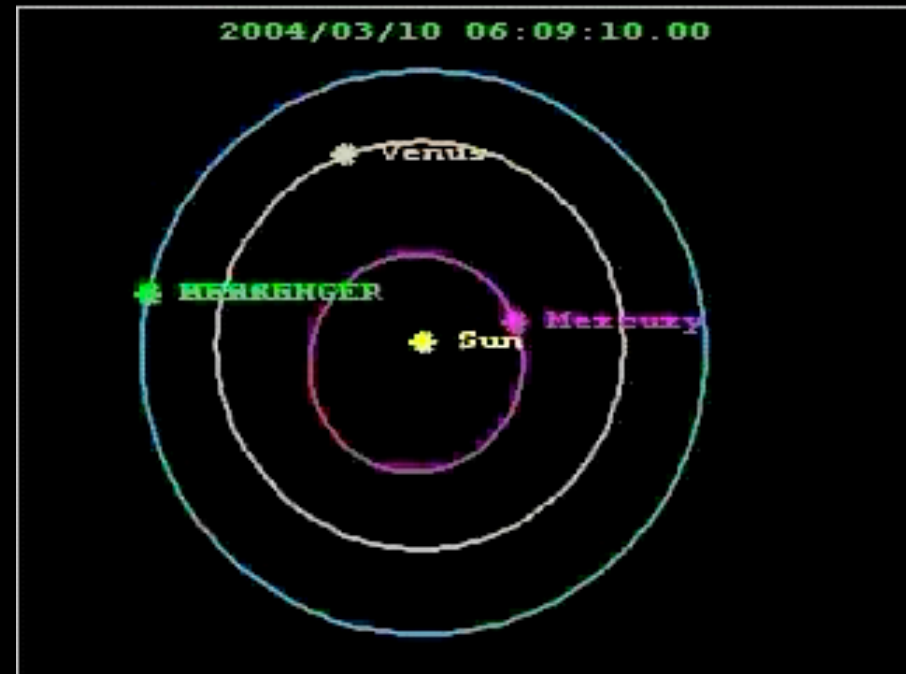
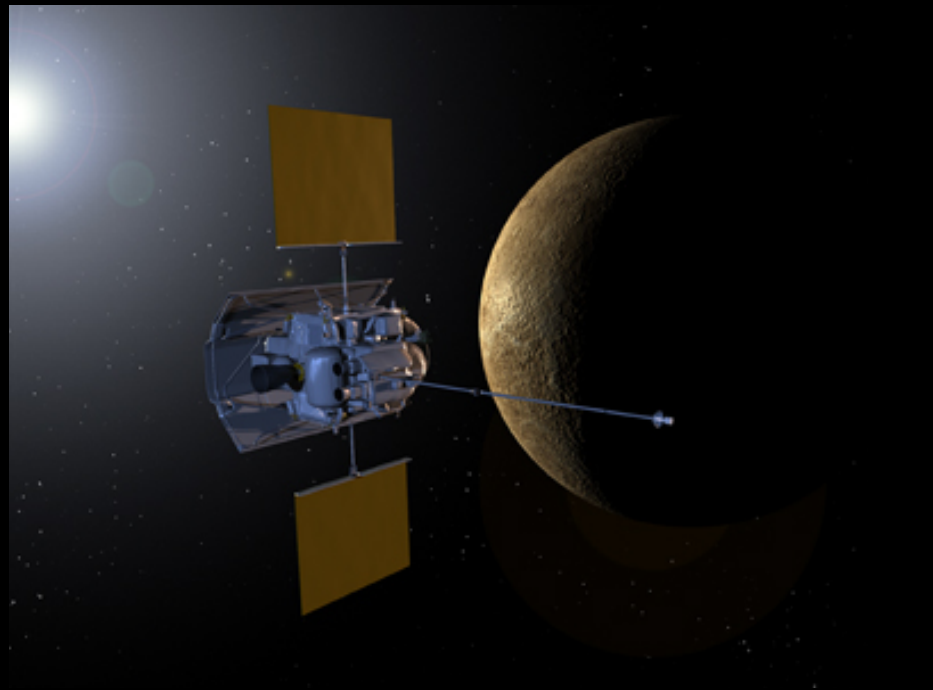
Mercury



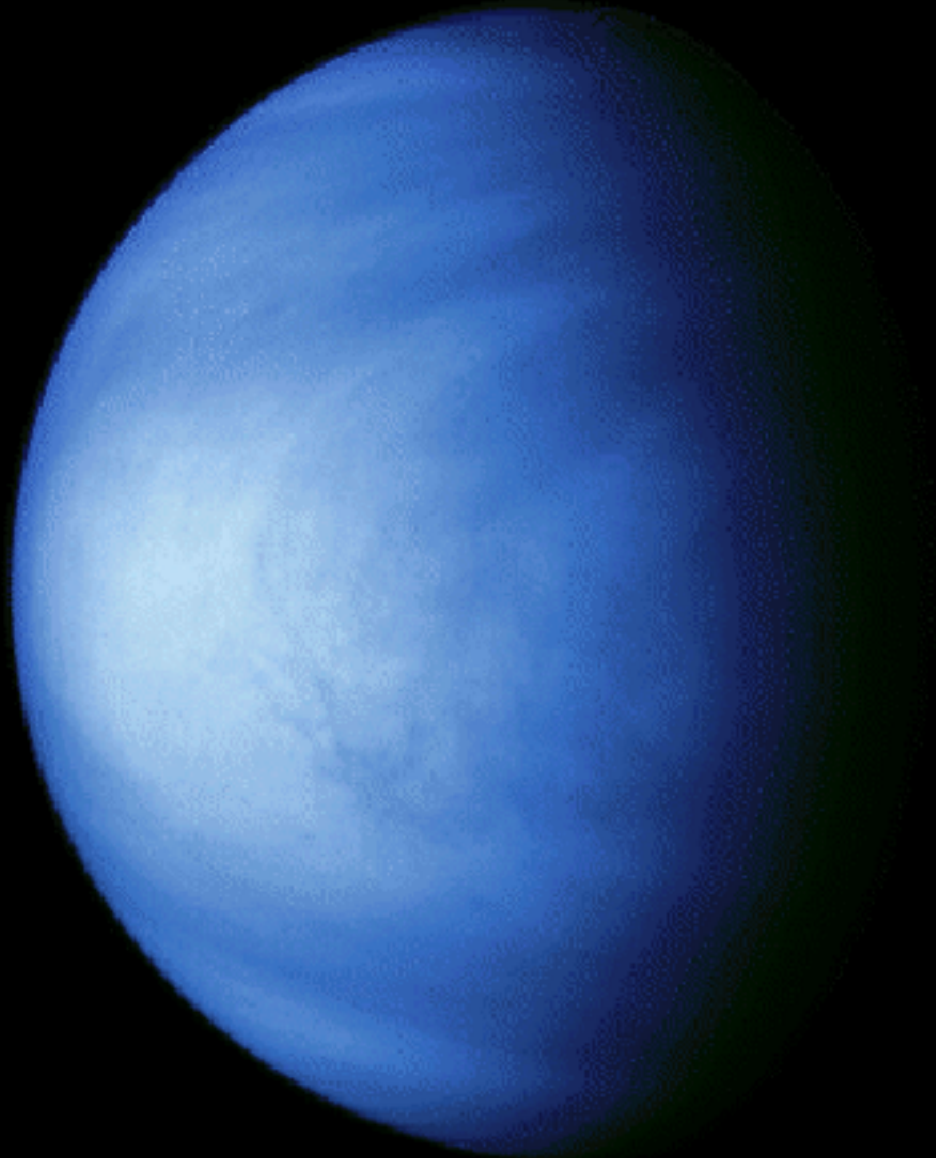
Mercury

MESSENGER - New Mission to Mercury

(MErcury Surface, Space ENvironment, GEOchemistry, and Ranging)

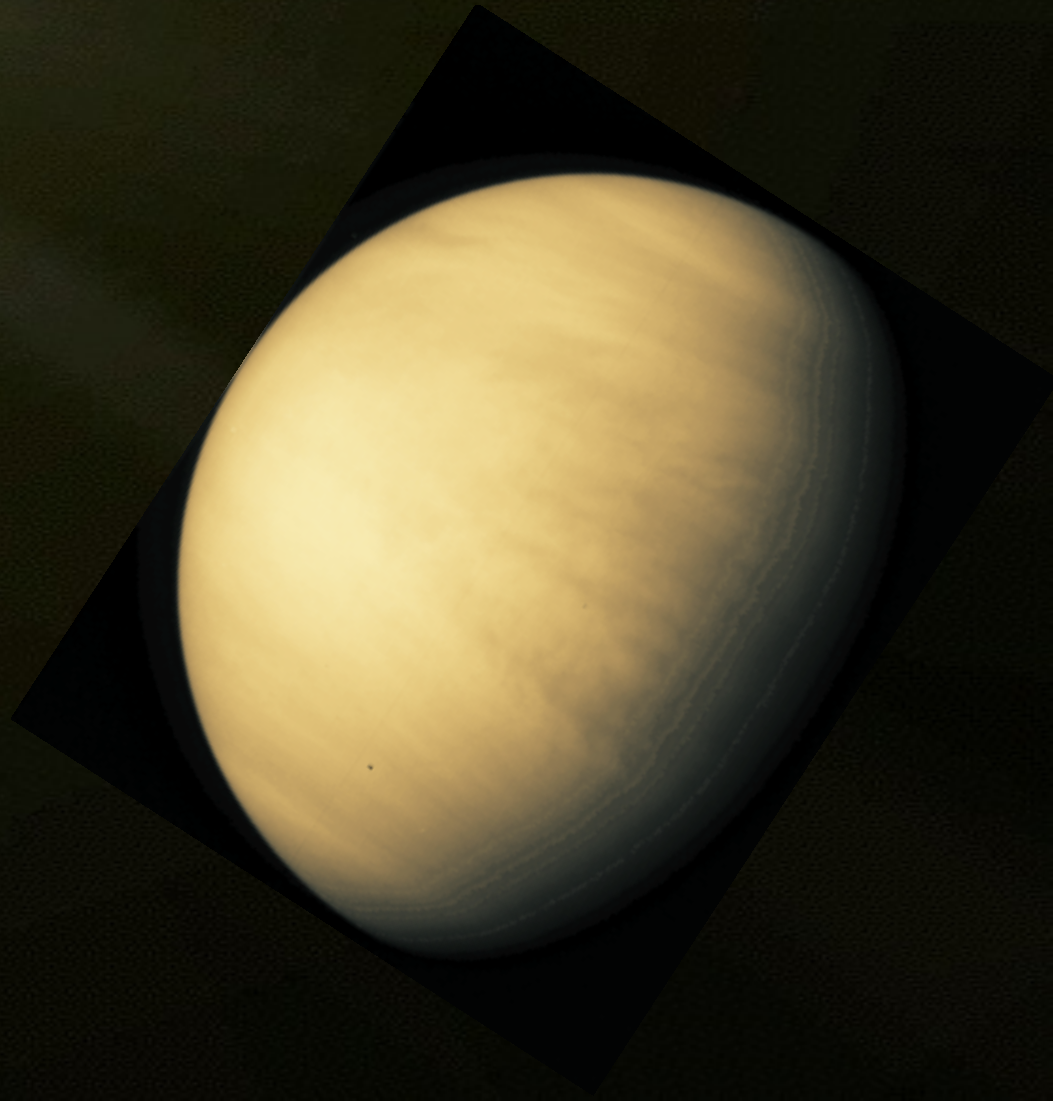


Venus



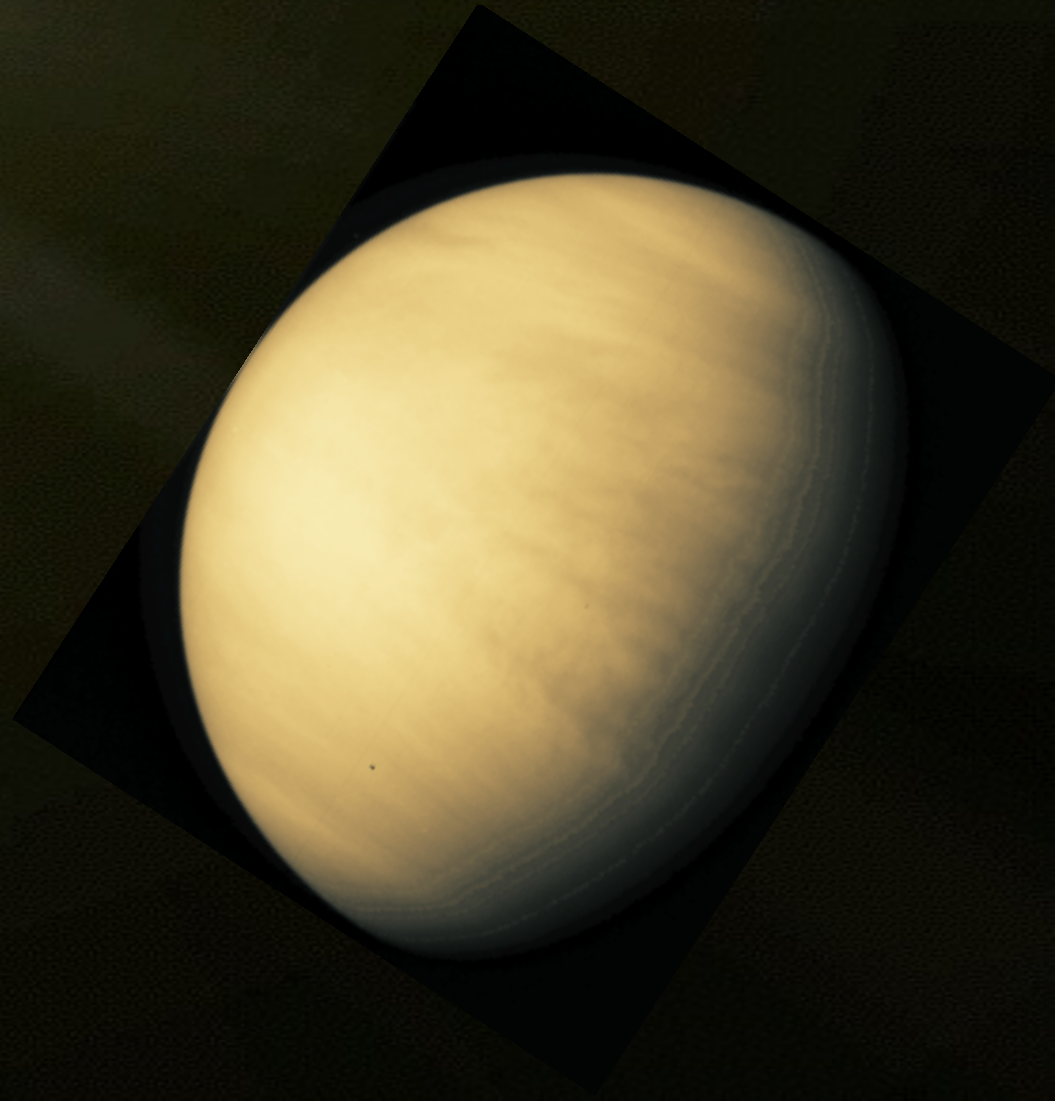
Venus

- 6th Largest Planet
- Nearly Circular Orbit
- The goddess of Love



Venus

- Revolves once every 243 Earth Days
- Rotates once every 224 Earth Days
- Thick CO₂ atmosphere
- Surface Temp=740K



Venus



- High Velocity Winds
- No longer any water
- Some Volcanic activity

Venus

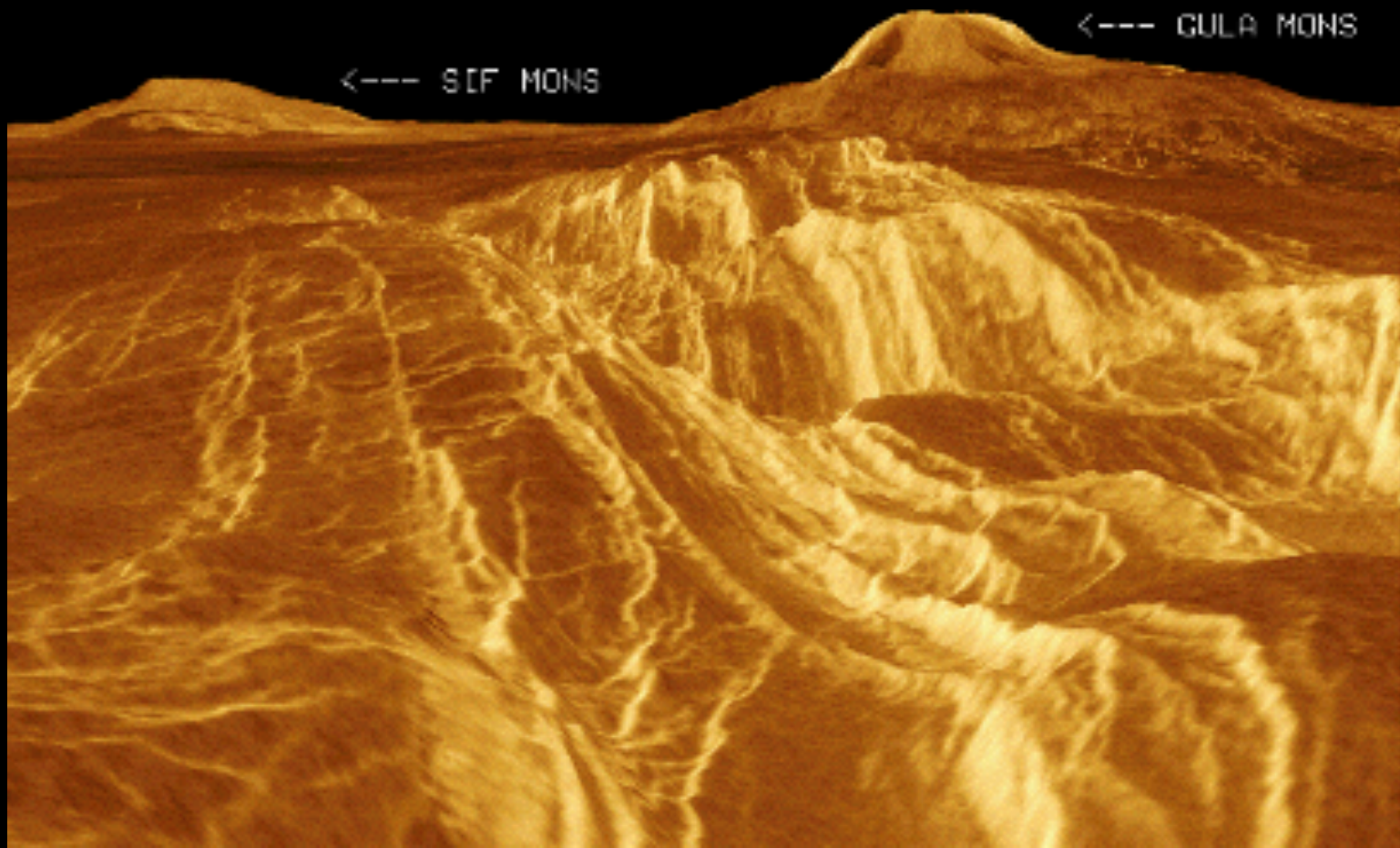


- Runaway Greenhouse Effect
- Could predict the future for Earth

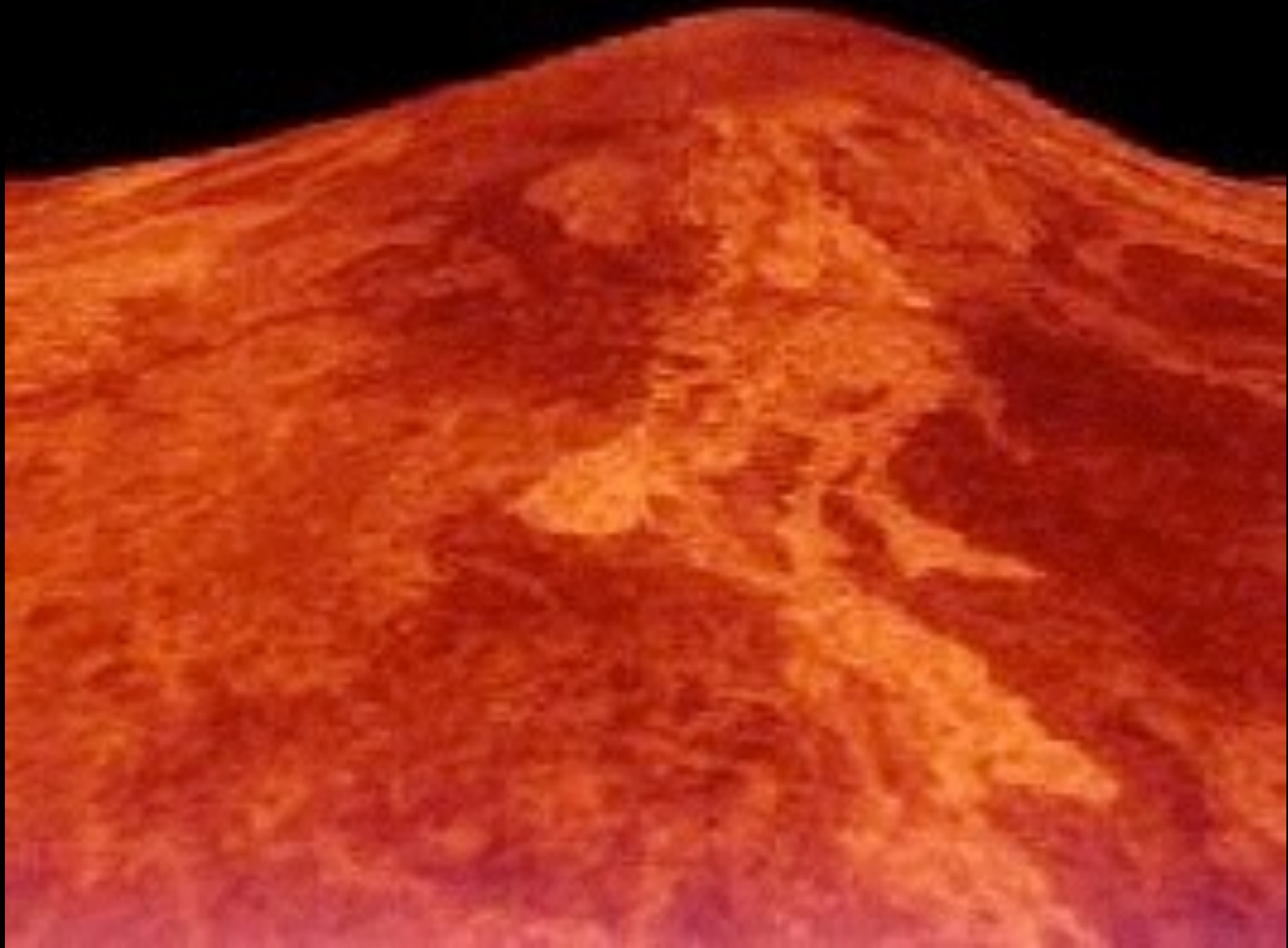
Venus

MAGELLAN 3D IMAGE
A RIFT VALLEY (FOREGROUND)
WEST EISTLA REGIO
VENUS
FEBRUARY 29, 1992

VERTICAL TOPOGRAPHY EXAGGERATION: 22.5
COLOR FROM VENERA 13/14 LANDER IMAGES
GIF CONVERSION BY RON BAALKE
JET PROPULSION LAB



