

Astronomy

Semester 2: Weeks 1 – 2

January 6 – 16, 2026

Tuesday / Wednesday (Jan 6th and 7th)

- **T:11C** compare the planets in terms of orbit, size, composition, rotation, atmosphere, natural satellites, magnetic fields, and geological activity; and
- **O:** I will be able to describe Mercury
- **D:** after watching a couple of videos and participating in a class discussion about the notes.
- **A:** Mercury, Retrograde, Terrestrial Planets
- **Y:** What similarities and differences do Mercury, and Earth have?

Journal 4.1

- Same requirements as always, write **today's date**, write the prompt, and write at least 4 complete sentences in response to the prompt.
- Prompt: **Get to know your group.**
 - Instructions: Each person in your group will share the following information for you to write down as your journal.
 - Name (yes, some of you have no idea what your classmates' names are)
 - Age
 - Birthday
 - A fun fact about them that has nothing to do with school.

Unit 6 – Planets

The Terrestrial Planets ²

- The four terrestrial planets (Mercury, Venus, Earth, and Mars)– have similar sizes and structure.
- These rocky worlds orbit in the inner part of the Solar System, too small and too warm to have captured massive hydrogen atmospheres like the Jovian giants.
- They have very few natural satellites – Earth has the relatively large Moon and Mars has two small captured asteroids as moons.

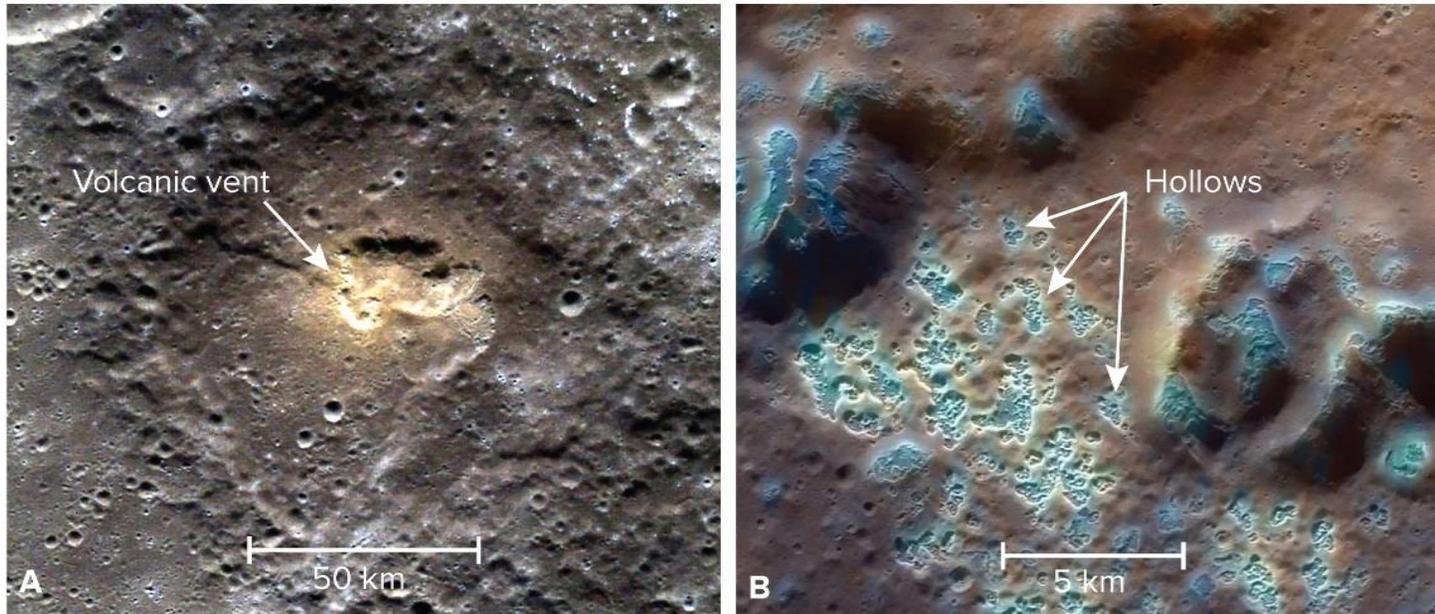
Mercury

- Mercury's radius is $\frac{1}{3}$ and its mass $\frac{1}{28}$ that of Earth.
- Circular craters cover the surface with the largest one being Caloris Basin with a diameter of 1300 km.
- Congealed lava flows are found in many of Mercury's old craters and pave much of its surface.



Surface Features of Mercury

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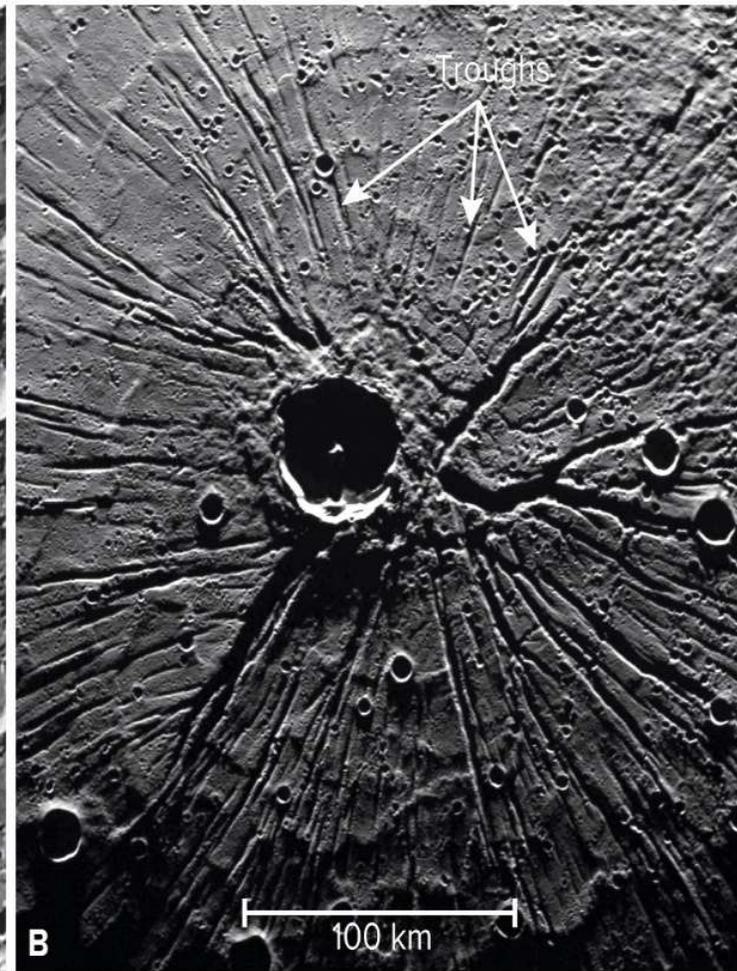
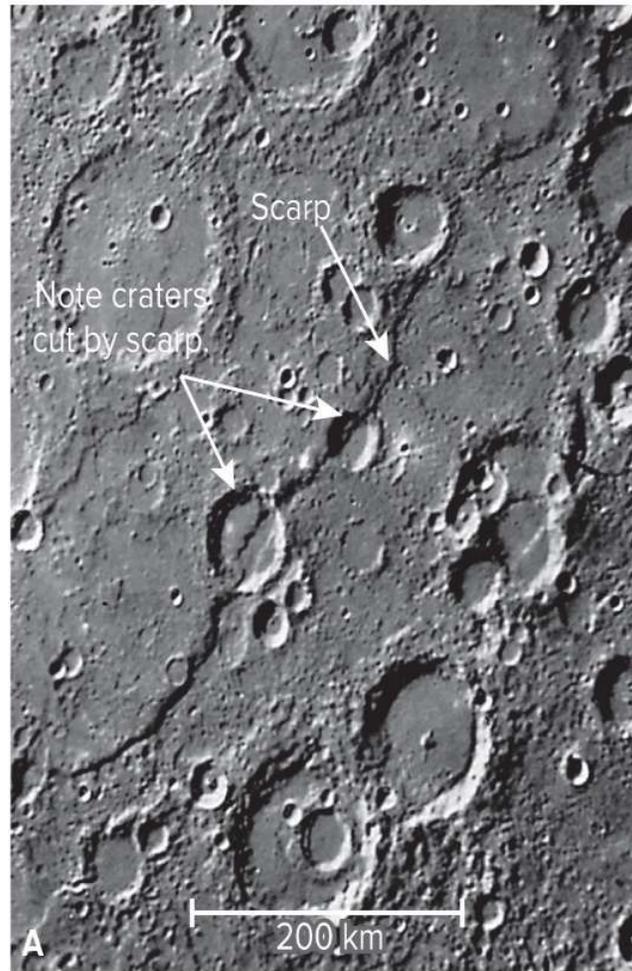


- Large-scale lava flows pave much of the surface.
- There is evidence for “recent” volcanic eruptions!

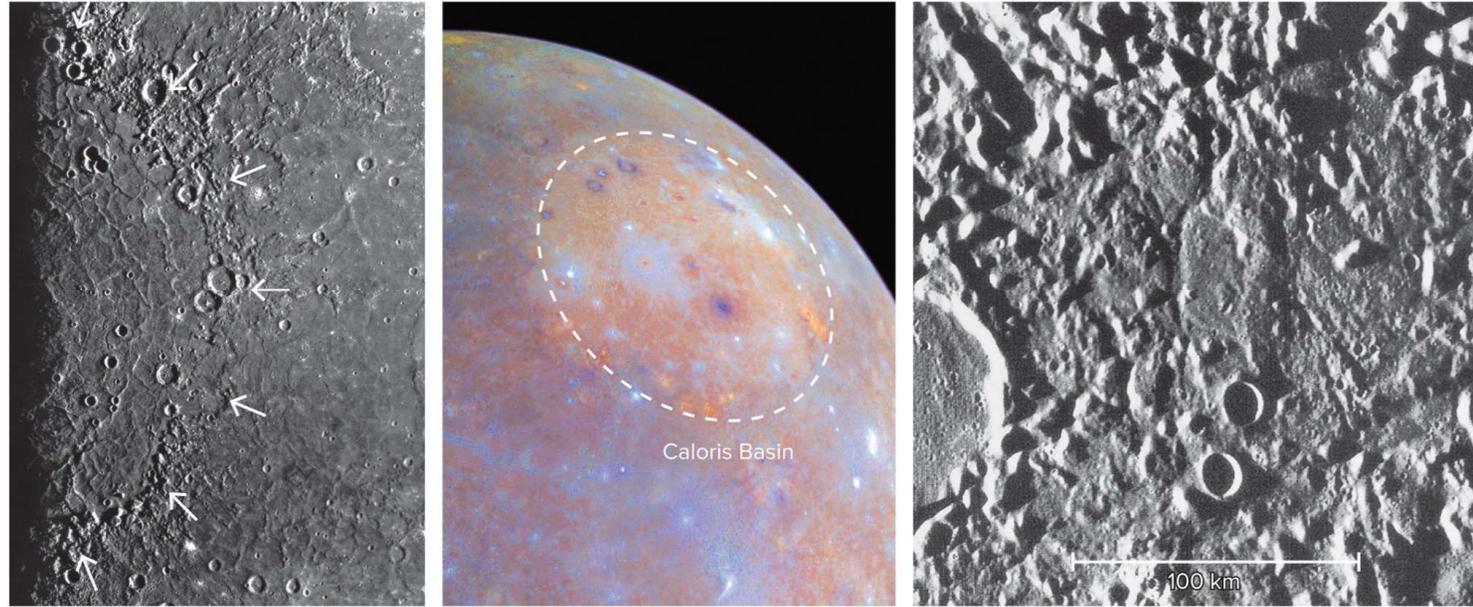
Scarps

- Enormous **scarps** (cliffs), formed as Mercury cooled, and shrank, wrinkling like a dried apple.

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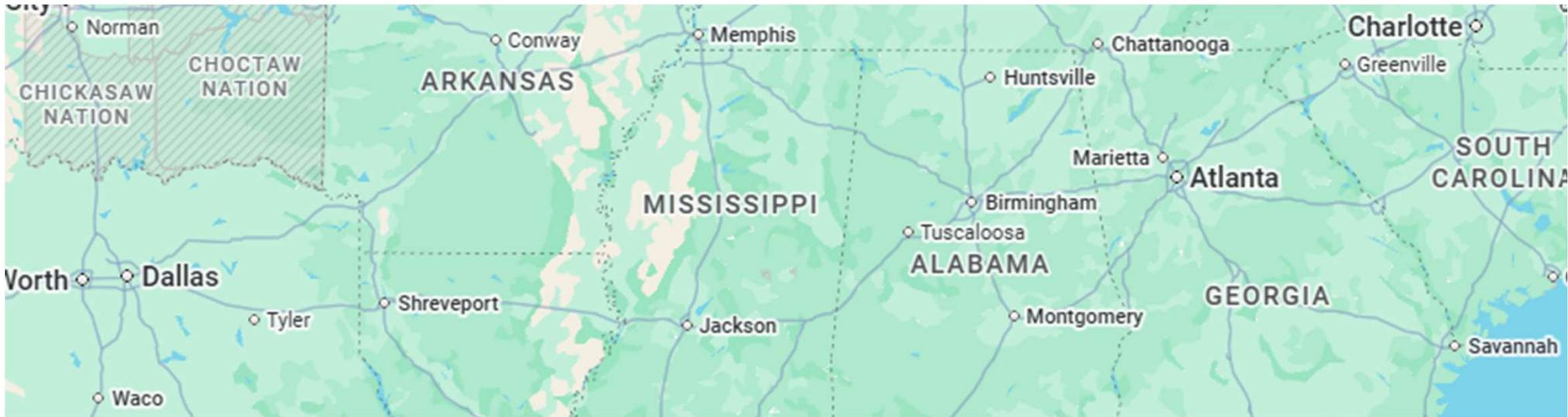


Caloris Basin



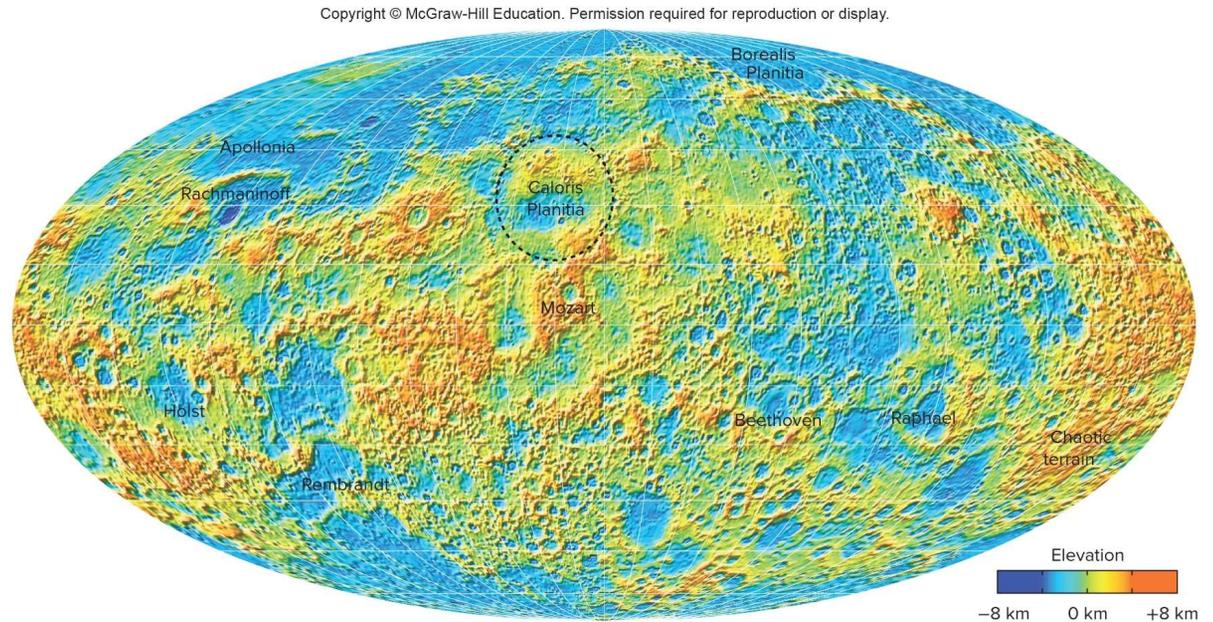
- Largest crater basin on Mercury: 1300 km across
- Appears to have formed 3.8 billion years ago.
- Odd radial cracks near the center.
- Uplifting in the region occurred later.