Venus



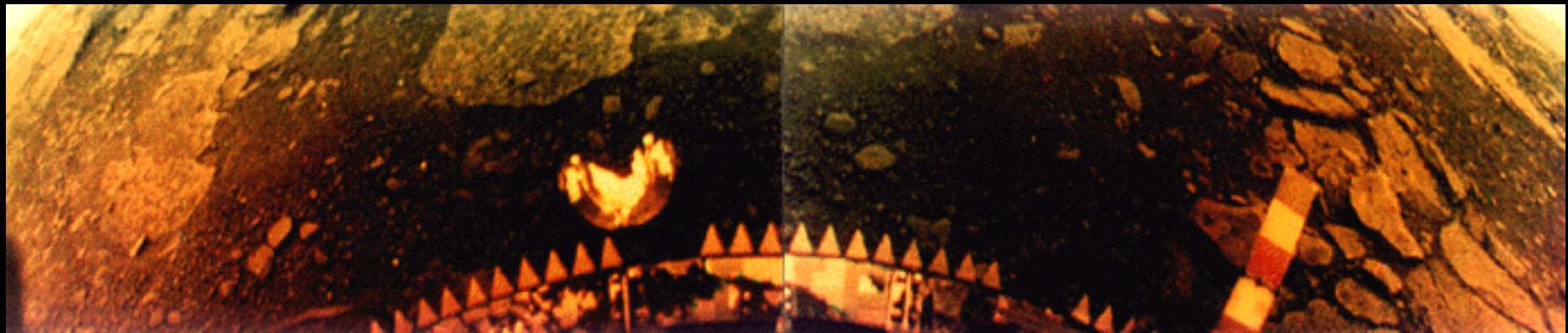
Venus



ВЕНЕРА-14 ОБРАБОТКА ИППИ АН СССР И ЦДКС



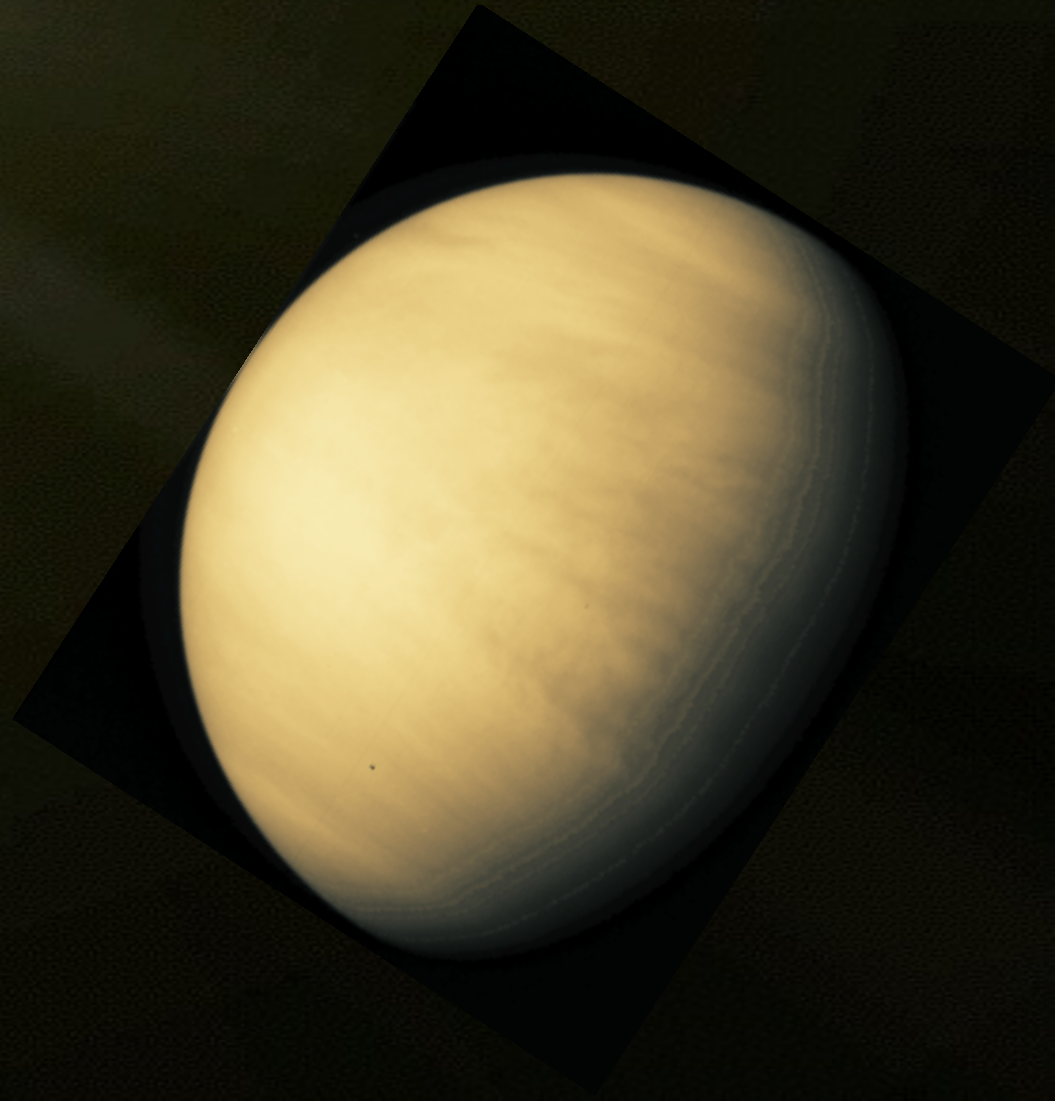
ВЕНЕРА-14 ОБРАБОТКА ИППИ АН СССР И ЦДКС



- View from Russian spacecraft Venera 14

Venus

- No moons
- No magnetic Field
- Single Plate Surface





No significant magnetic field

Rock crust

Rock mantle

One revolution around the Sun lasts 224,70 Earth days

Core of molten iron-nickel

Pressure at the surface about 92 bar, temperature about 460°C

Active volcanoes

Impact craters

Coronae



Venus phases



Venus from Earth



Retrograde rotation with a long period of 243 Earth days. Rotation axis is inclined by 177° to the plane of the ecliptic

Wind speeds in the upper atmosphere over 100m/s

Surface viewed from Earth shows no structure and has the highest albedo of all planets

Clouds 45-65 km altitude

Equatorial highland

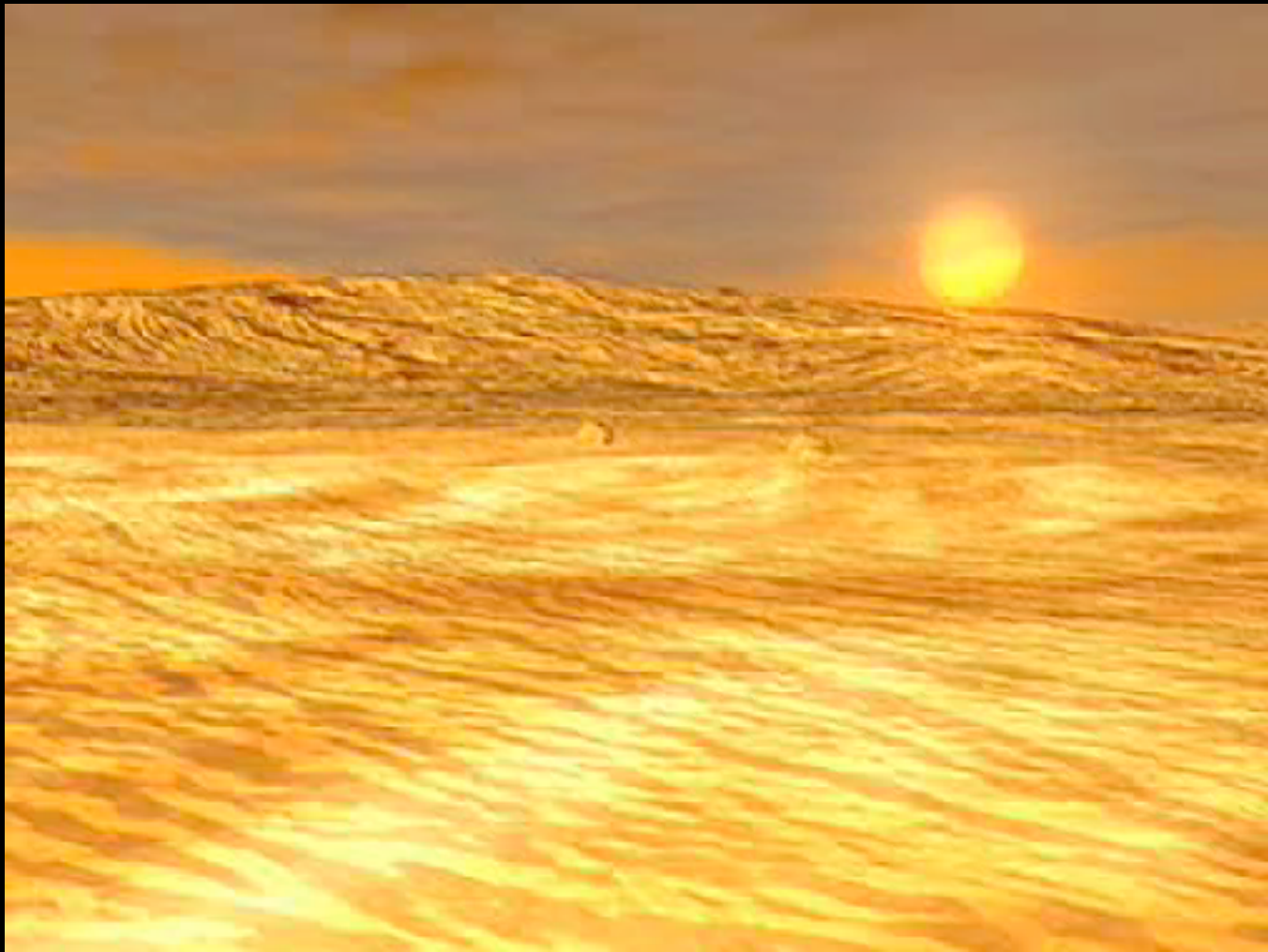
© Calvin J. Hamilton



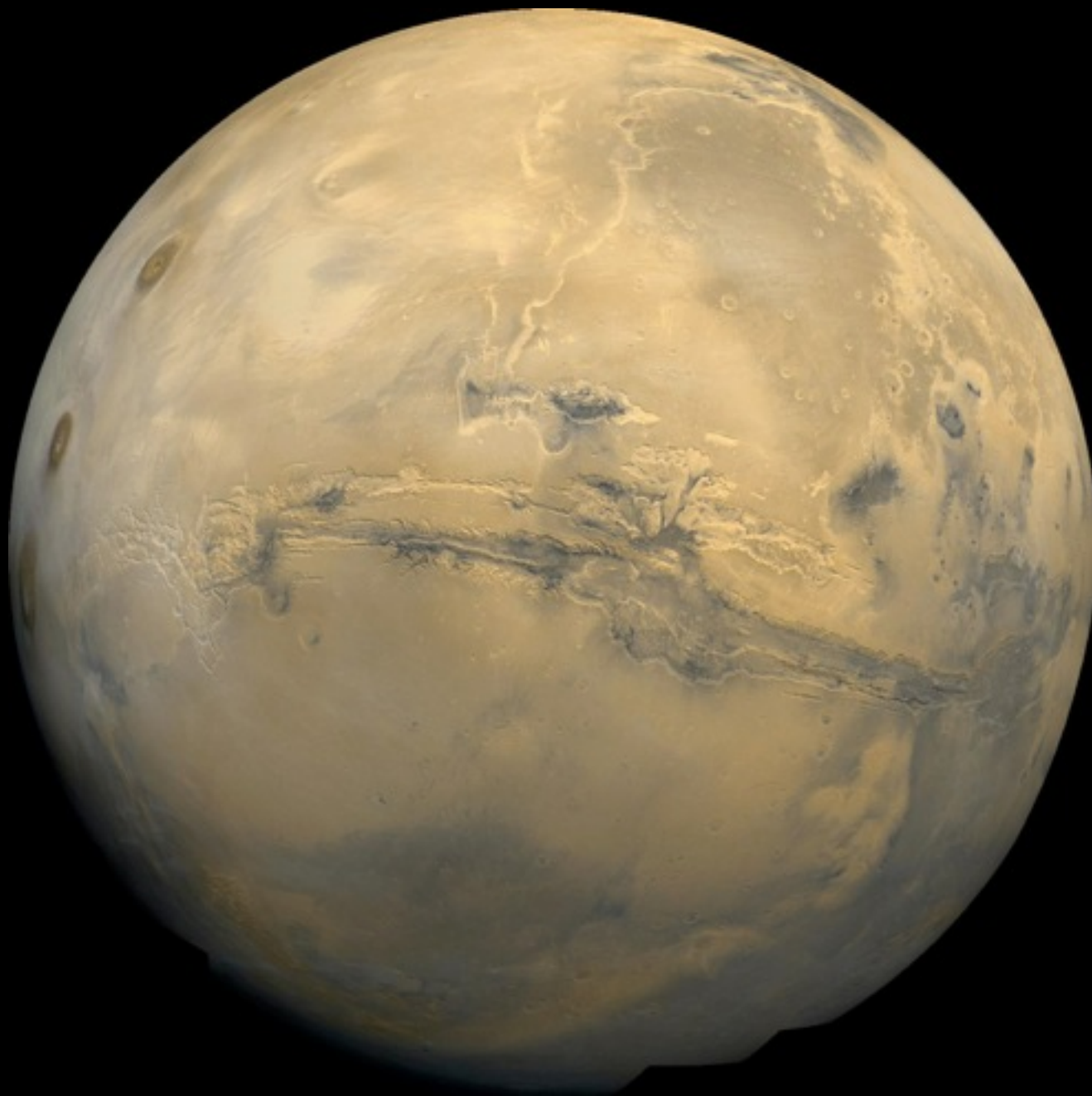
Dense atmosphere with sulphur dioxide clouds and greenhouse effect, composed of roughly 96,5% carbon dioxide and 3,5% nitrogen



Cloud Structure



Mars



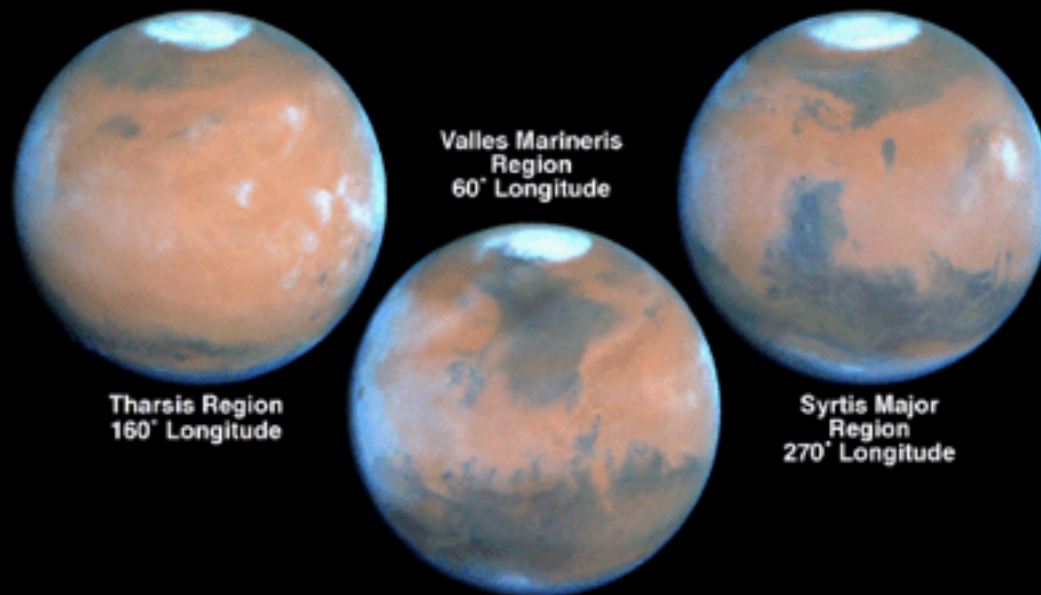
Mars

- The god of war
- Half the size of Earth



Mars

- Earth based observations:
 - Polar ice caps waxing and waning with seasons
 - Mountain ranges that looked like canals
 - Areas of color change that were thought to be vegetation
 - Has an atmosphere



Mars • February 1995

HST • WFPC2

PR95-17 • ST ScI OPO • March 21, 1995 • P. James (U.Toledo), S. Lee (U.CO), NASA

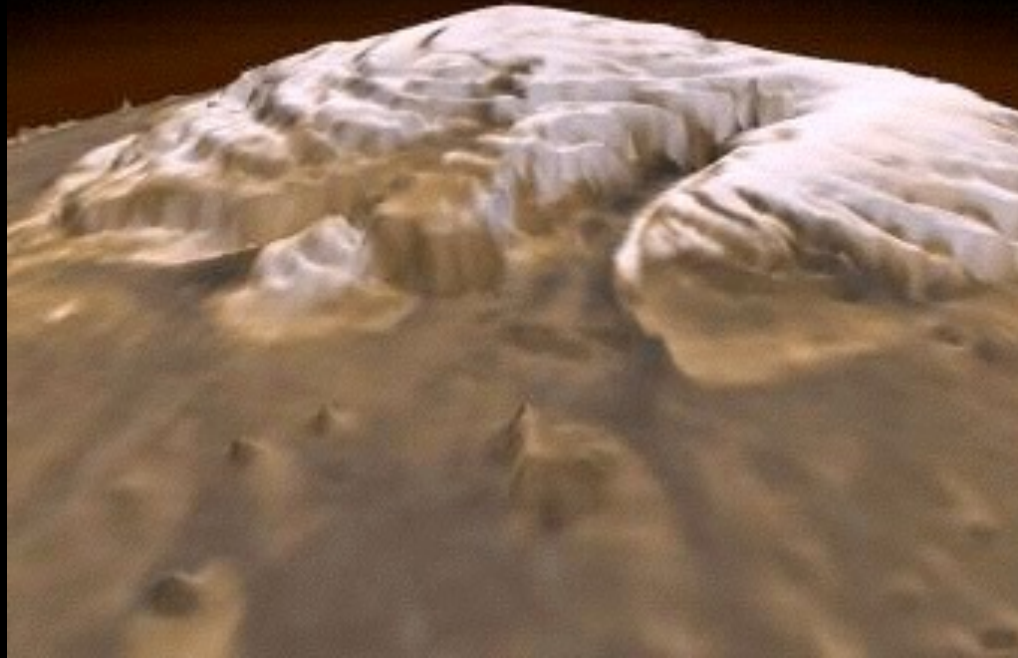
Mars

- Interesting Geological Features
 - Meteor craters and volcanic plains
 - Gorges larger than the Grand Canyon