1300 km = 800 miles



Topographic Map of Mercury

- The surface of Mercury is flatter than that of the Moon.
- Likely due to Mercury's stronger gravitational pull and hotter interior.



Mercury's Temperature

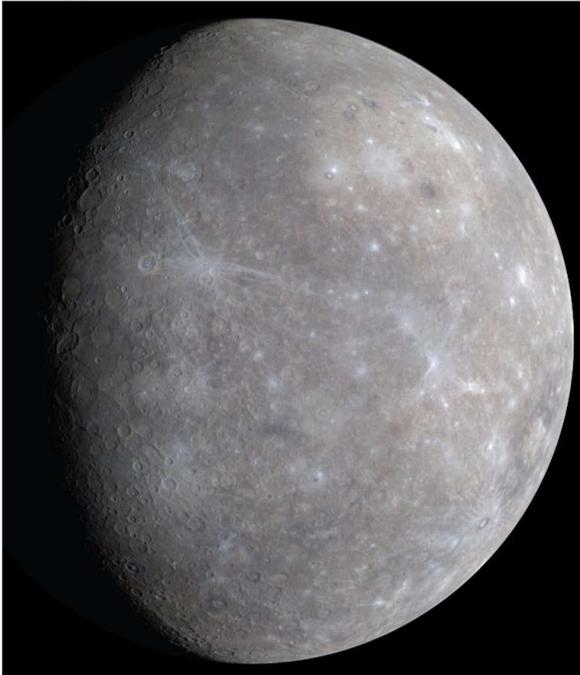
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- Mercury's noon temperature at the equator (about 710 K = 820°F) and nighttime temperature (80 K = -320°F)

Mercury's Atmosphere?

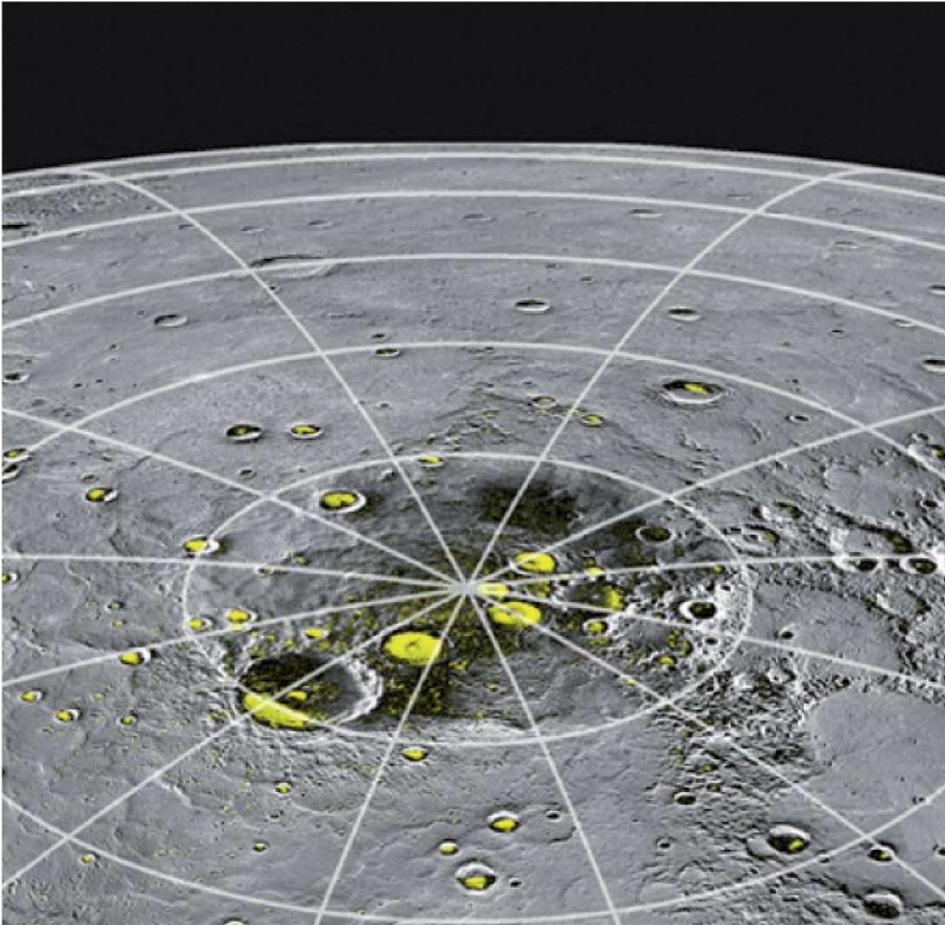
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- Trace gases detected, but its low mass and proximity to the Sun do not allow Mercury to retain an atmosphere of any significance.

Ice on Mercury?

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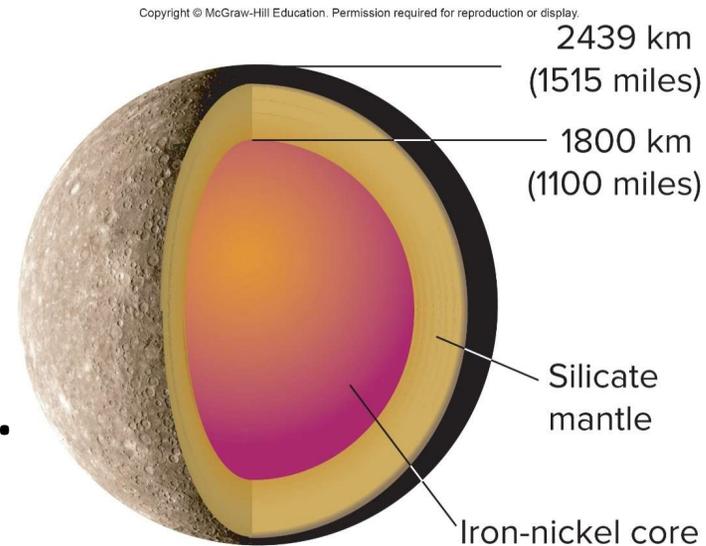


NASA/JHU Applied Physics Lab/Carnegie Inst. Washington

- Presence of ice was confirmed by Messenger spacecraft.
- Ice is located in permanently shadowed craters.
- Ice may have come from cometary impacts.

Mercury's Interior

- Mercury's very high average density suggests that its interior is iron-rich with only a thin rock (silicate) crust and mantle.