Mars

- Interesting Geological Features
 - Vast sedimentary deposits in the Polar regions



Mars

- Interesting Geological Features
 - Valleys that look as if they could be water formed

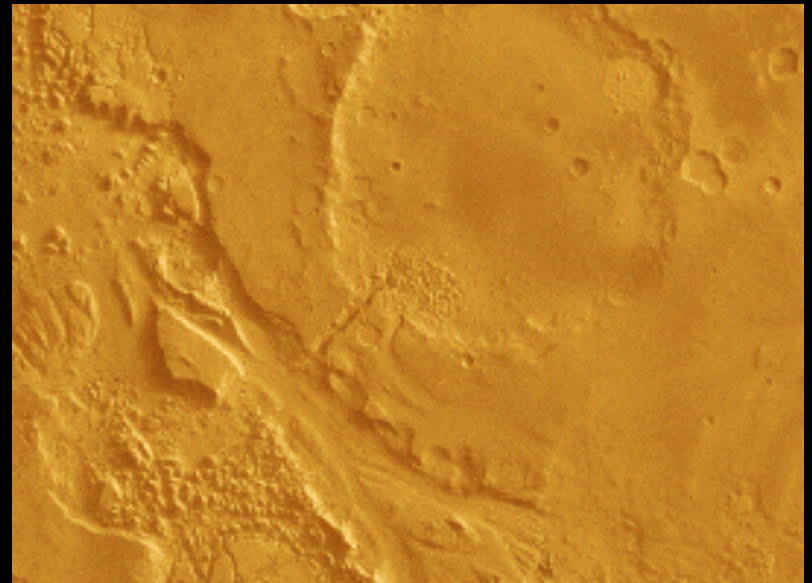
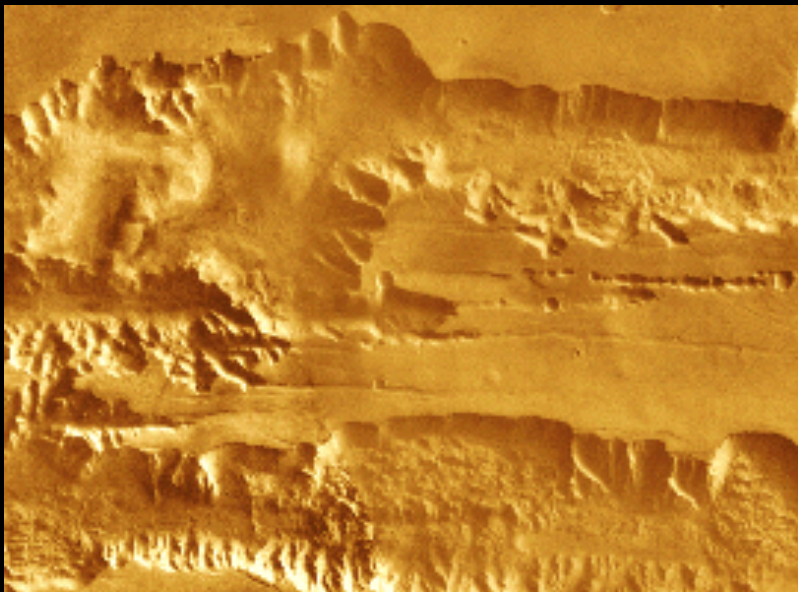


Mars

Colorado River Delta,
Mexico

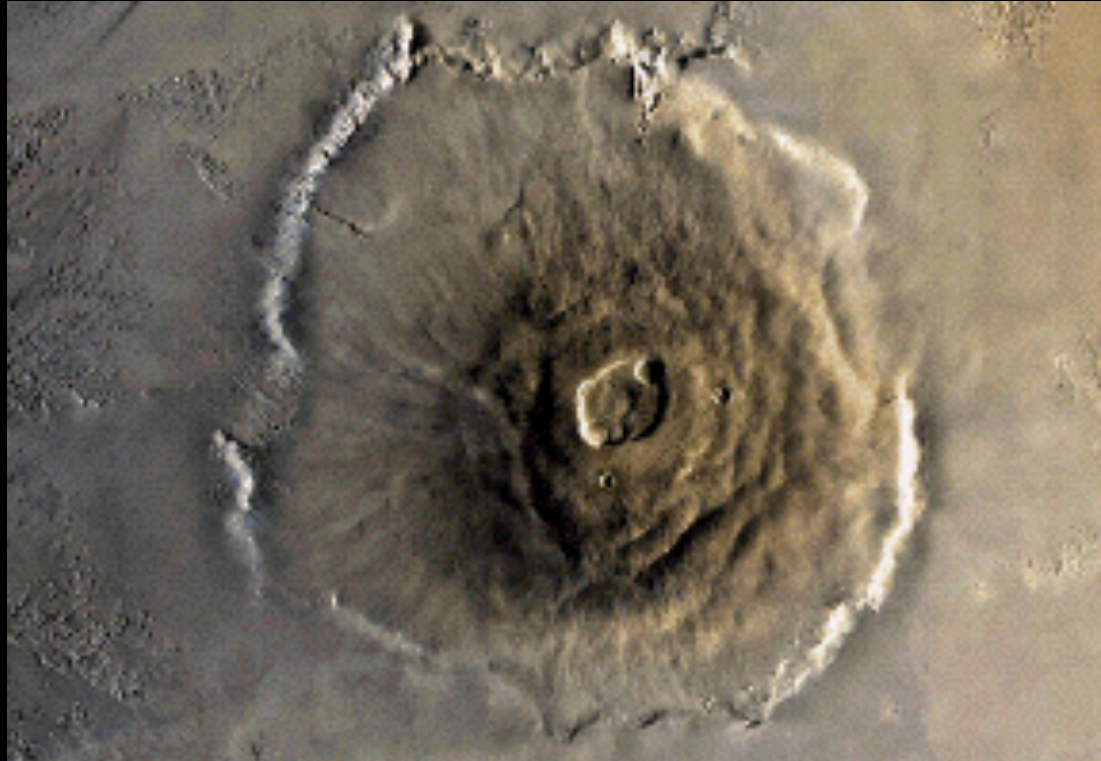
Mars

- Surface Features
 - Water Erosion?



Mars

- Surface Features
 - Giant Volcanoes
 - The size of the state Arizona
 - 3 times the elevation of Mount Everest



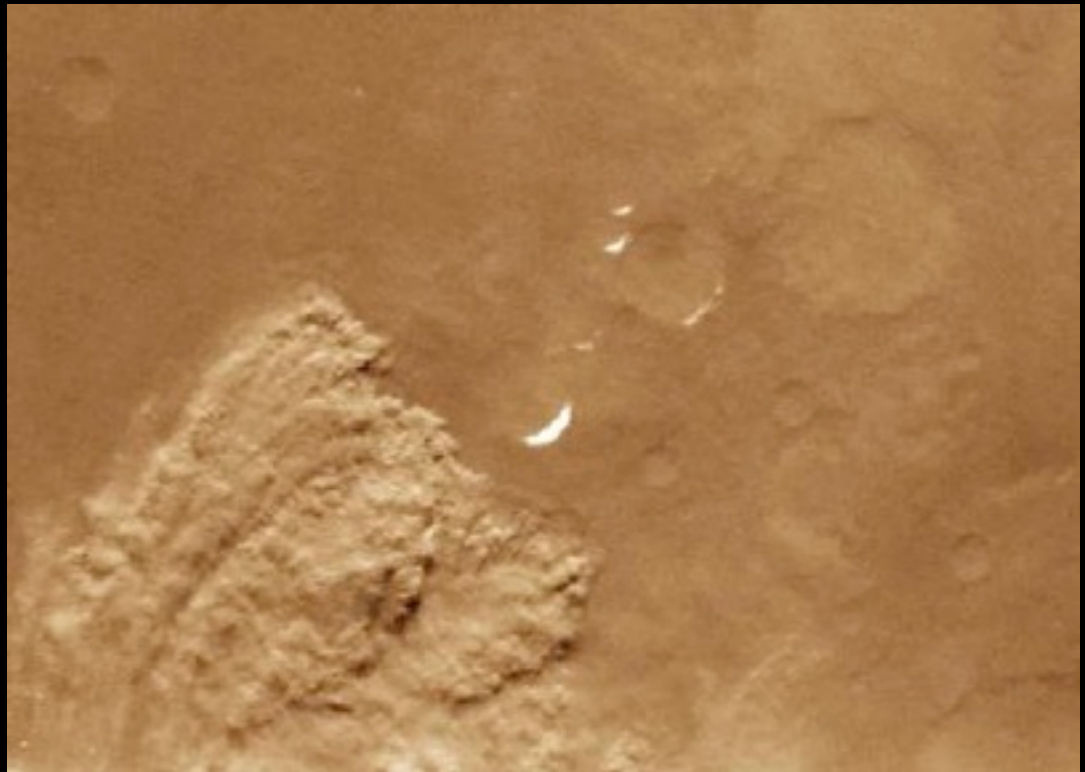
Mars

Olympus Mons:



Mars

- Surface Features
 - Wind Erosion



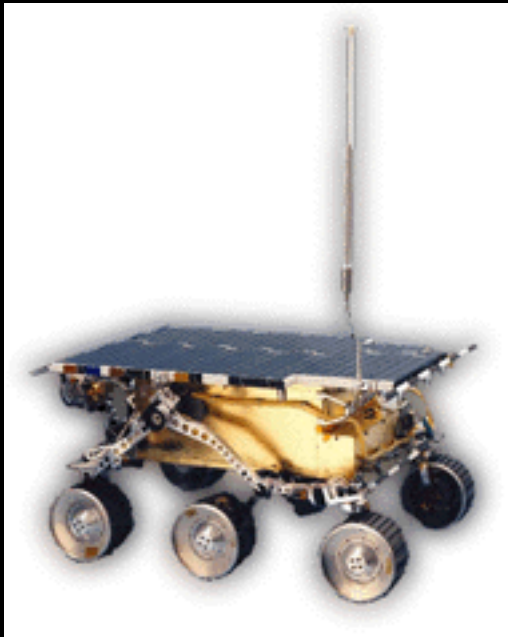
Mars exploration



- 1970's Viking mission:
Returned no signs of life
Was it accurate?

Mars exploration

- 1980's Many failed missions:
- 1996: Pathfinder: First rover on Mars;
Found evidence of erosion, but no life or liquid water.

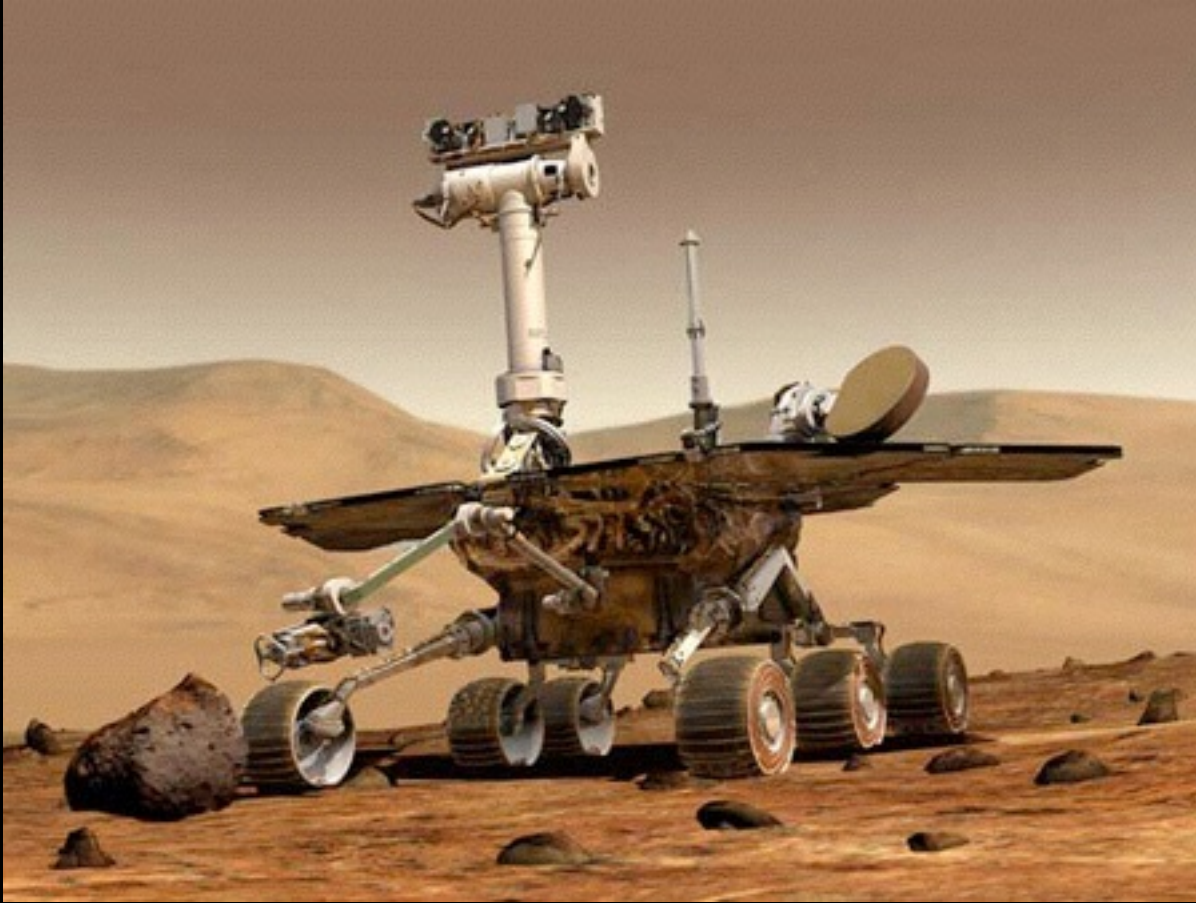


Mars exploration



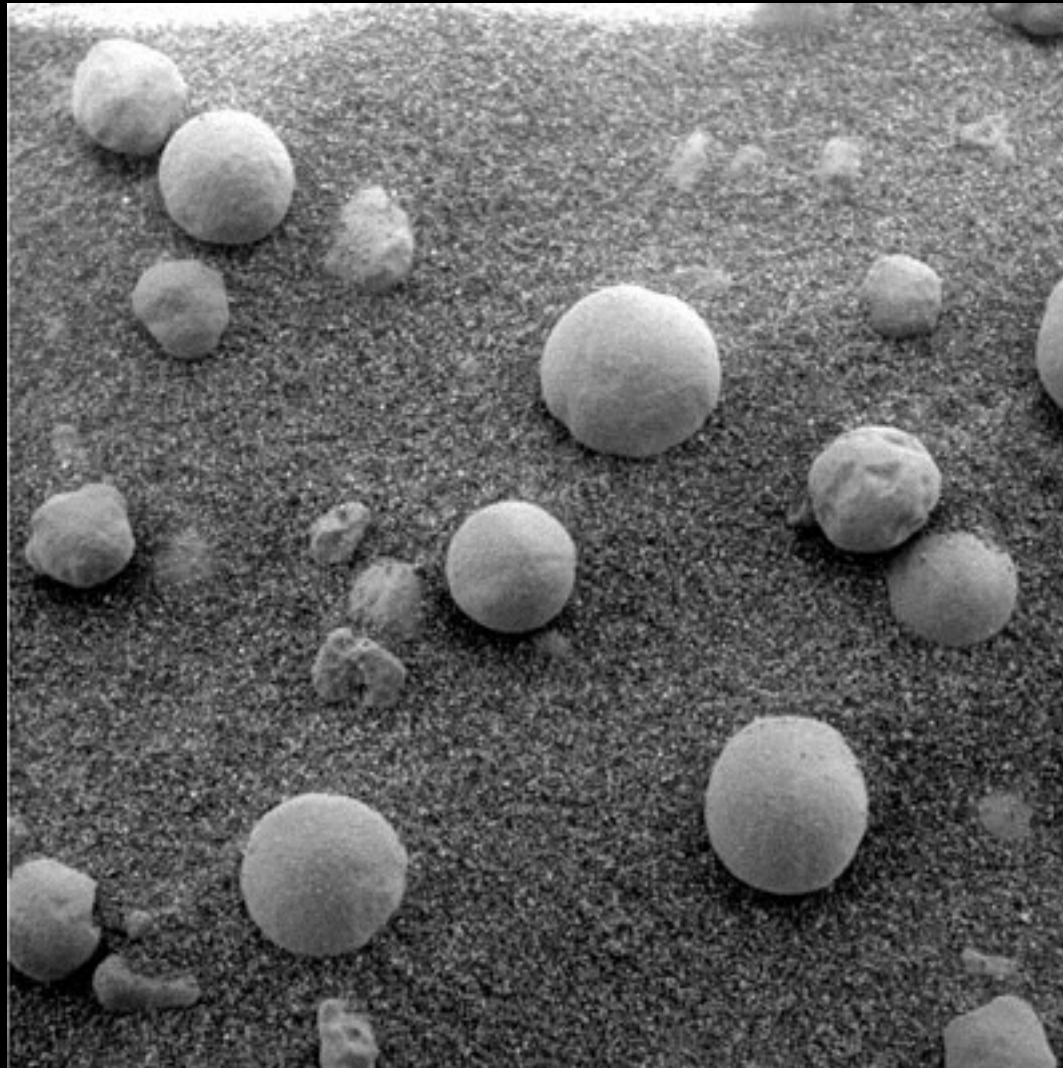
Mars exploration

Mars exploration



- 2004 - Spirit & Opportunity: Long distance rovers
Supposed to last 90 sols; they are still running
Found strong evidence of water, lots of water!

Mars exploration



Mars exploration



Mars exploration



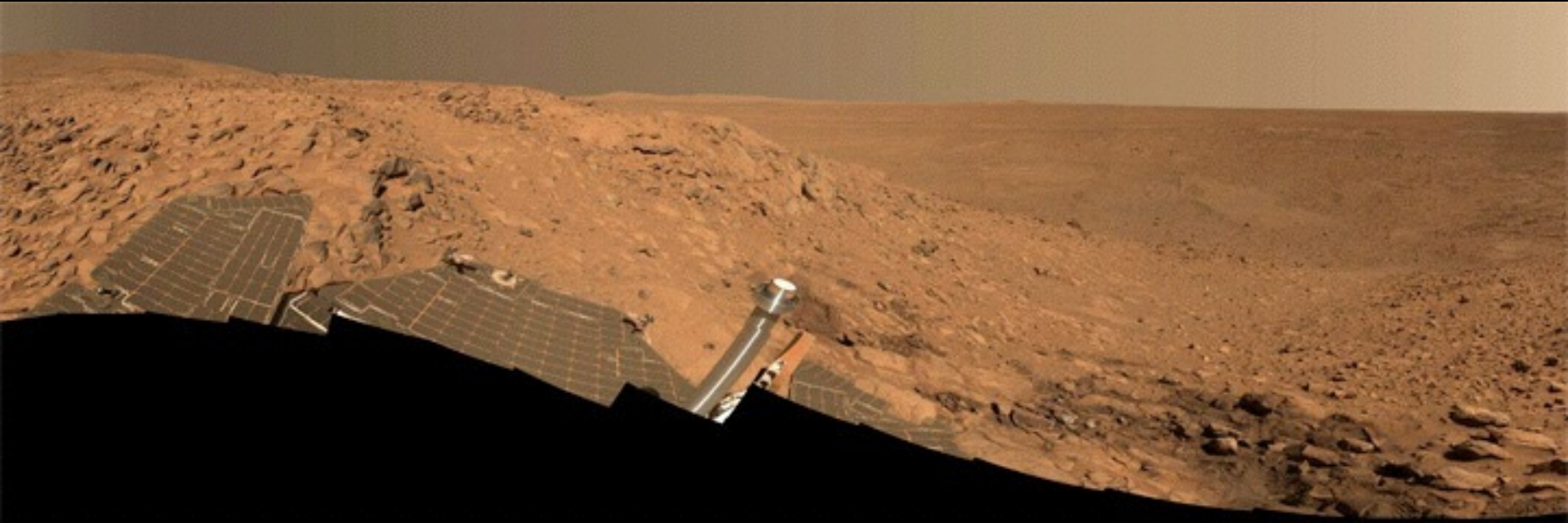
Mars exploration



Mars exploration



Mars exploration



Mars exploration



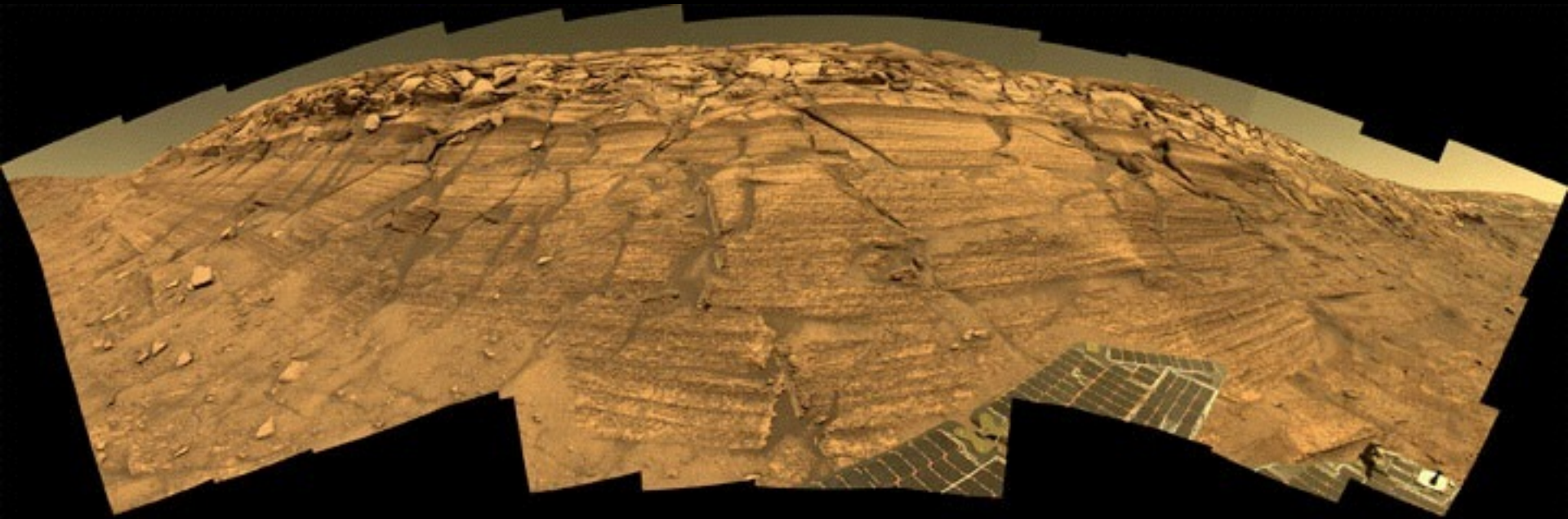
Mars exploration



Mars exploration



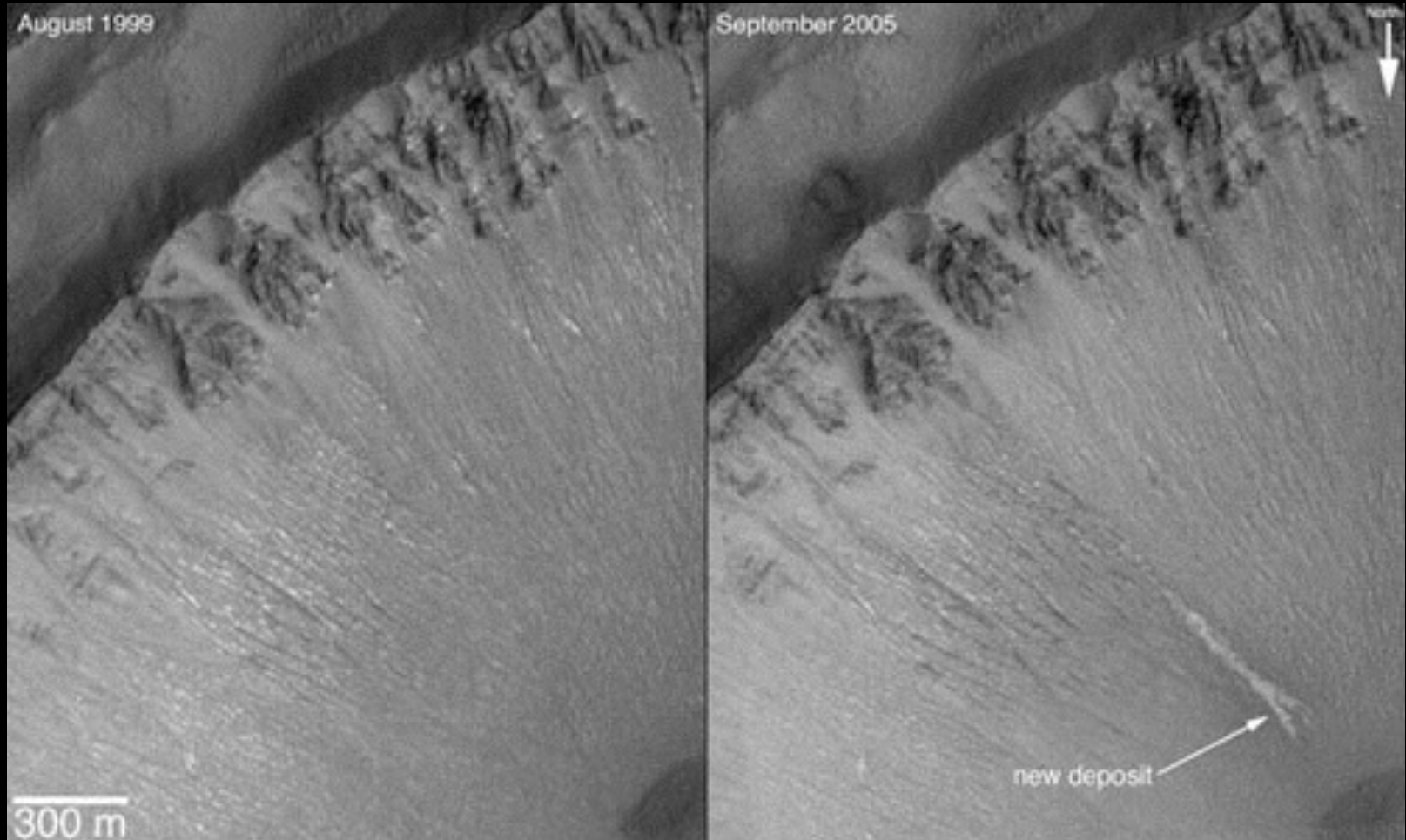
Mars exploration



Mars exploration



Mars exploration

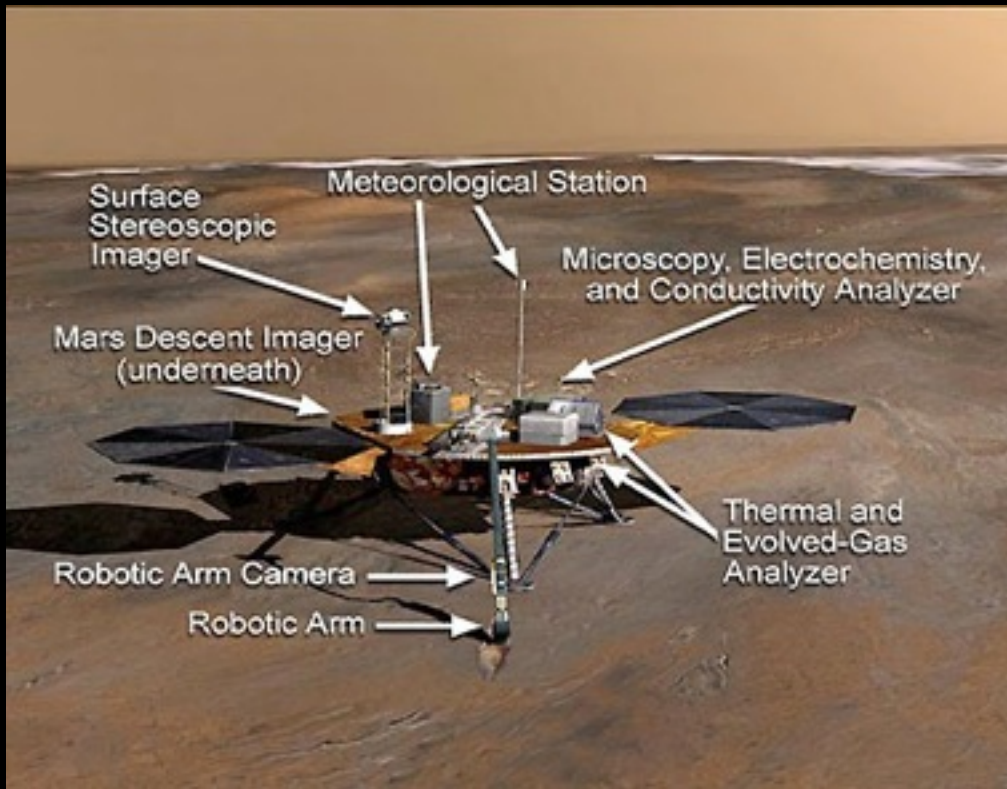


Mars exploration



Mars Exploration

- - 2008 - Mars Phoenix: Lander not a rover.
 - Has found glaciers on Mars
 - Evidence of liquid water under the surface



Mars Phoenix



lander →

heat shield →

parachute ↘





MSL

Launched in November 2011.

- Much larger than previous rovers
- No solar panels, nuclear battery.
 - Why??



MSL

More Science Laboratory

Mars Science Laboratory



- -Mars rock ALH-84001
 - Found in Antarctica
 - 1996 Suggested possible microbial fossils!!



Mars

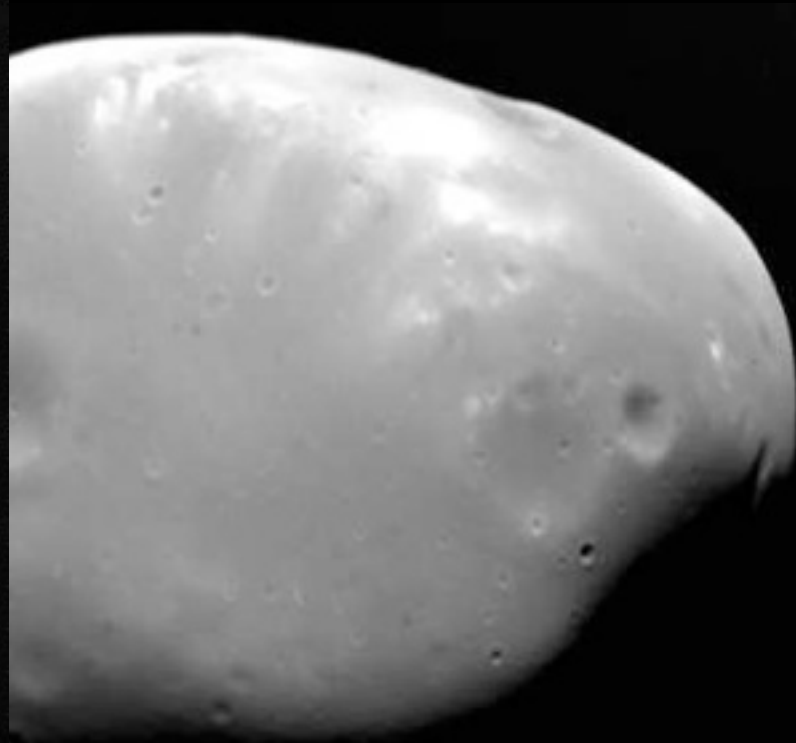
- -No Magnetic Field
 - CO₂ atmosphere is about 1% the thickness of Earth's
 - After planet cooled, the core hardened
 - The magnetic field shut down.
 - This exposed Mars to solar wind which tore the atmosphere away.
 - Without pressure in the atmosphere, liquid water cannot exist on the surface.

Moons of Mars

Phobos



Deimos

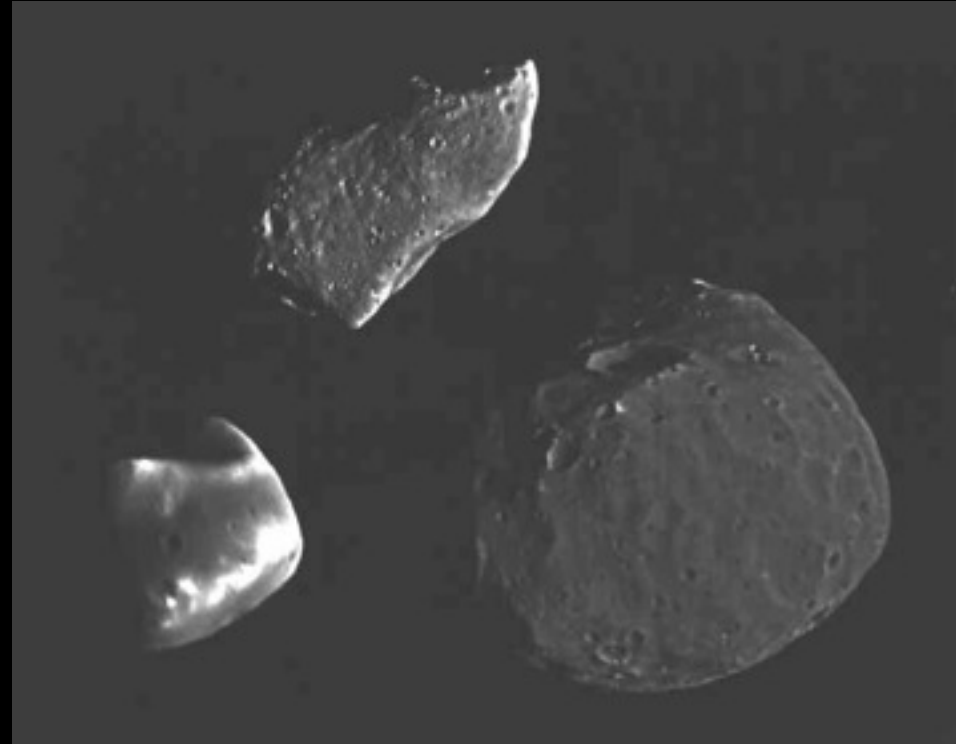


The Four Terrestrial Planets

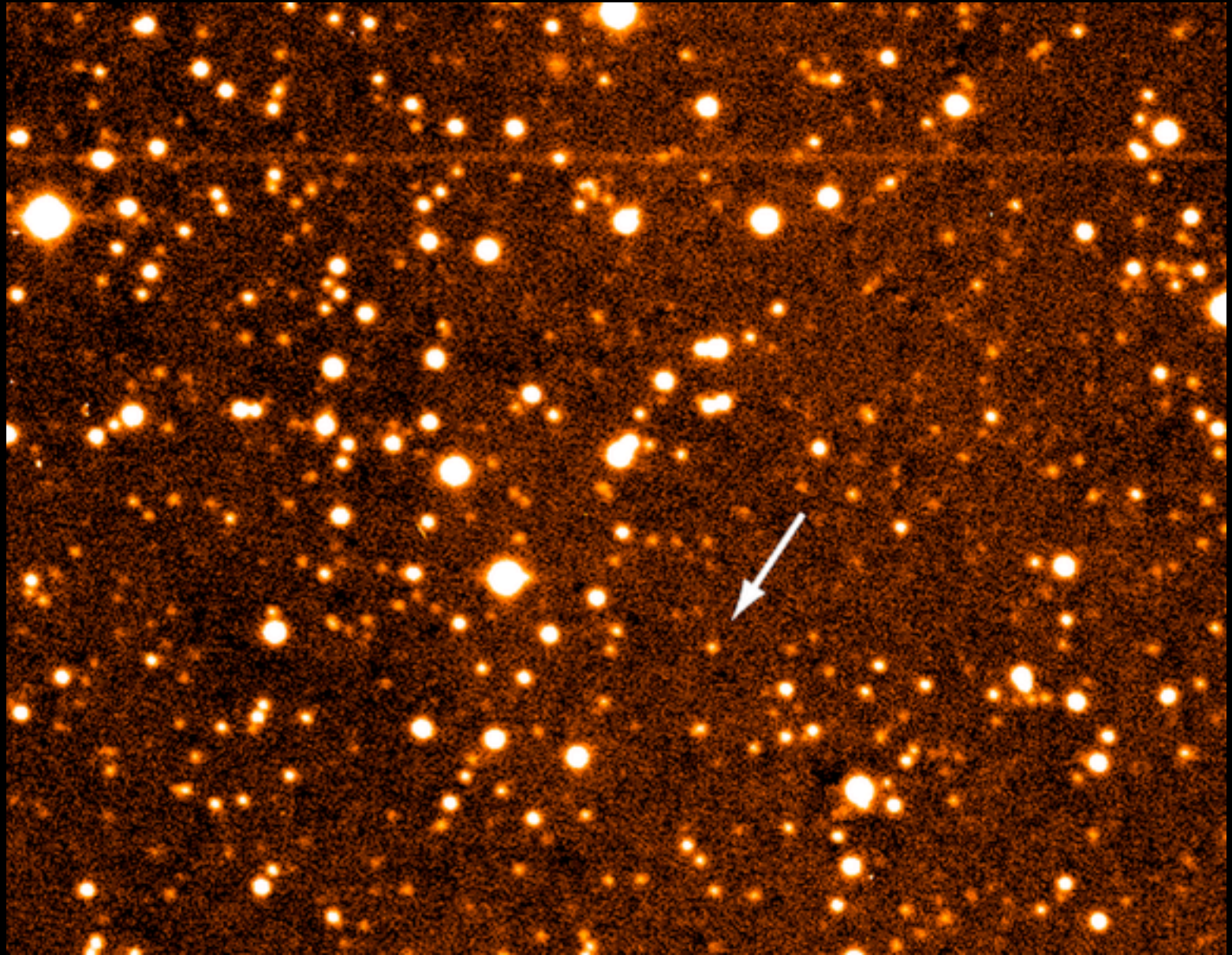


Minor planets

- Once thought that a planet orbited between Jupiter and Mars.
- They began to discover minor planets
- The Asteroid Belt



Minor planets



Minor planets



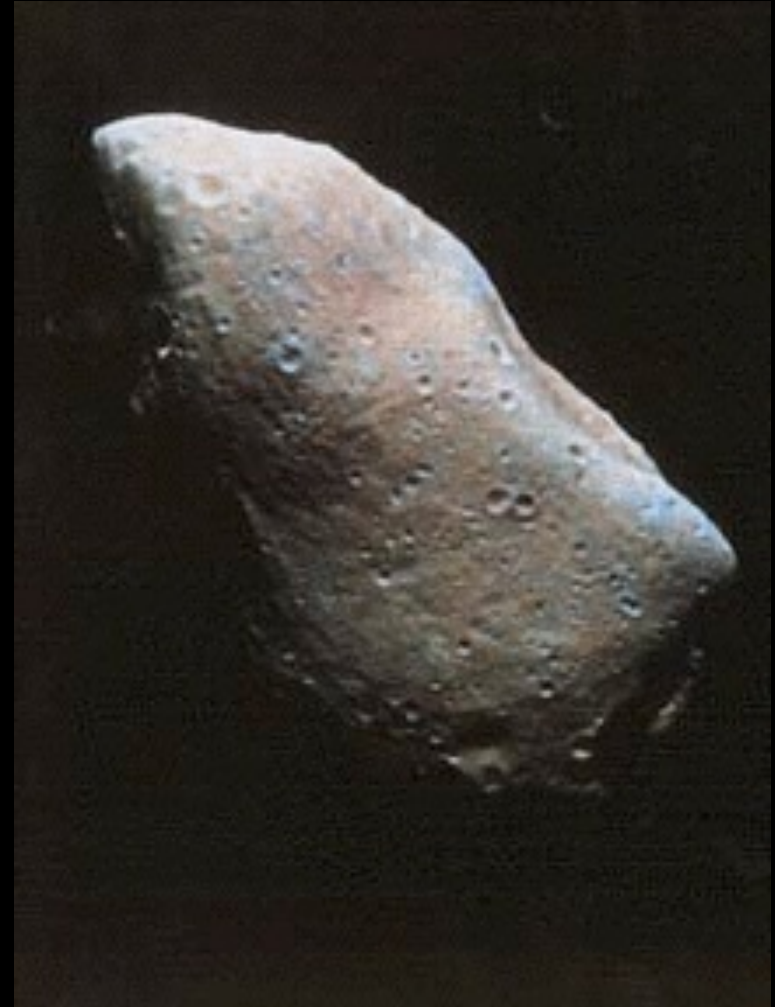
Minor planets

- Largest is Ceres, <1000 km diameter.
- ~1 million with diameter > 1km
- Total mass is much less than Earth's Moon
- Dark (think charcoal)
- Compositional types include stony, iron, carbonaceous.