Mercury's Magnetic Field

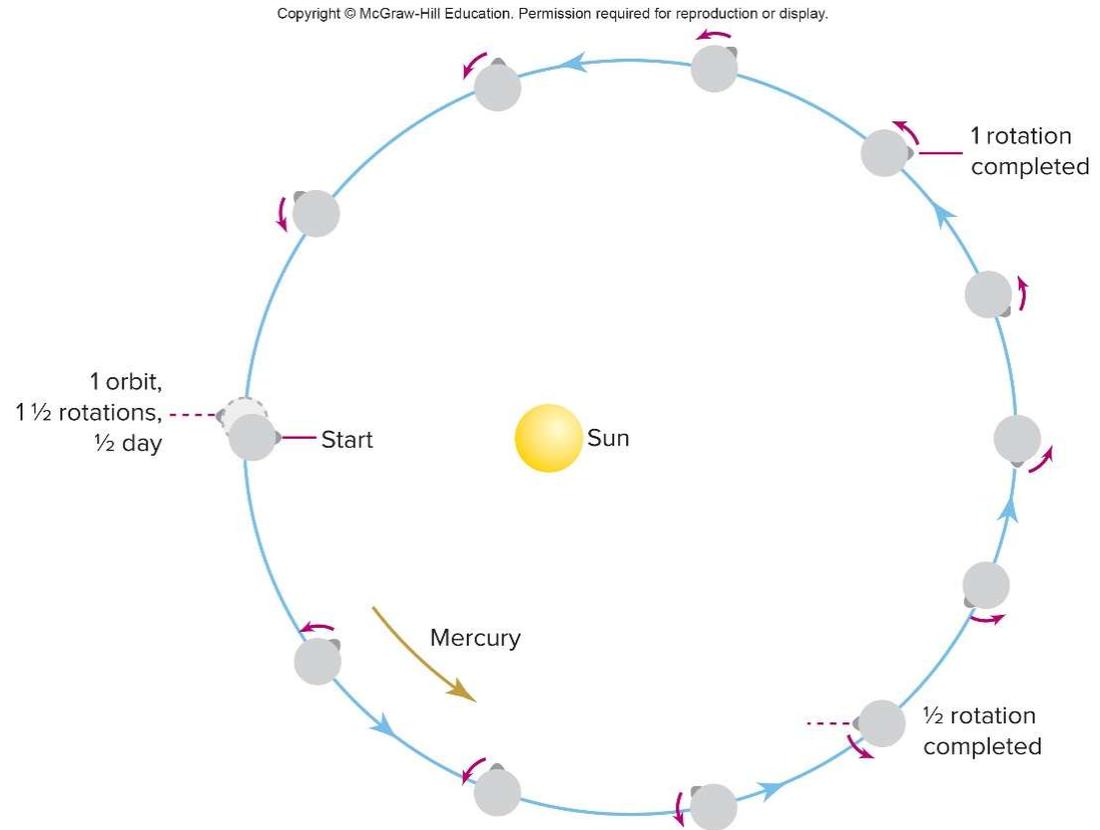
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- 1% as strong as Earth's.
- Mercury's very weak magnetic field probably due to:
 - Partially molten core.
 - Slow rotation rate.

Mercury's Rotation

- Mercury rotates once every 58.646 Earth days, exactly $\frac{2}{3}$ its orbital period around the Sun of 87.969 Earth days.



Thursday / Friday (Jan 8th & 9th)

- **T:11C** compare the planets in terms of orbit, size, composition, rotation, atmosphere, natural satellites, magnetic fields, and geological activity; and
- **O:** I will be able to describe Venus
- **D:** after watching a couple of videos and participating in a class discussion about the notes.
- **A:** Mercury, Venus, Retrograde, Terrestrial Planets
- **Y:** What similarities and differences do Mercury, Venus, and Earth have?

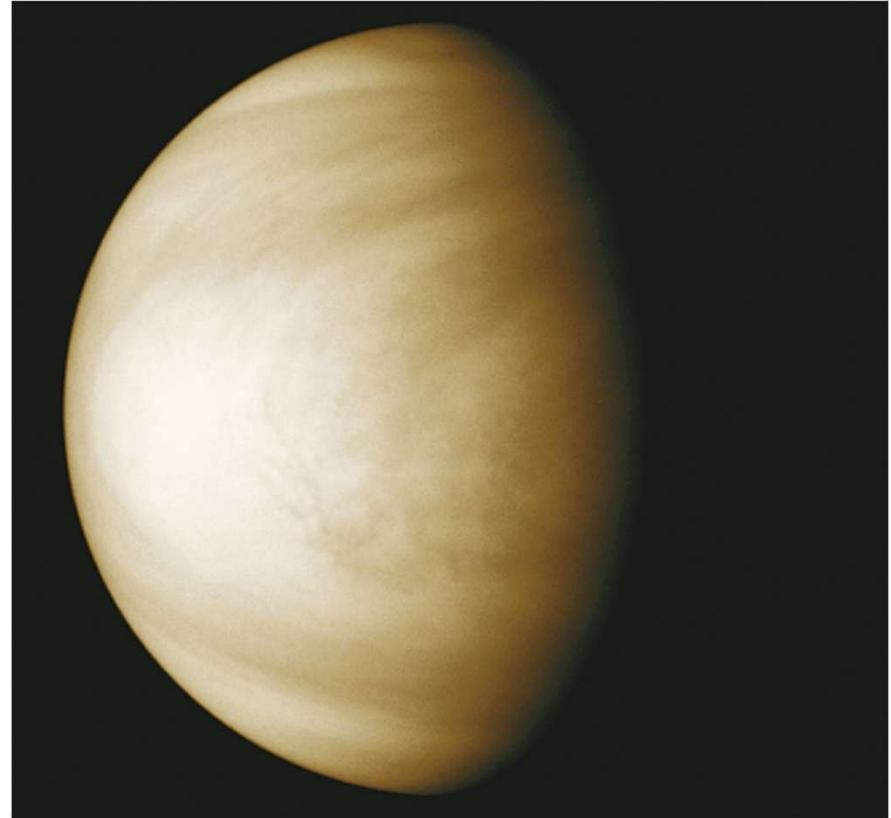
Venus

- Venus has a mass and diameter very close to that of Earth.
- However, the two planets have radically different surfaces and atmospheres.

The Atmosphere of Venus

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- Reflected spectra and spacecraft measurements show the Venusian atmosphere is 96% CO₂, 3.5% N₂, and small amounts of H₂O and other gases.



Clouds of Sulfuric Acid

- The clouds of Venus are sulfuric acid droplets with traces of water.

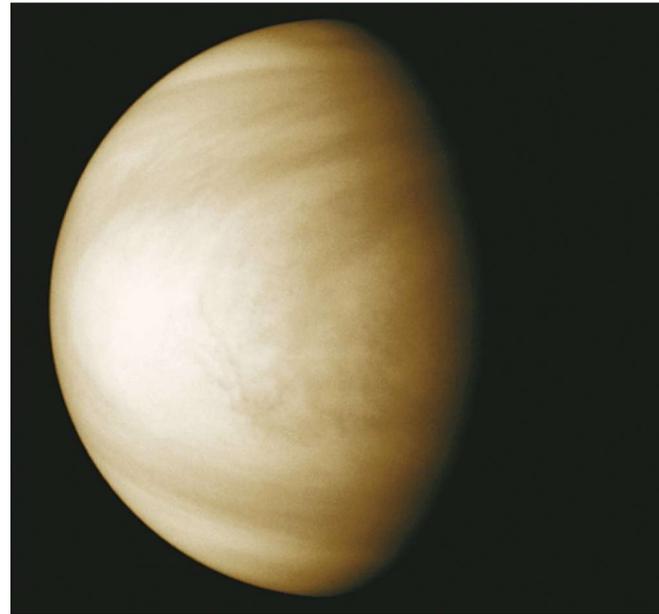
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Atmospheric Pressure

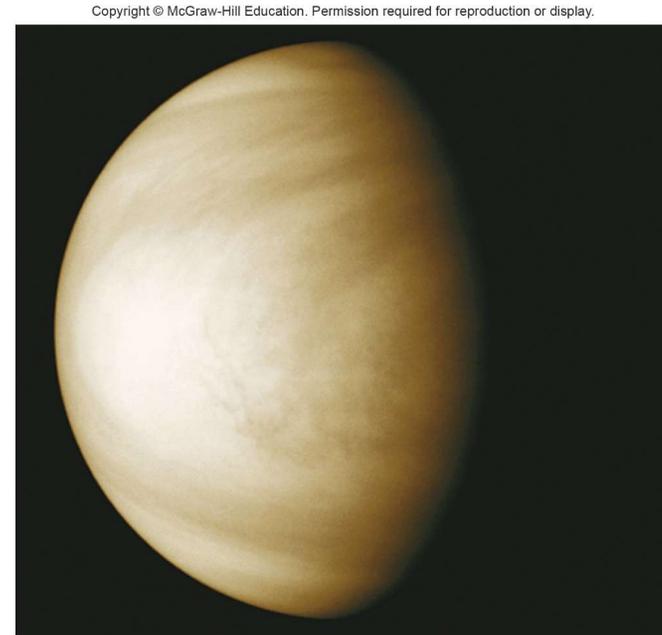
- The atmosphere is extremely dense, reaching pressures about 100 times that of Earth's.
- The lower atmosphere is very hot with temperatures of 750 K (900°F) at the surface, enough to melt lead.
- Spacecraft have landed on Venus, but do not survive long.

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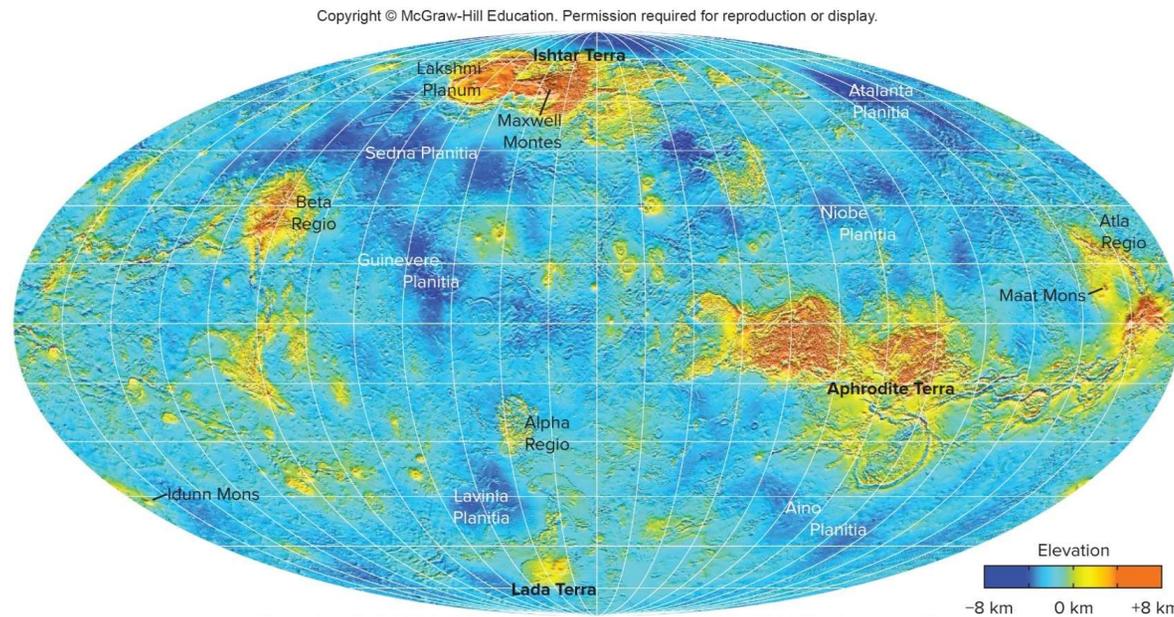
The Greenhouse Effect on Venus

- Large amounts of CO₂ in the Venusian atmosphere create an extremely strong greenhouse effect.
- The effect is so strong Venus's surface is hotter (750 K!) than Mercury's although Venus is farther from the Sun.



Ishtar and Aphrodite Terra

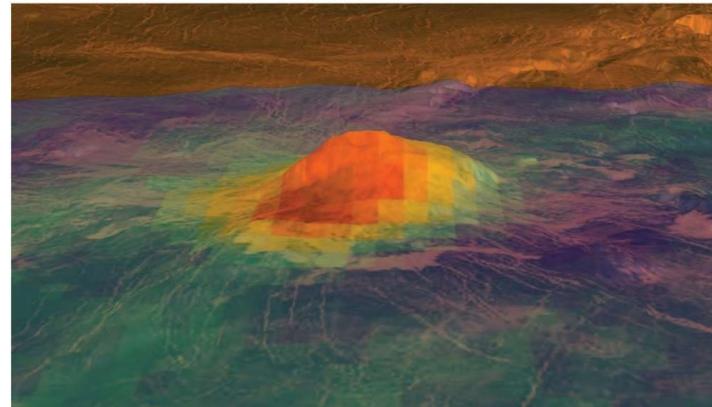
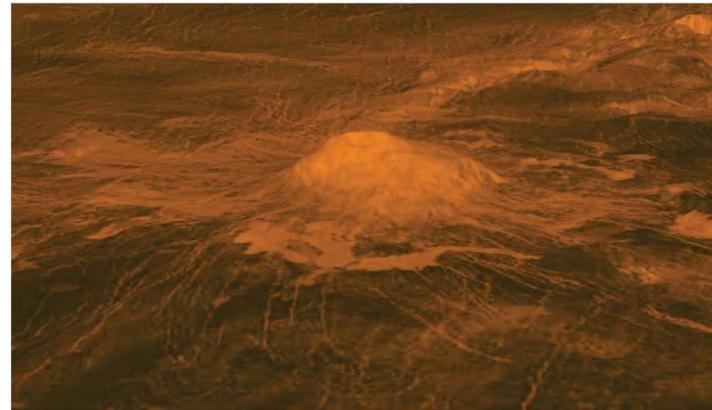
- Only two major highlands, Ishtar Terra and Aphrodite Terra and about 8% of the surface, rise above the plains to form land masses similar to terrestrial continents.



An Active Surface?

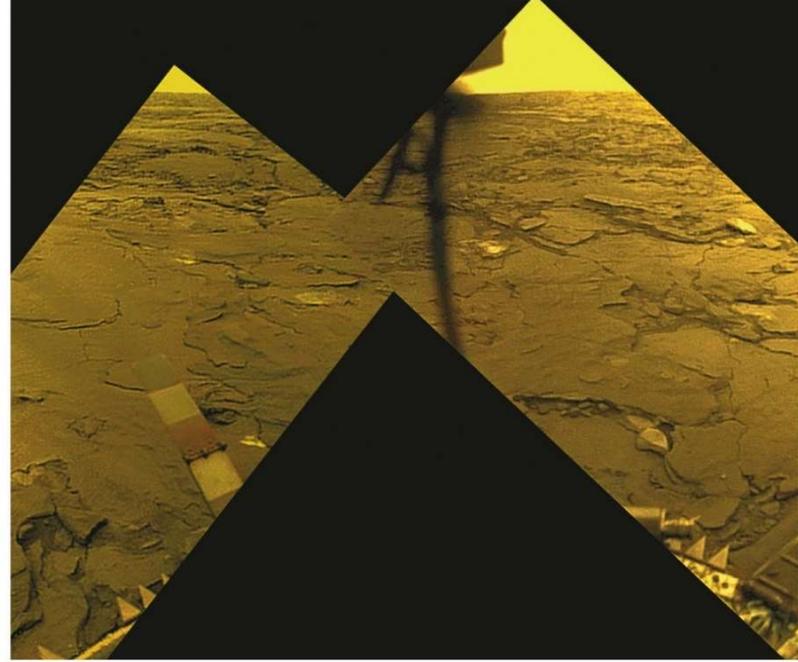
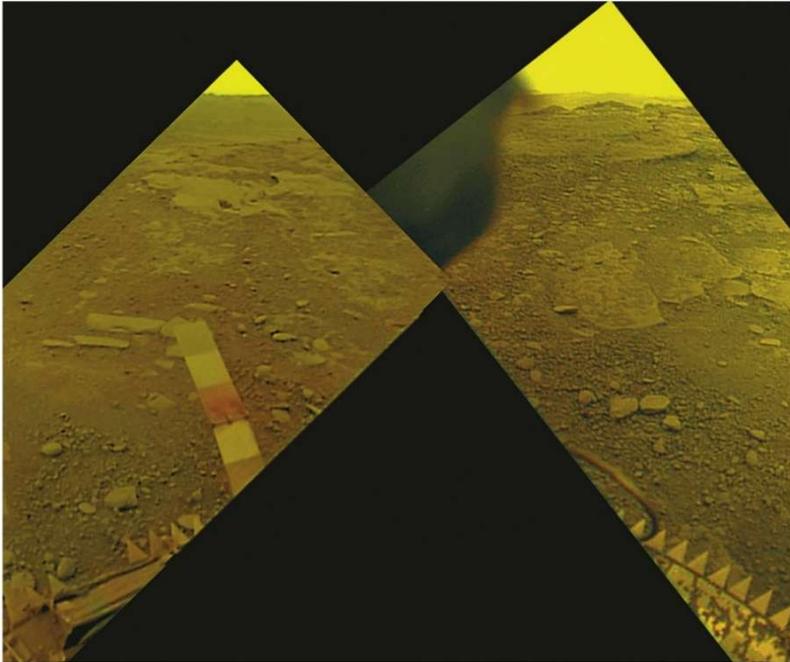
- Eruptions have not been seen directly, but some lava flows appear very fresh.
- Idunn Mons appears to have relatively recent lava flows surrounding it.