Minor Planets

- Three types of Asteroids
 - Main Belt Asteroids
 - Jupiter's Trojan Asteroids
 - Near-Earth Asteroids



Main Belt Asteroids



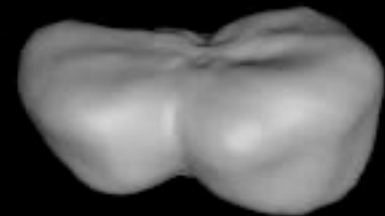
Geographos



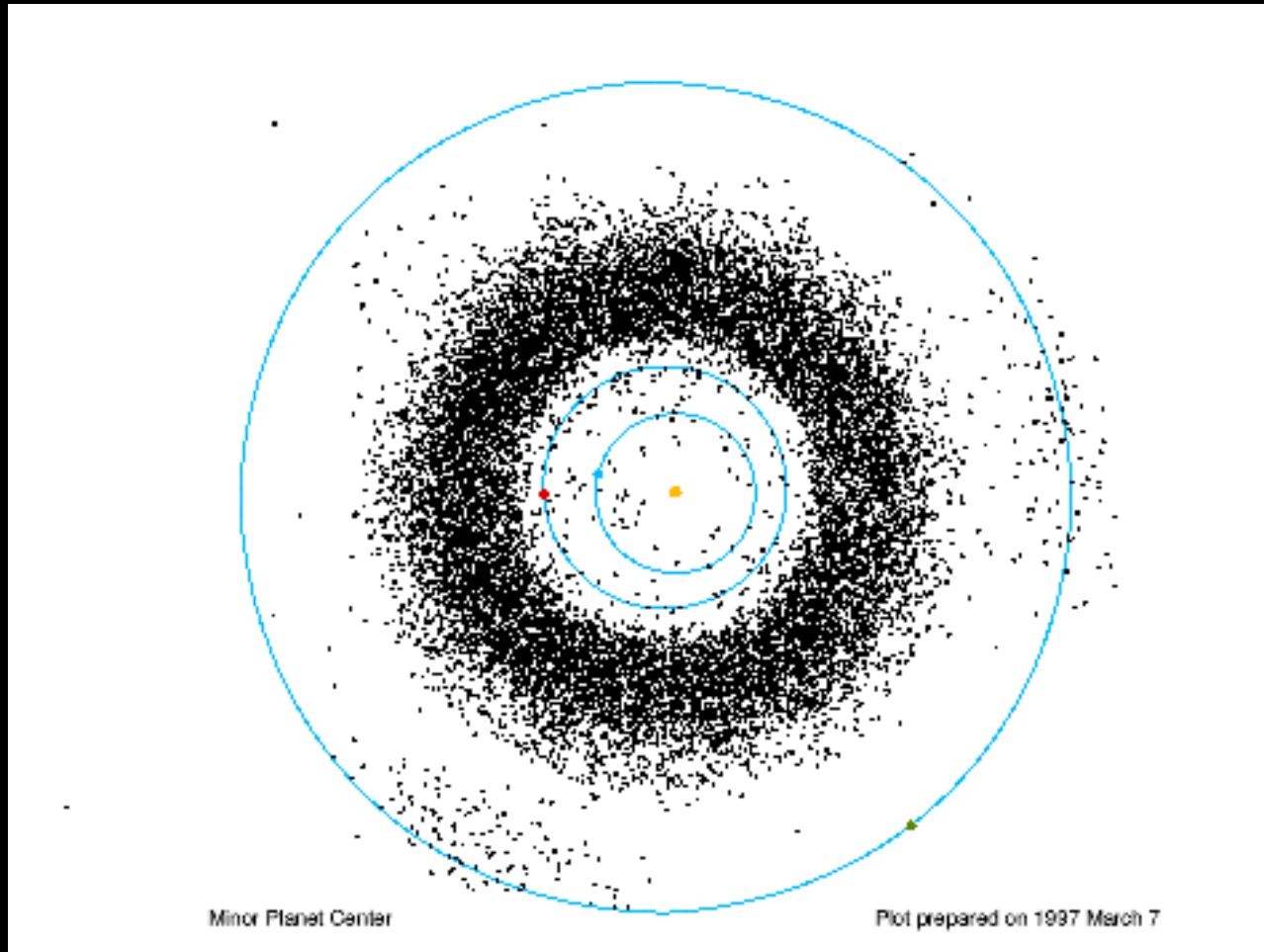
Toutatis



Kleopatra



-Jupiter's Trojan Asteroids



Near-Earth Asteroids

- Asteroids routinely cross the orbit of the Earth

- **Atens** Venus crossing Asteroids
- **Apollos** Earth crossing Asteroids
- **Amors** Mars crossing Asteroids

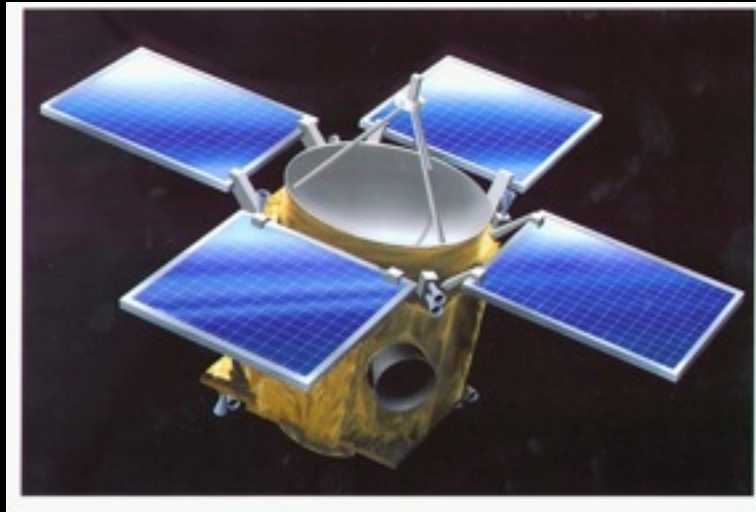
THE INNER SOLAR SYSTEM

This animation shows the motion of the inner part of the solar system over a two-year time period. The sun is at the center and the orbits of the planets Mercury, Venus, Earth and Mars are shown in light blue (the locations of each planet are shown as large crossed circles). Comets are shown as blue squares (numbered periodic comets are filled squares, other comets are outline squares). Main-belt minor planets are displayed as green circles, near-Earth minor planets are shown as red circles.

The individual frames were generated on an OpenVMS system, using the PGPLOT graphics library. The animation was put together on a RISC OS 4.03 system using !InterGif.

Asteroid exploration by spacecraft

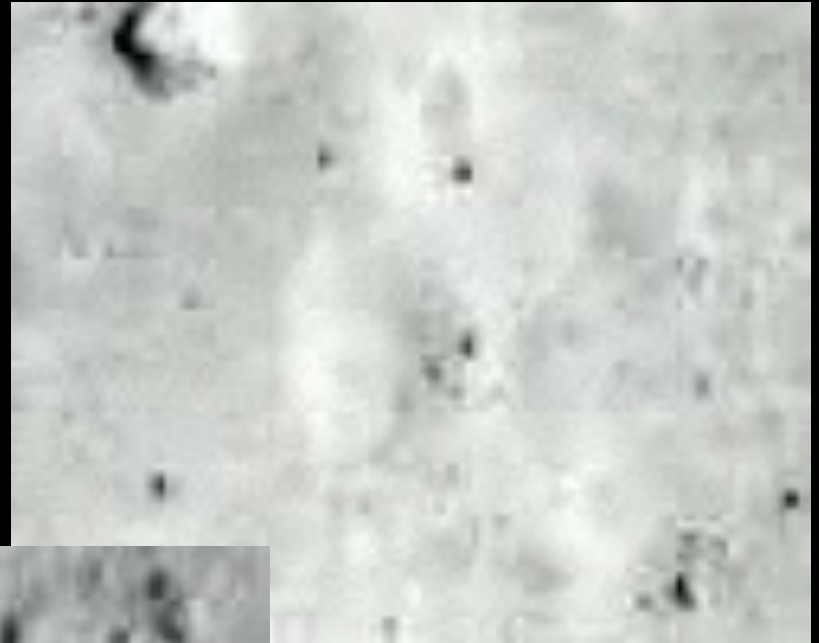
NEAR - Near Earth Asteroid Rendezvous



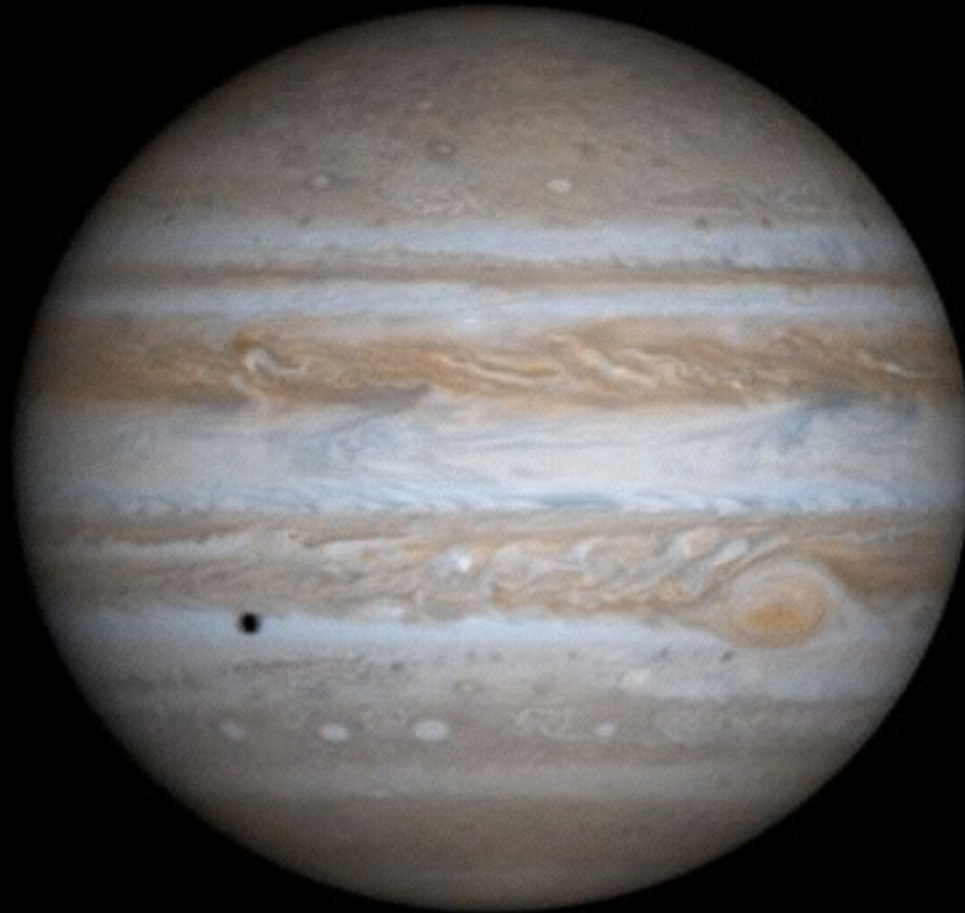
Asteroid exploration by spacecraft



Asteroid exploration by spacecraft

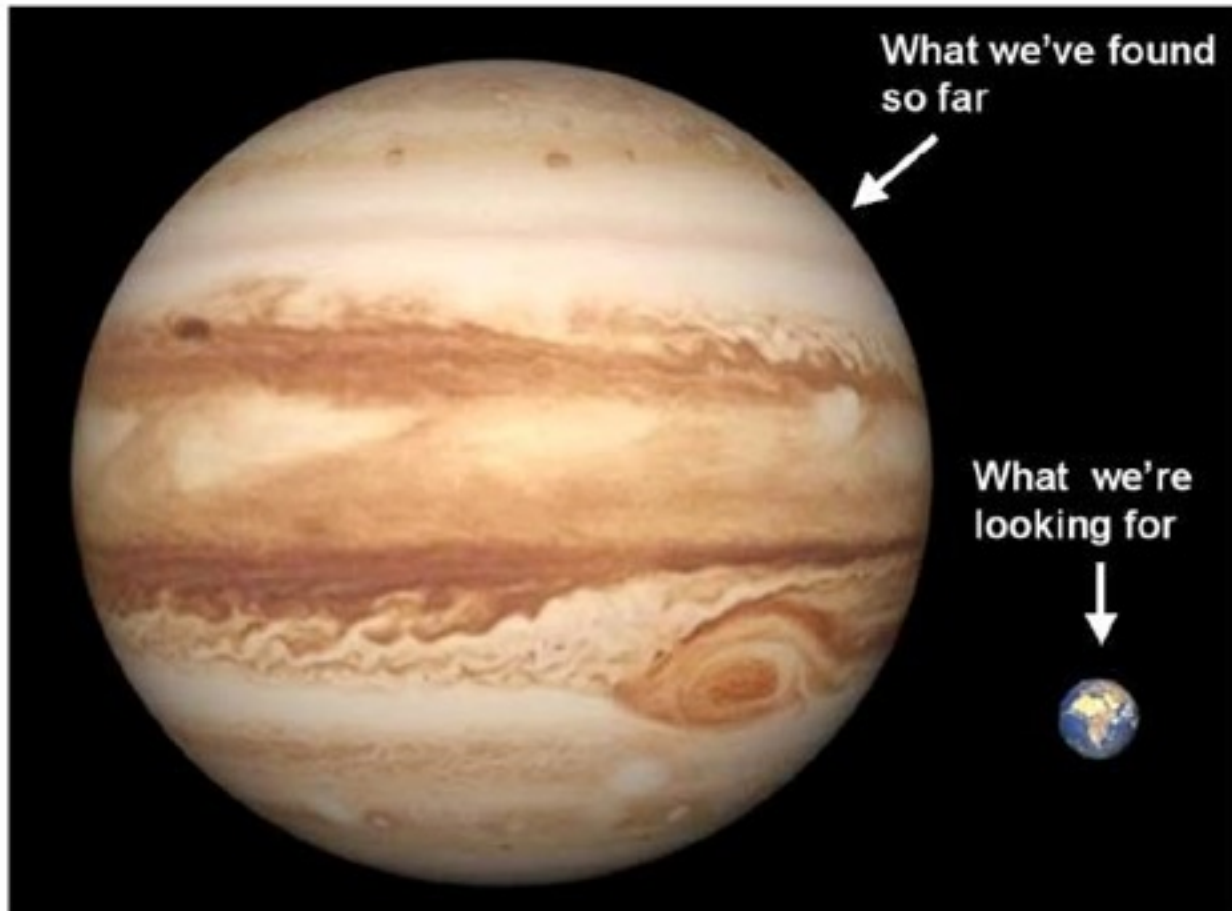


Jupiter



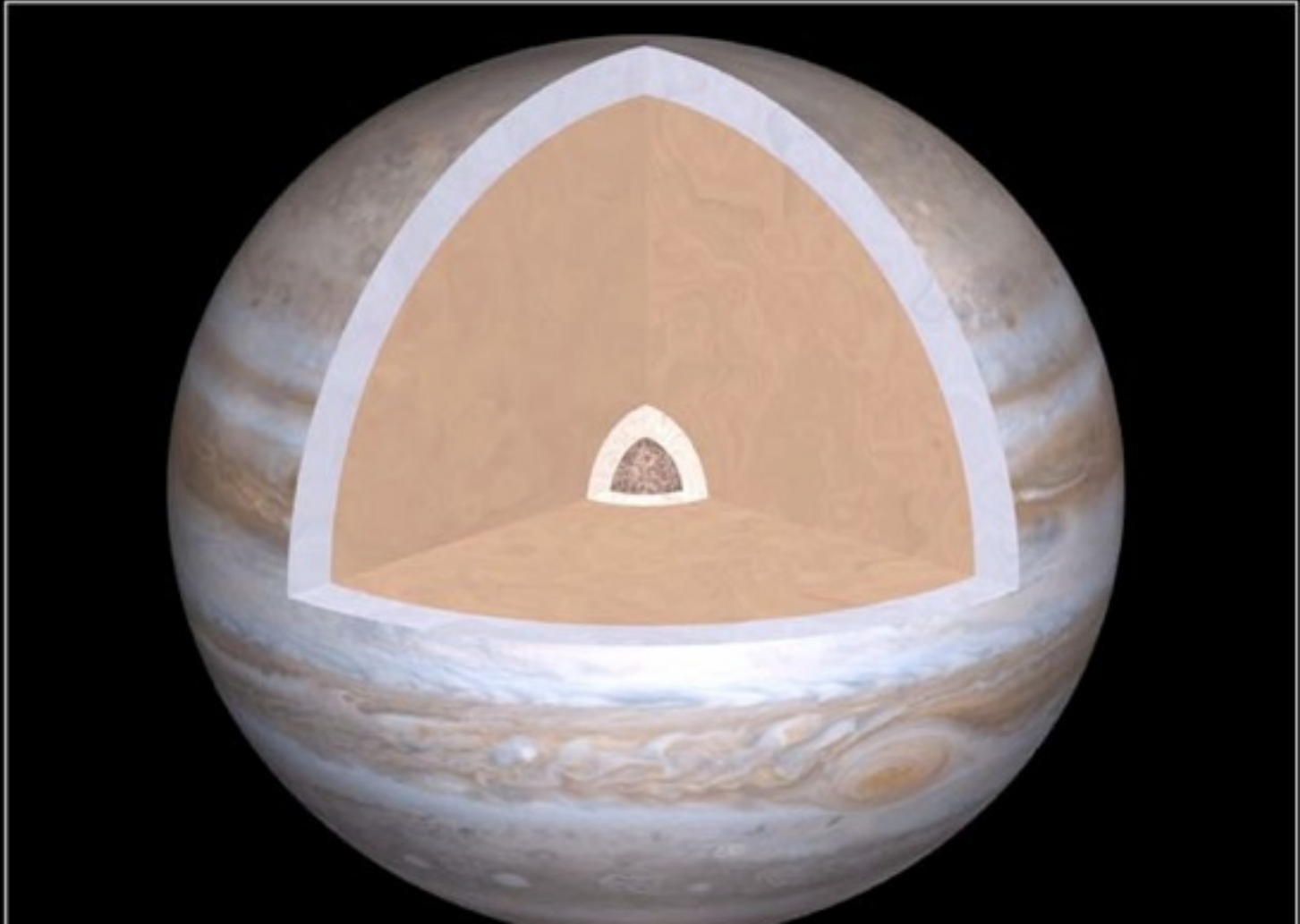
Jupiter

- Largest planet
- Named after Zeus, the king of the gods
- 11 times the size of the Earth



Jupiter

- Fastest rotation in the Solar System
 - 10 hours
- H and He atmosphere with a small rocky core.



Jupiter

- Amazing atmospheric activity
- Differential Rotation



Great Red Spot

- The differential rotation causes pressure differences.
- Pressure differences mean storms.

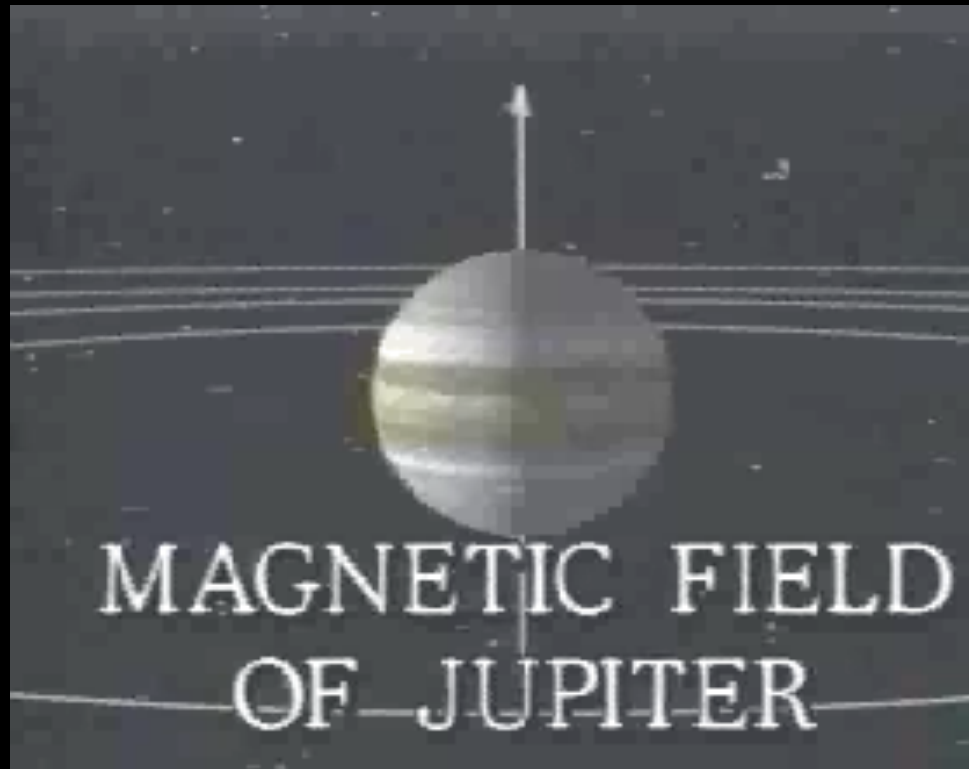


Great Red Spot



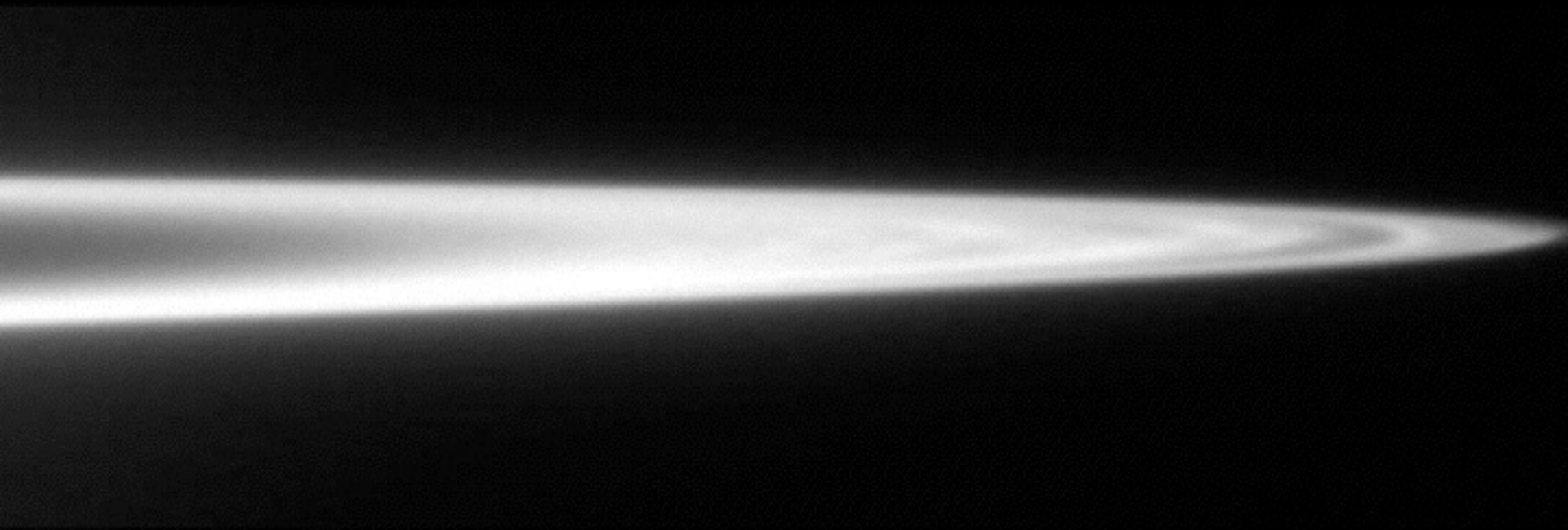
Jupiter

- Extremely large and intense magnetic field.



Jupiter

-Holds a thin ring of rocks and dust.



Jupiter

- At least 60 moons
- Acts as a small solar system



Jupiter

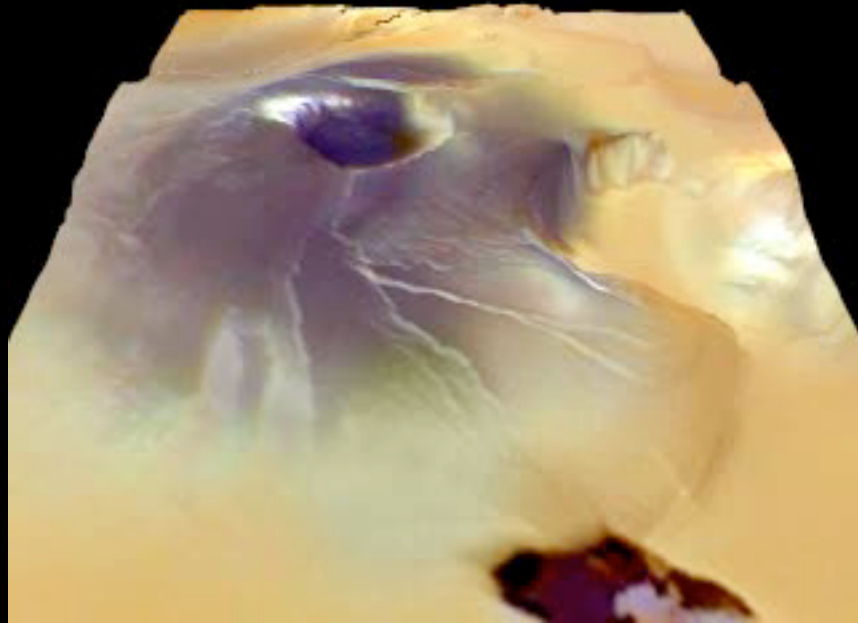


Io

- Innermost moon
- Heavy volcanic activity



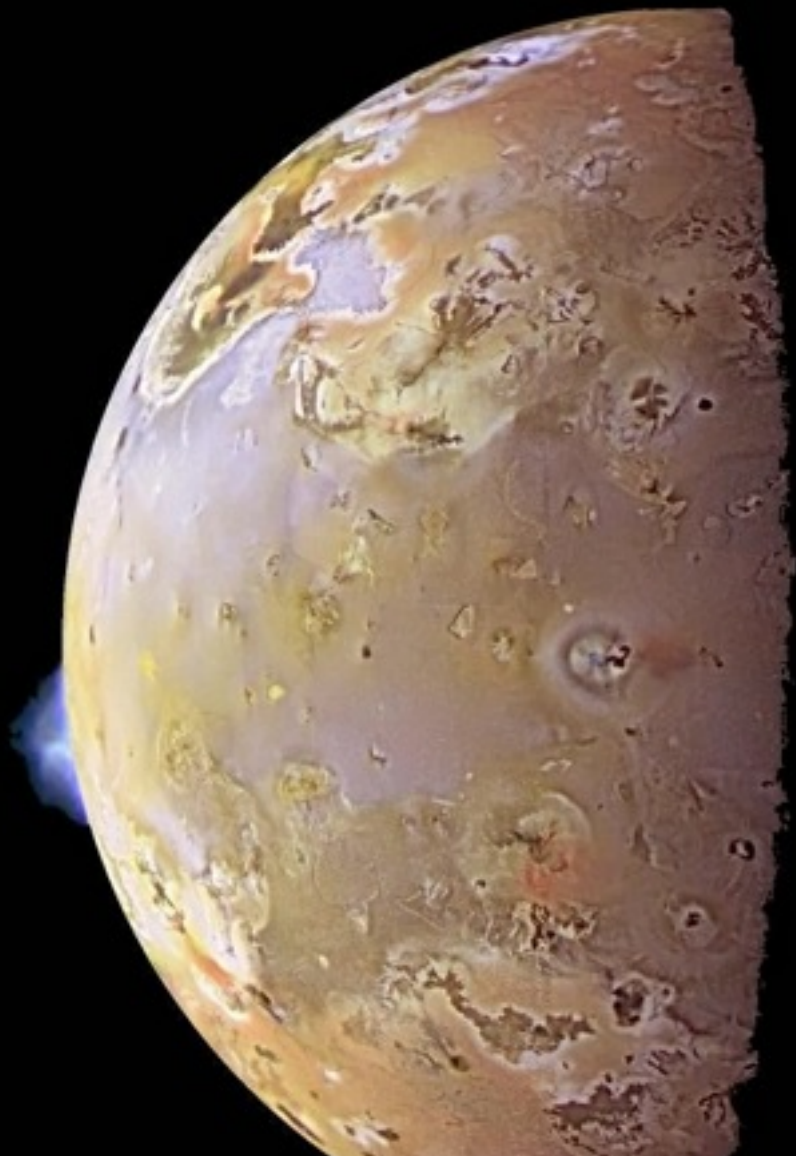
lo



Io



Io

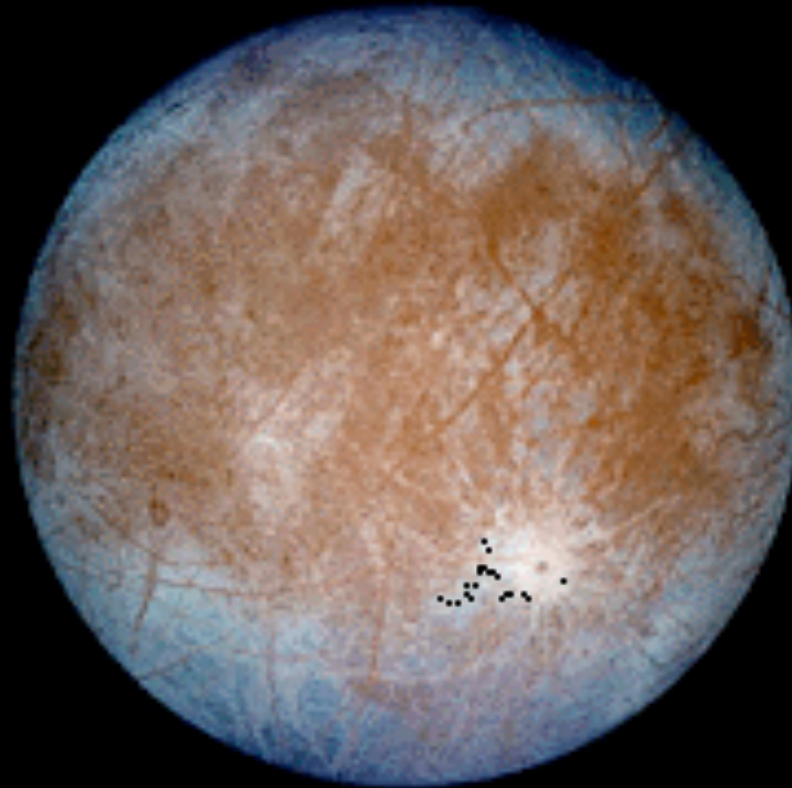


Io

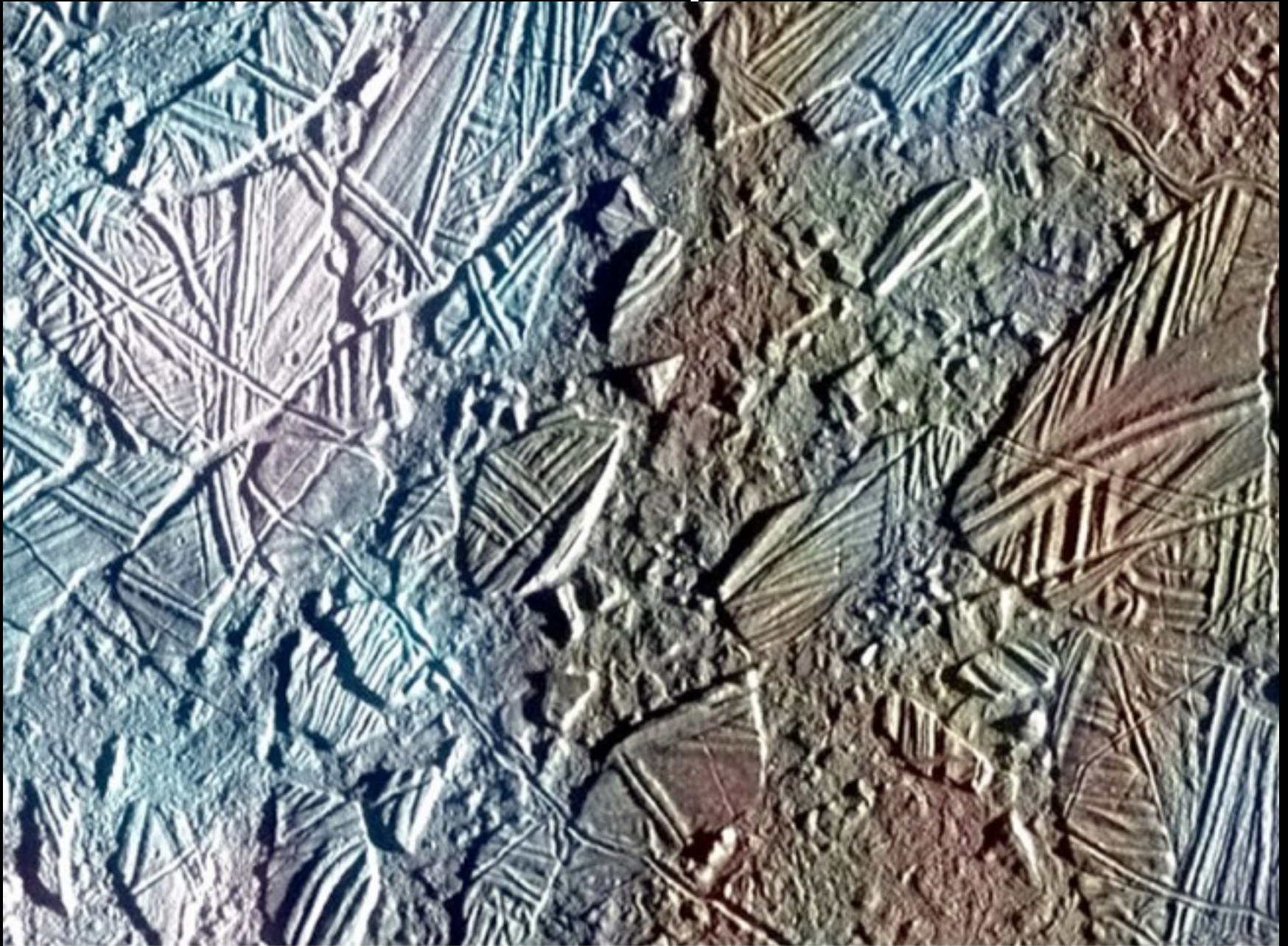


Europa

- Completely smooth surface
- Possibly covered in ice

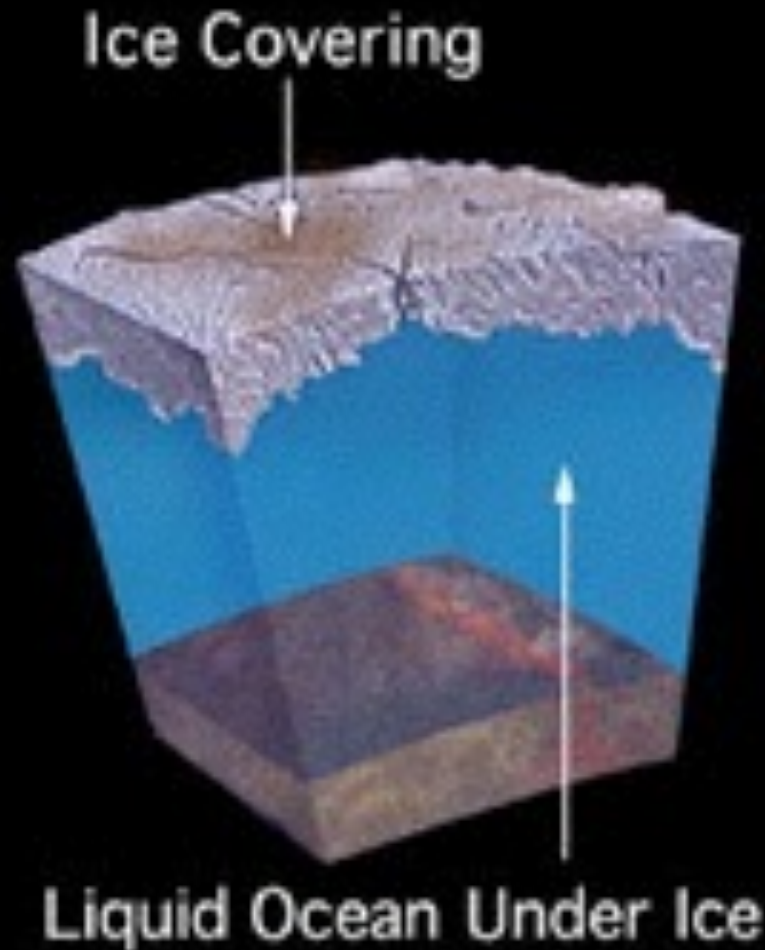


Europa



Europa

- Evidence suggests a deep ocean beneath the icy surface.



Europa



A JPL proposal for a European
ocean explorer

Ganymede

- Largest Moon in the Solar System
 - Larger than the planet Mercury

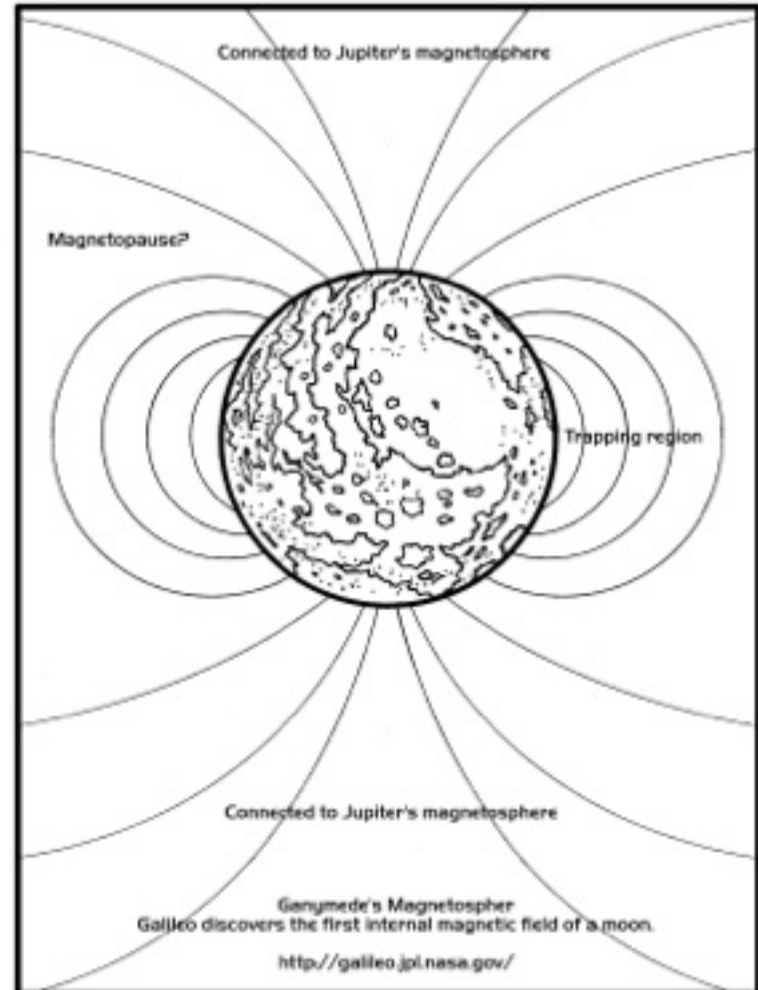


Ganymede



Ganymede

- Has the strongest magnetic field of any other moon in the solar system.