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Early Images from Venus

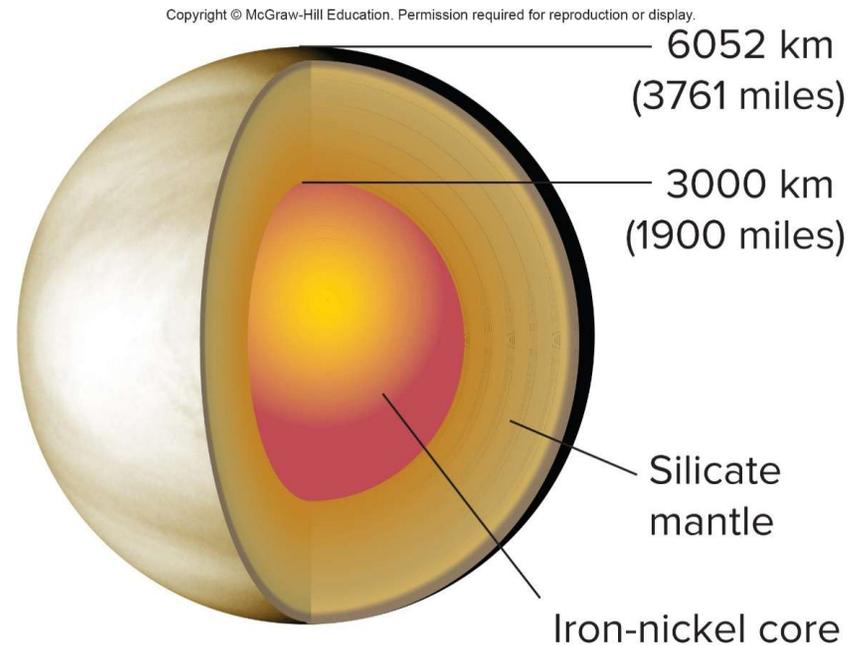
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- Pictures from the Russian *Venera* landers show a barren surface covered with flat, broken rocks lit by the pale orange sunlight – sampling also indicated the rocks are volcanic.

The Interior of Venus

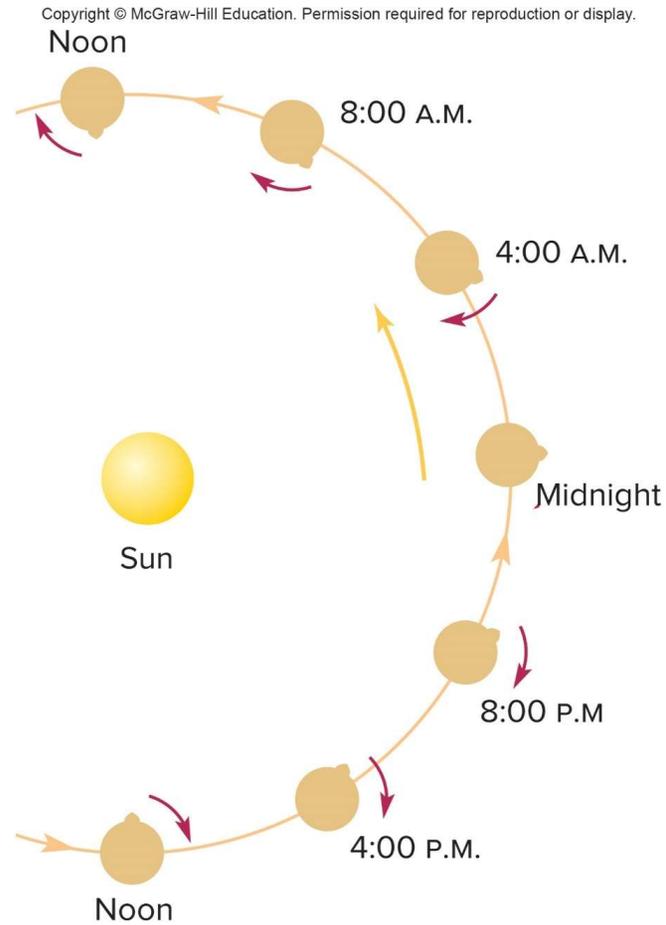
- The interior of Venus is probably similar to Earth's, an iron core and rock mantle.



Rotation of Venus

- Radar measurements show Venus is the slowest rotating planet, taking 243 Earth days to rotate once
- Venus rotates too slowly to generate a magnetic field.

Slow and Retrograde (spins backwards)



Monday / Tuesday (Jan 12 & 13)

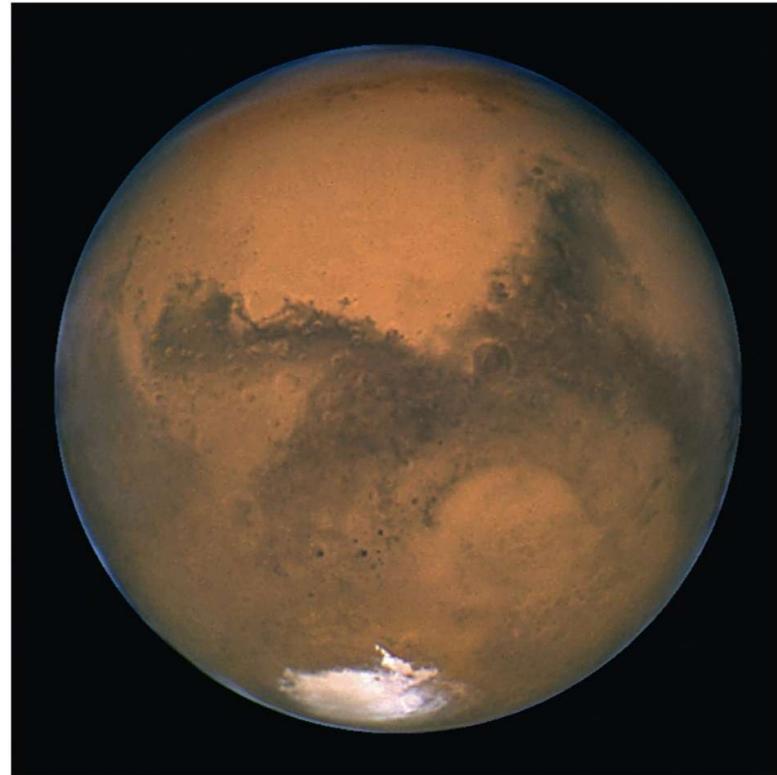
- Mars

- T: **11C** compare the planets in terms of orbit, size, composition, rotation, atmosphere, natural satellites, magnetic fields, and geological activity; and
- O: I will be able to understand the factors that make Mars similar and different from Earth
- D: by taking notes, watching a video, and interacting with my peers as Mars is discussed.
- A: Mars
- Y: What evidence suggests that Mars could have once had life?

Mars

- Although its diameter is $\frac{1}{2}$ and its mass $\frac{1}{10}$ that of Earth, Mars is the planet that most resembles Earth.
- Mars extensively photographed by the *Mariner*, *Viking*, and *Mars Reconnaissance Orbiter*, and many other spacecraft.

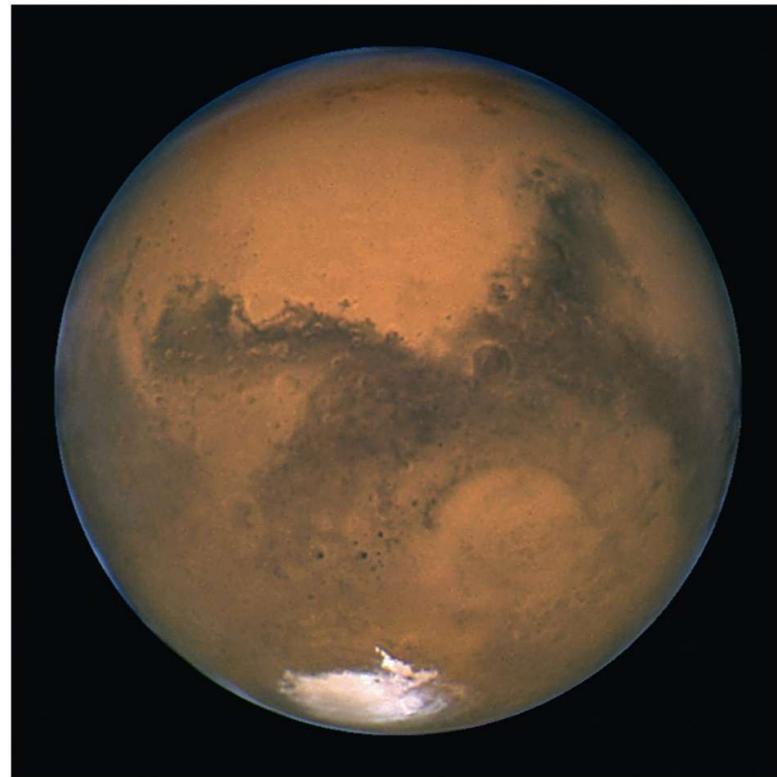
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More Like Earth

- On a warm day, the temperature hits about 50°F (10°C).
- Winds sweep dust and patchy ice crystal clouds through a sky that generally is clear enough for its surface to be seen from Earth.
- Sparkling white polar caps contrast with the reddish color of most of the planet.

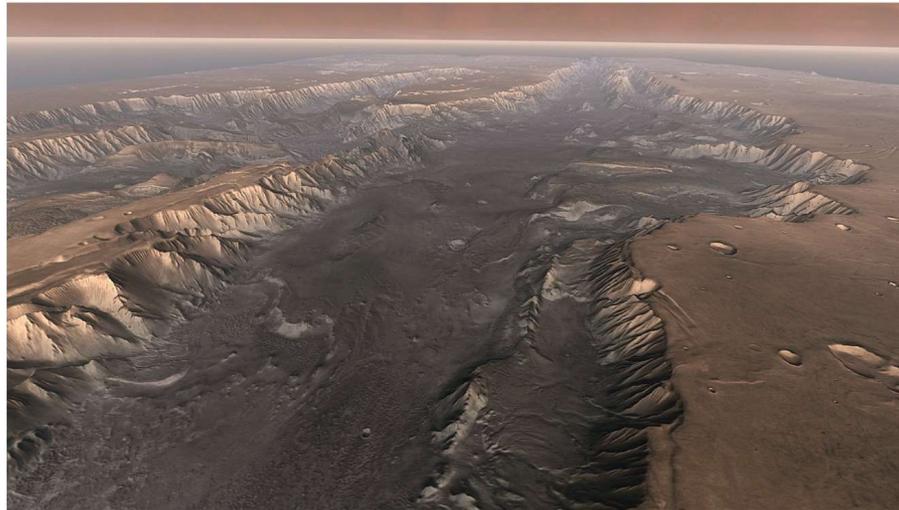
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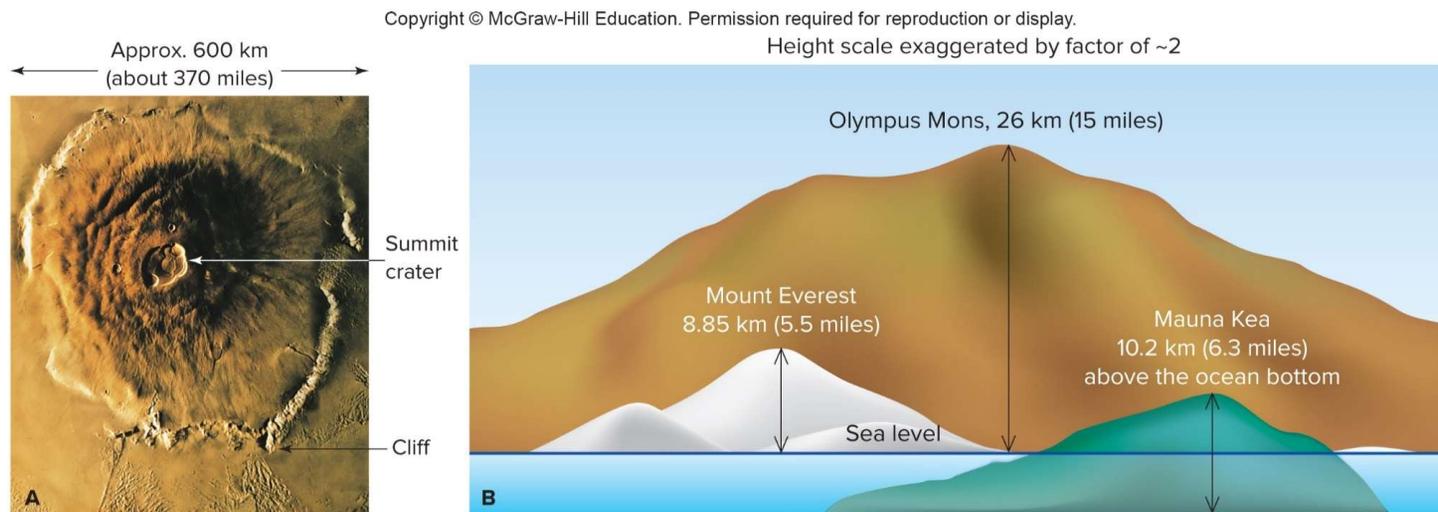
Vallis Marineris

- A rift running along the equator stretching 4000 km long, 100 km wide, and 7 km deep.
- This canyon, named after *Mariner*, dwarfs the Grand Canyon and would span the U.S.

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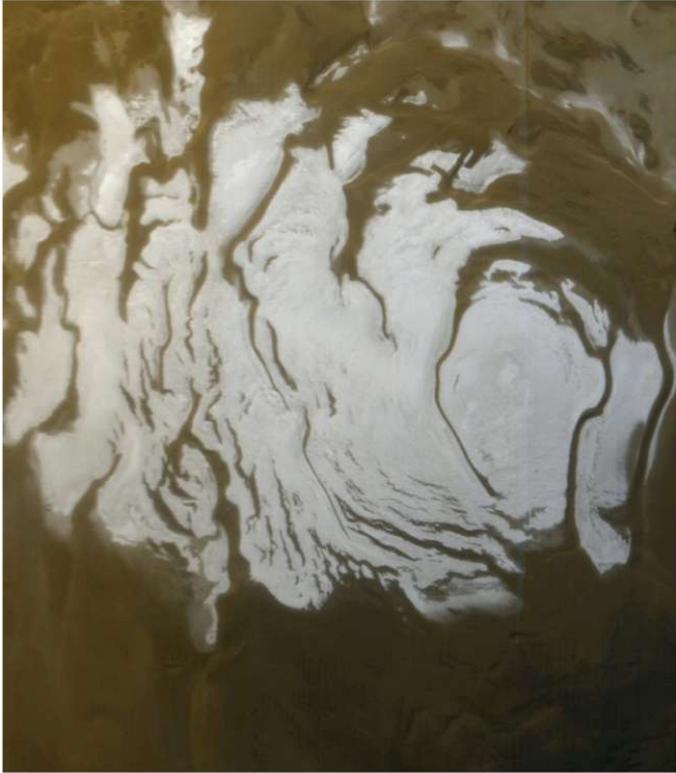


Largest Mountain in the Solar System



Southern Polar Ice Cap

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A

- Change in size with seasons (Mars tilt similar to Earth's).
- Thin atmosphere creates more severe extremes in the seasons leading to large ice cap size variations.
- Southern cap diameter varies from 5000 km in winter to 350 km in summer.