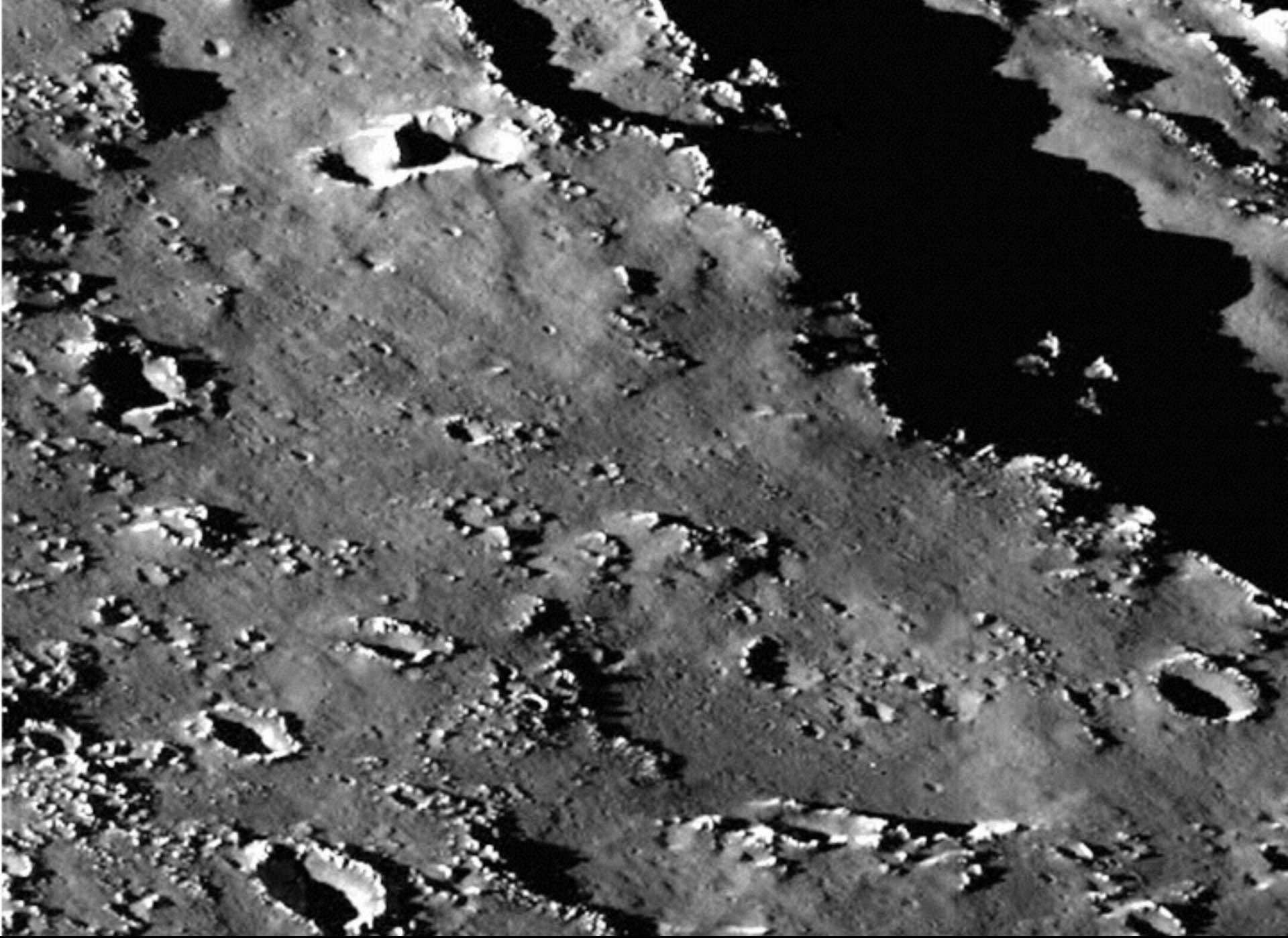


Callisto

- Extremely cratered
- Shows evidence of its own ocean beneath the surface.







Saturn



Saturn

- Named after the god of time and agriculture.
- Very low density
- 10 times the size of Earth



Saturn

- Less active H, He system
- System of Rings:
 - Rock/debris
 - Only 100 meters thick



Saturn



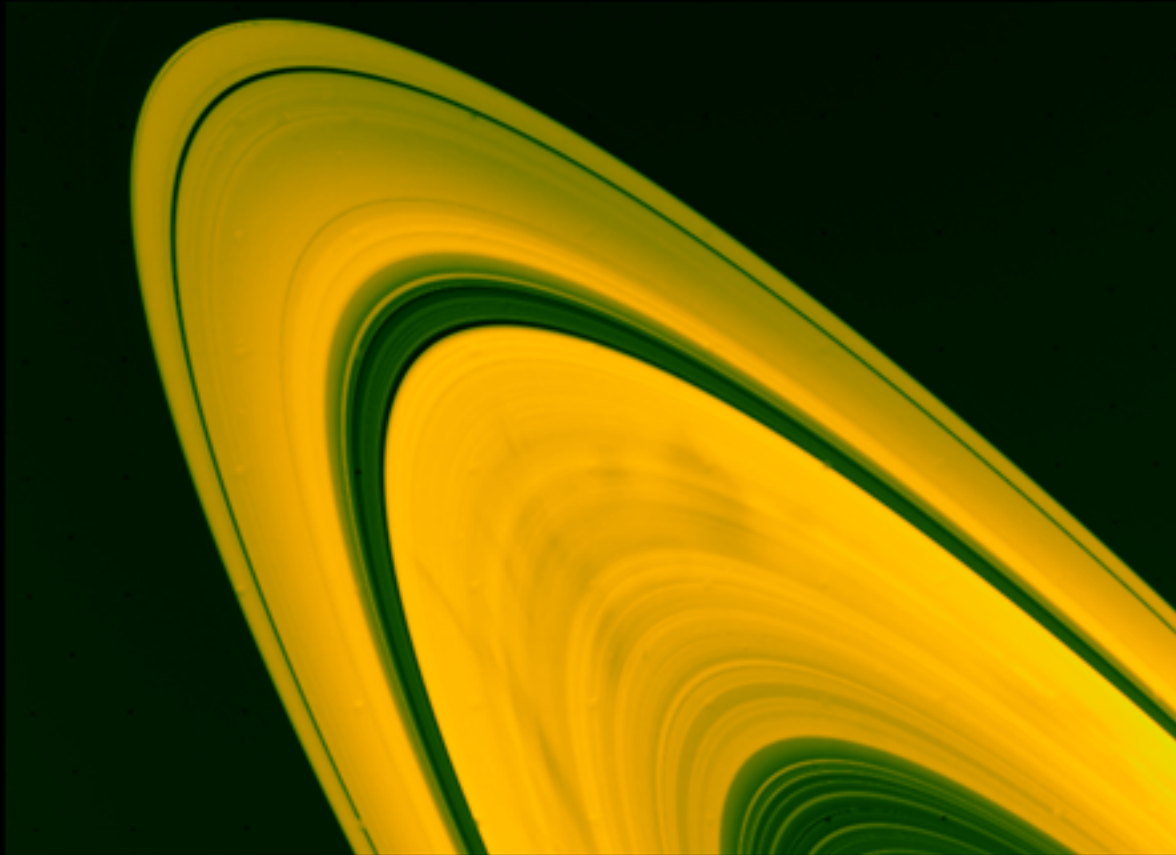
Saturn

-Ring Formation



Saturn

- Division between the rings is called the Cassini Division



Saturn

- Around 18 moons



Titan

- 2nd Largest moon in the Solar System
 - Behind Ganymede



Ganymede
5262 km



Titan
5150 km



Mercury
4880 km



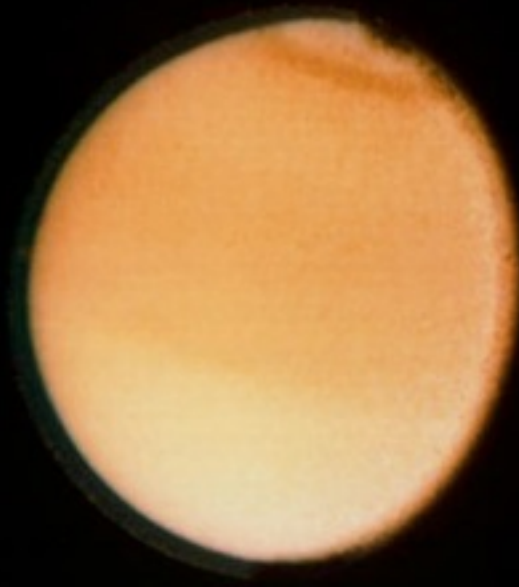
Callisto
4806 km



Moon
3476 km

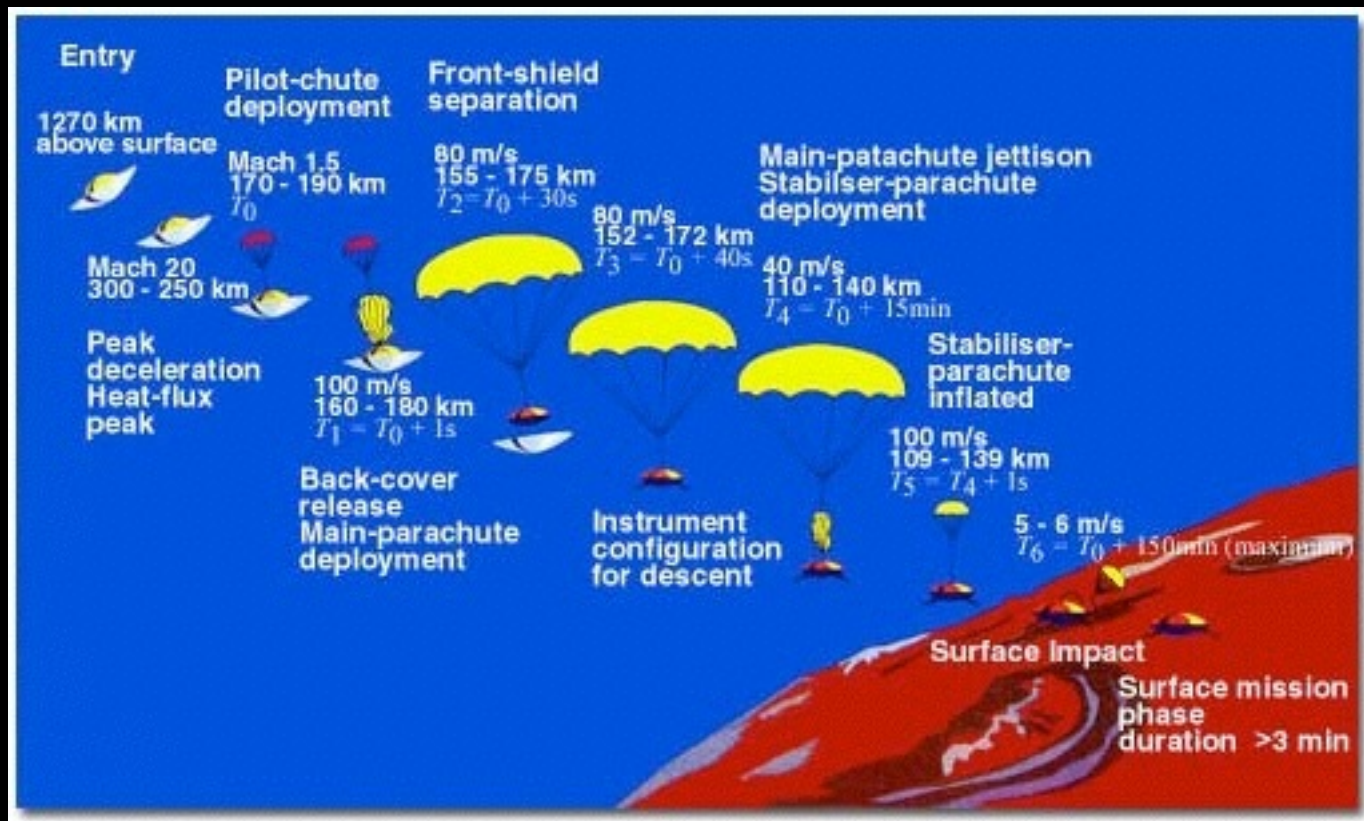
Titan

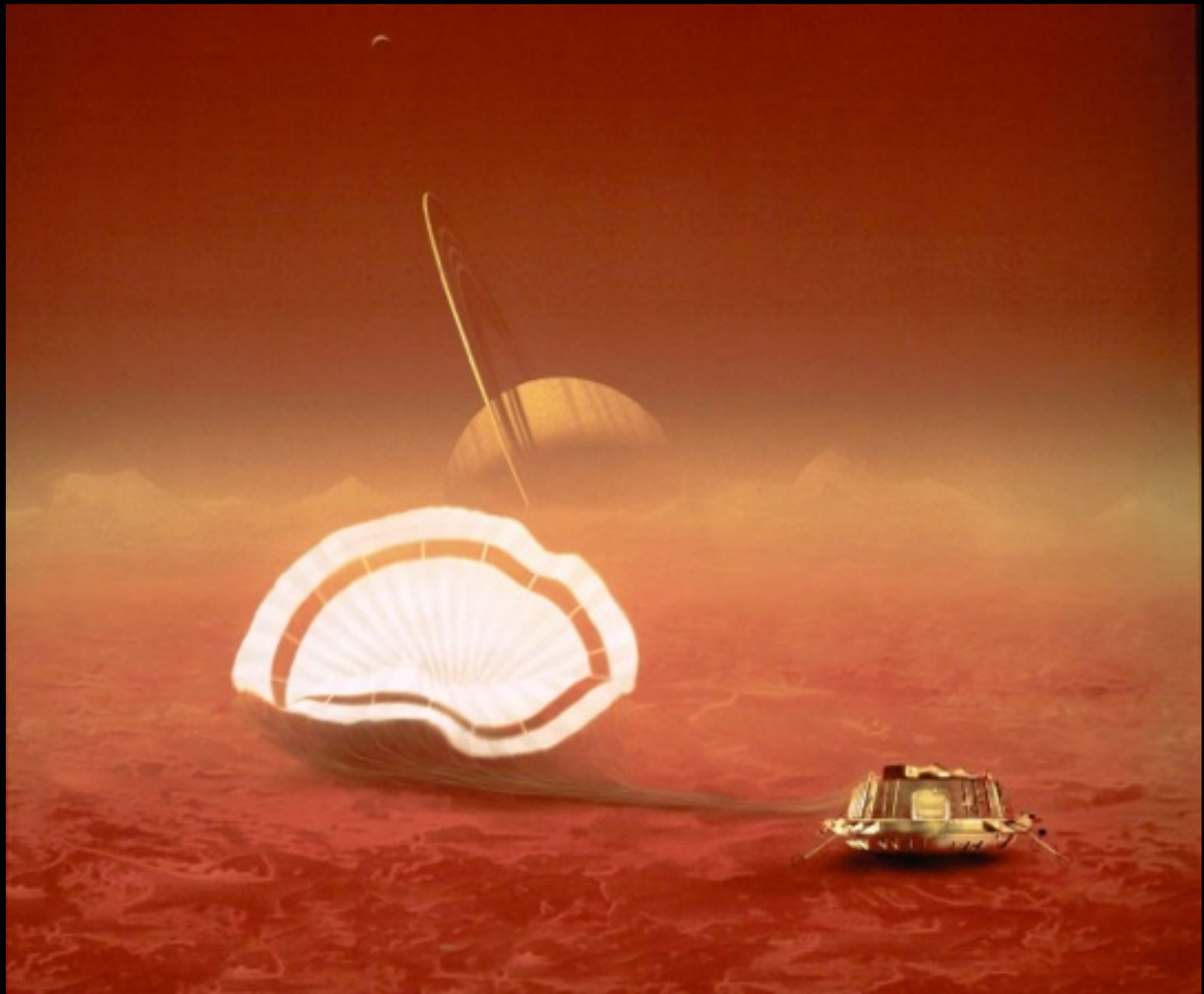
- Thick N atmosphere
- May experience seasons



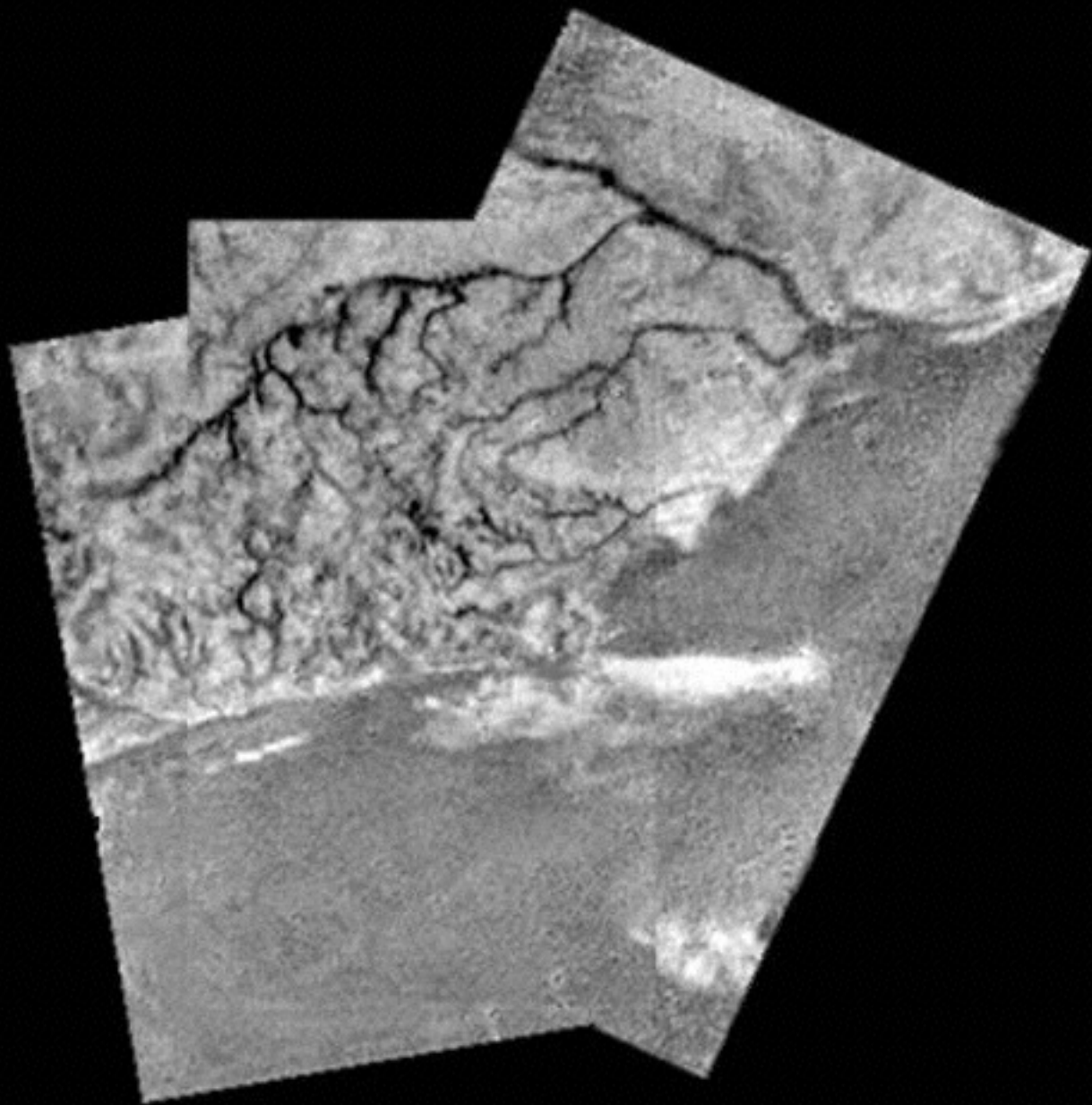
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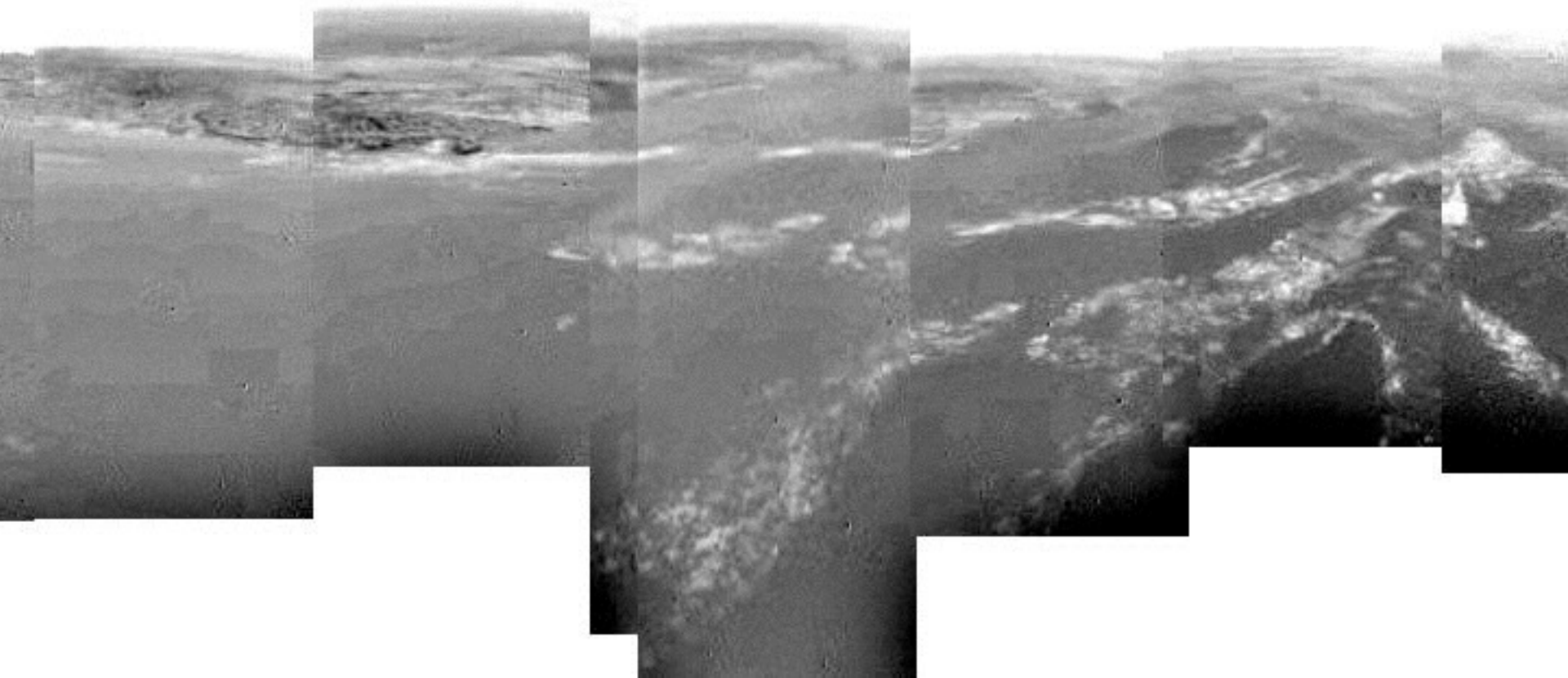
-Huygens Probe dropped off by Cassini
landed on its surface.





Titan





Titan

-Surface



Mimus



Enceladus



Tethys



Uranus



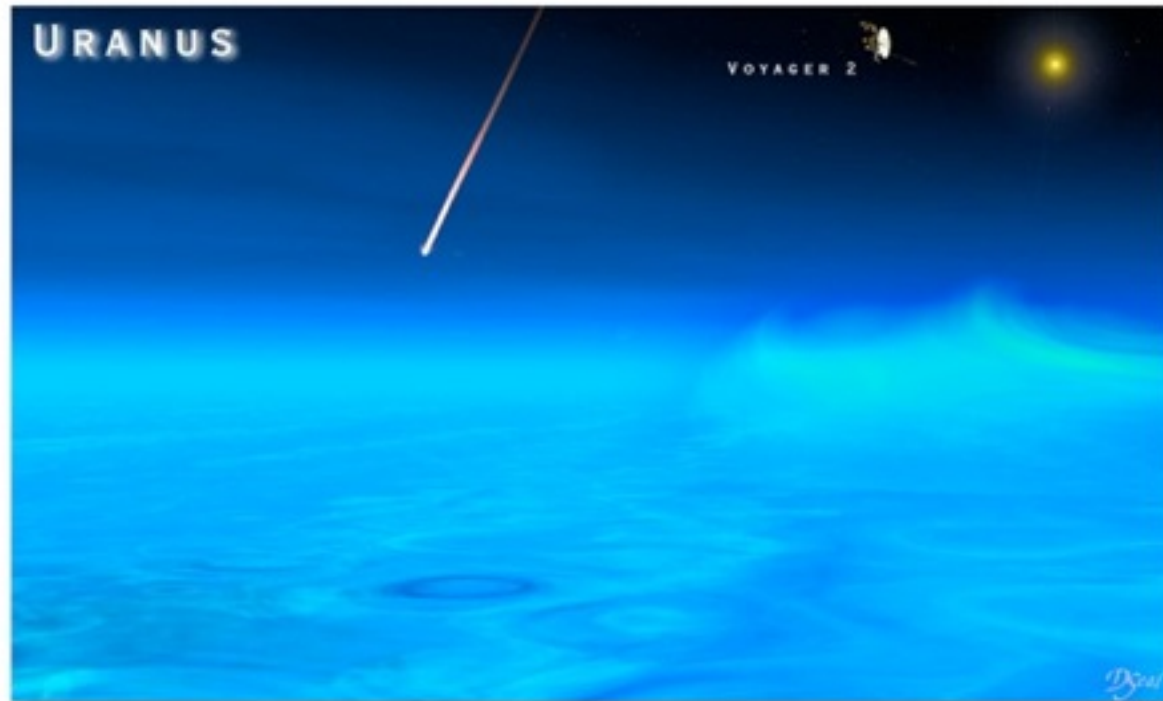
Uranus

- Discovered in 1781
by William Herschel



Uranus

- Rotates backwards compared to other planets (Besides Venus)
- H, He atmosphere



Uranus

- Faint ring system
- Around 15 moons



Uranus



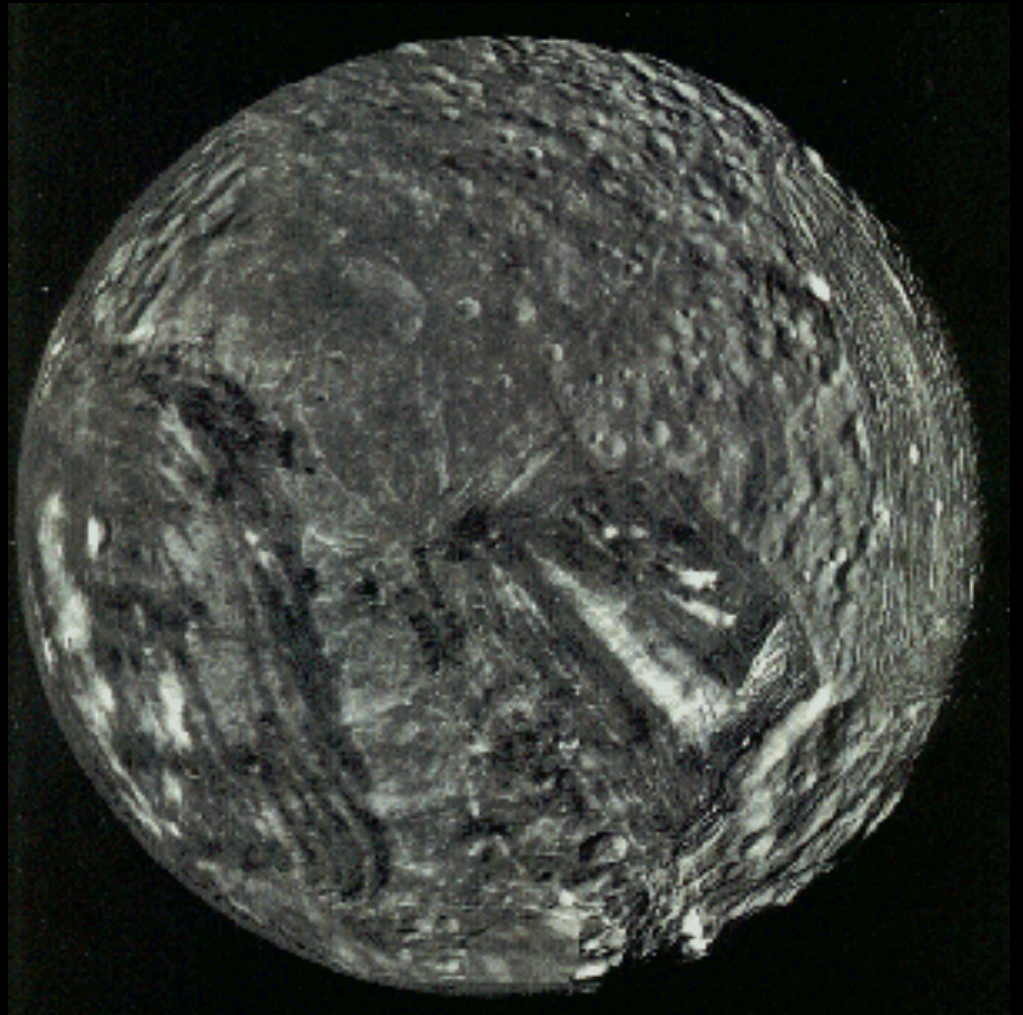
Uranus

Aug 1
94

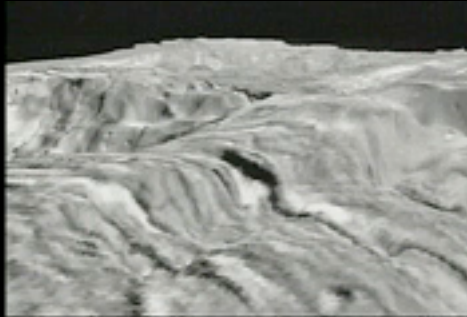


Miranda

- Strange geological past



Miranda



Farewell Uranus



Neptune



Neptune

- Discovered in 1846
- Almost doubled the size of the original Solar System
- Named for the Roman god of the deep sea



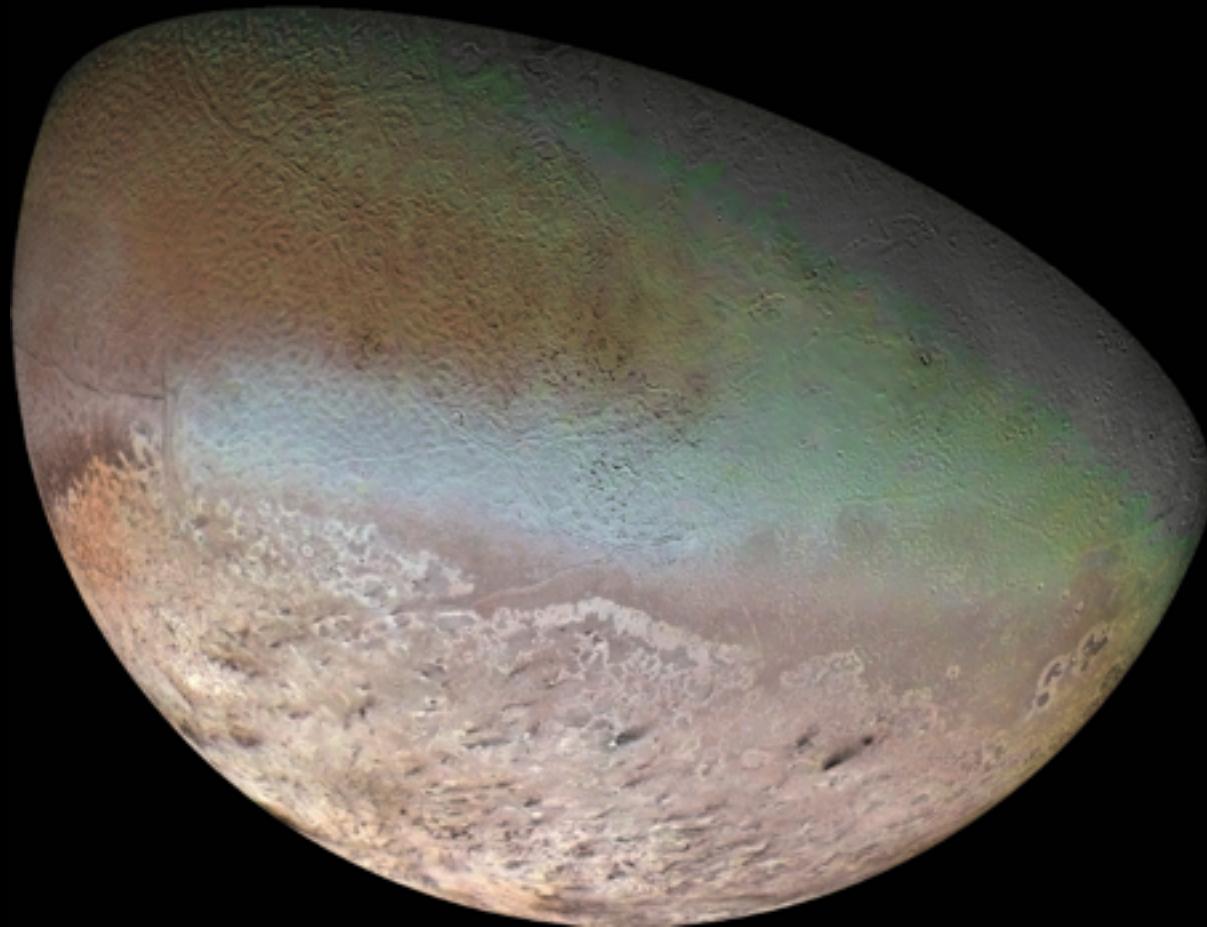
Neptune

- H, He atmosphere
- Faint ring system
- Very circular orbit



Neptune

- Around 28 moons including:
 - Triton; thin N atmosphere, geologically active



Farewell Neptune



Voyager

- Most of what we know/see comes from Voyager missions



Pluto



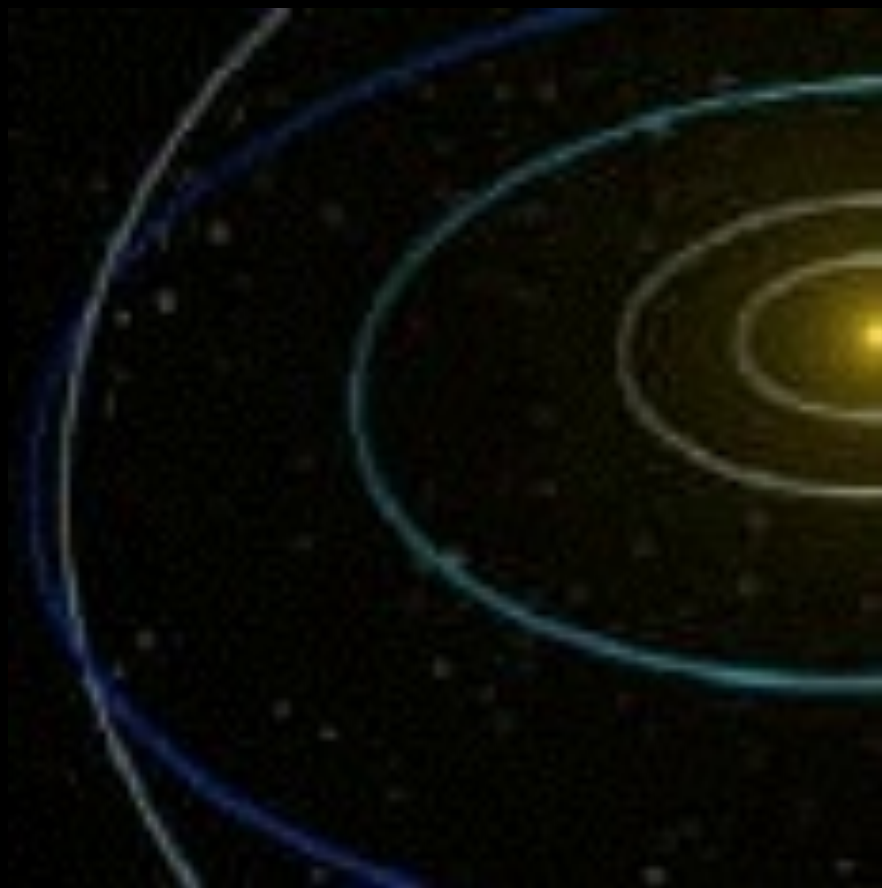
Pluto

- Discovered in 1930 by Clyde Tombaugh
- Roman god of the underworld



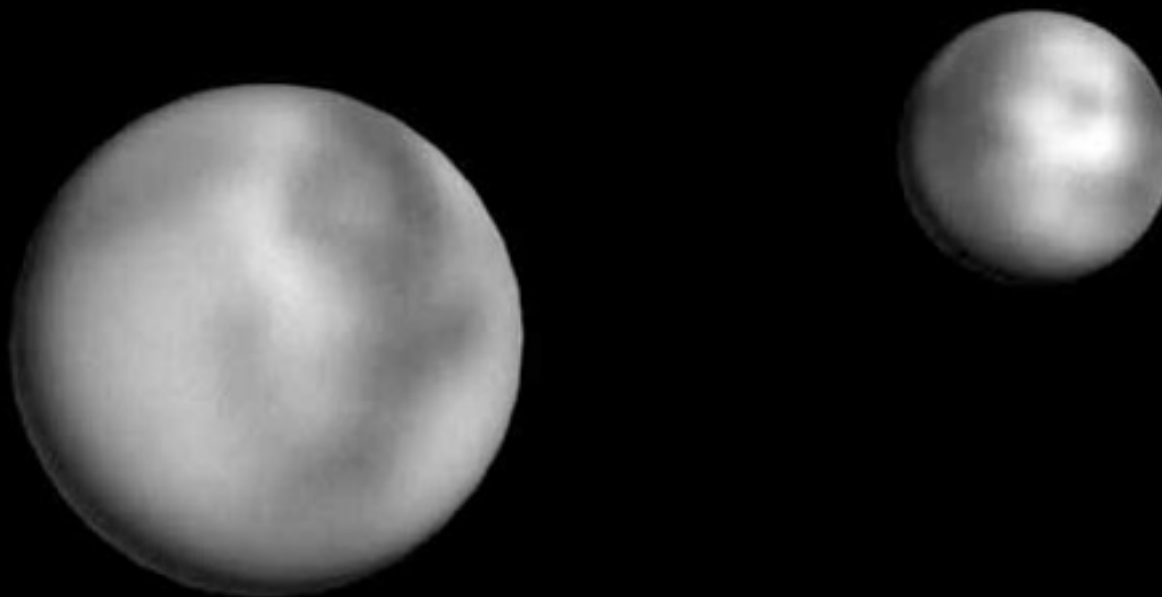
Pluto

- Extremely cold
 - 50-60K
- Wildly elliptical orbit
 - Crosses Neptune's orbit



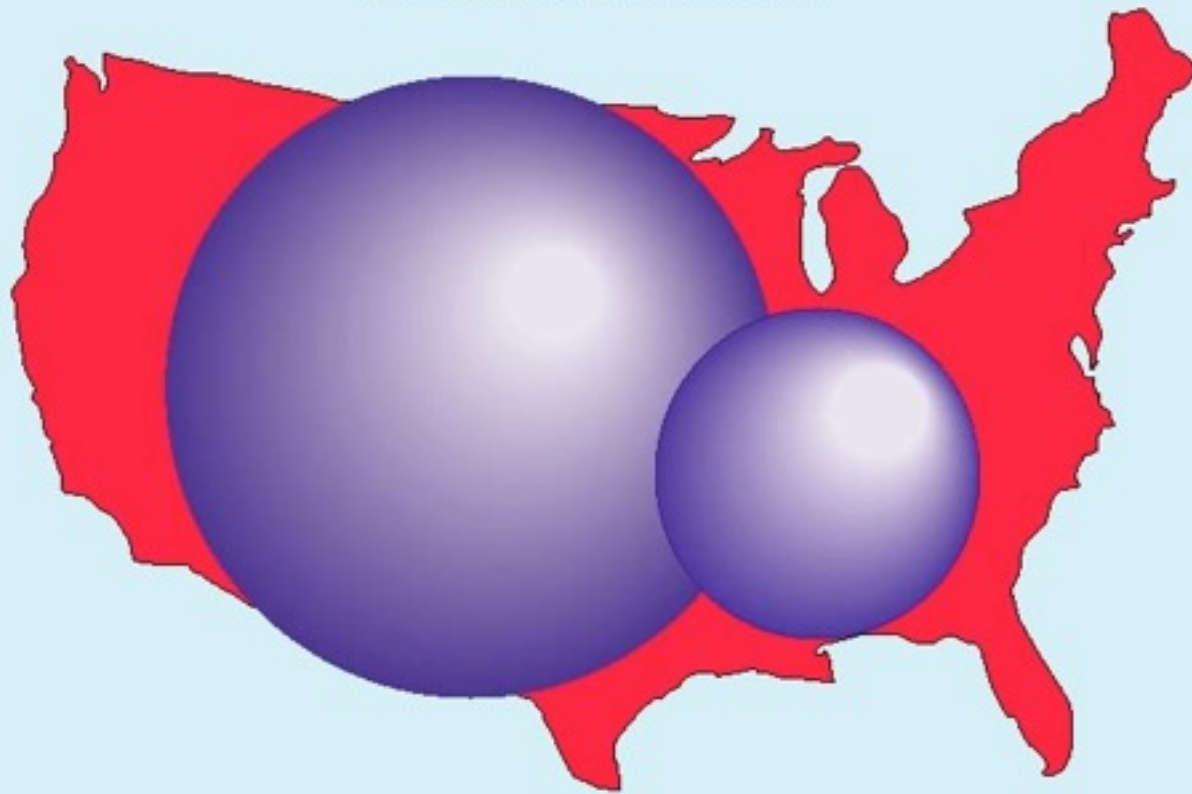
Pluto

- One moon
 - Charon
 - Resonant bodies
- Classification called into question



Pluto

PLUTO and CHARON



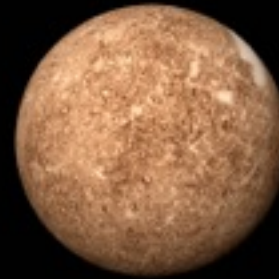
Overview of Planetary Satellites



Ganymede
5262 km



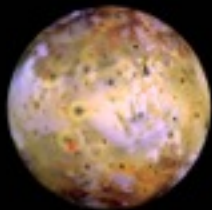
Titan
5150 km



Mercury
4880 km



Callisto
4806 km



Io
3642 km



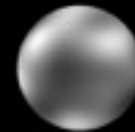
Moon
3476 km



Europa
3138 km



Triton
2706 km



Pluto
2300 km



Titania
1580 km