Northern Polar Ice Cap

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B

- Northern cap shrinks from 3000 km to about 1000 km across in summer, has a surface layer of CO₂, but is primarily water ice.
- Caps are water ice covered in frozen CO₂ (dry ice).
- Enough water in the caps to cover Mars to depth of 10 m.
- 15% of Mars's total atmospheric mass vaporizes from the poles each spring, causes strong winds and swirling wind canyons.

Orbital Effects on Mars's Climate

- Mars's seasons are a combination of the effects of its axial tilt (like Earth's seasons) and its varying distance from the sun.
- Due to Mars's orbital eccentricity, northern climate is more mild than southern.
- Warmer southern summers, colder winters--southern ice cap changes size more dramatically.

Dune Fields

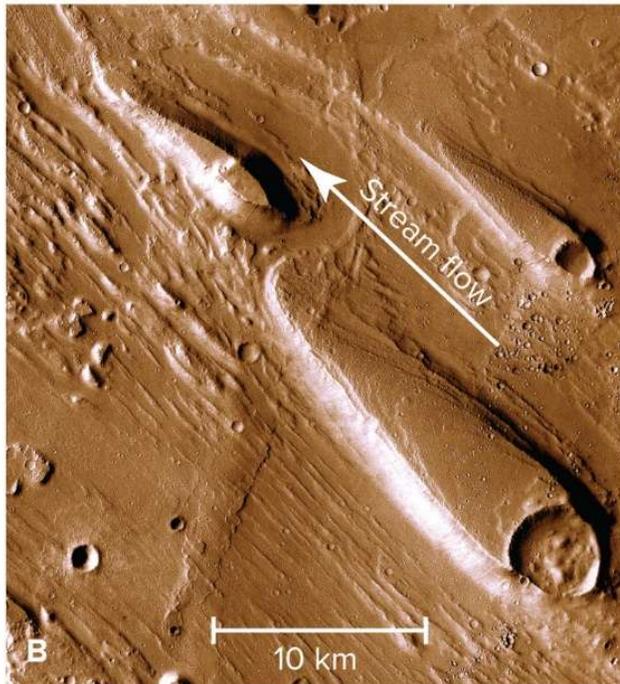
- Martian poles are bordered by immense deserts with dunes blown by winds into parallel ridges.

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Water on Ancient Mars

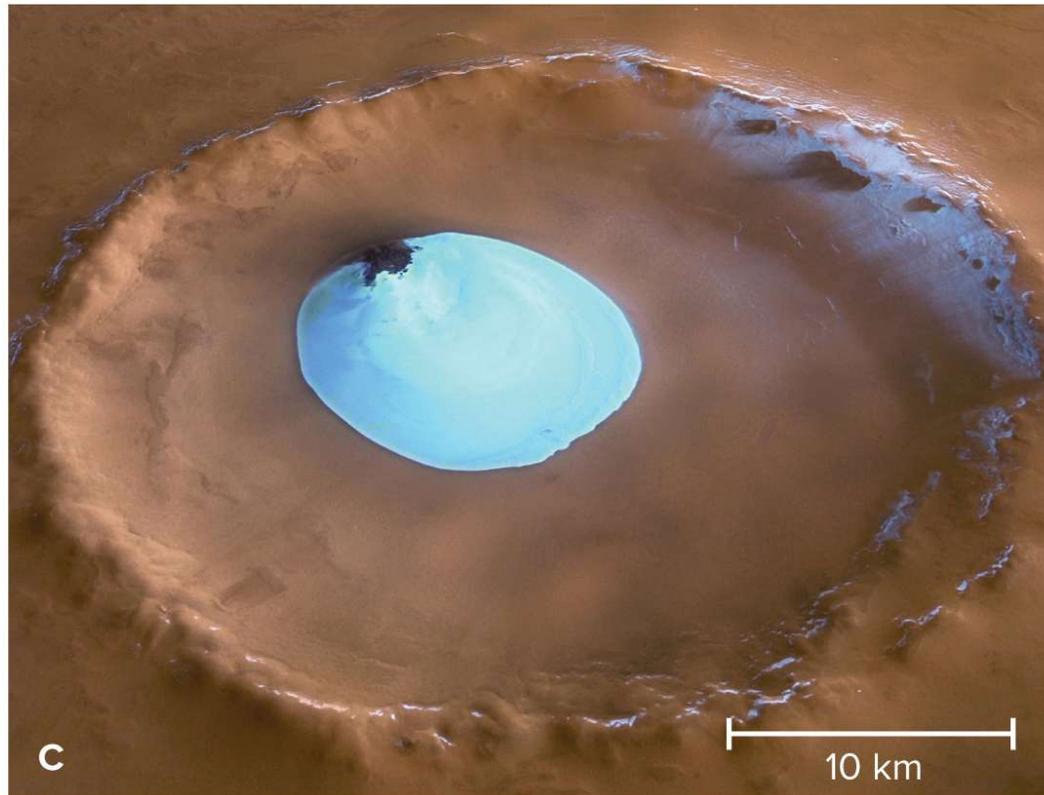
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- Huge lakes and small oceans thought to have once existed – evidence comes from smooth traces that look like old beaches around edges of craters and basins.

Ancient Lake?

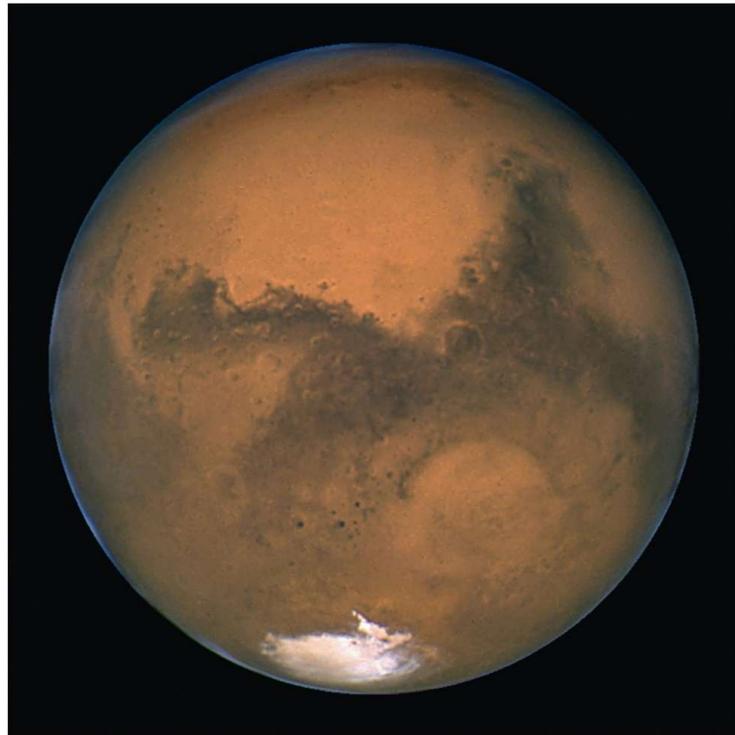
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The Atmosphere of Mars

- Clouds and wind blown dust are visible evidence that Mars has an atmosphere.
- Spectra show the atmosphere is mainly CO_2 (95%) with traces of N_2 (3%), oxygen and water.
- The atmosphere's density is about 1% that of Earth's.

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Temperatures on Mars

- The lack of atmospheric density and Mars distance from the Sun make the planet very cold.
- Noon temperatures at the equator reach a bit above the freezing point of water.
- Night temperatures drop to a frigid 218 K (−67° F).
- Thus, most water is frozen, locked up either below the surface as permafrost or in the polar caps as solid ice.

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Martian Wind

- Clouds, generally made of dry ice and water-ice crystals, are carried by the winds.
- As on Earth, the winds arise from warm air that rises at the equator, moves toward the poles, and is deflected by the Coriolis effect.
- Winds are generally gentle, but can strengthen and carry lots of dust!

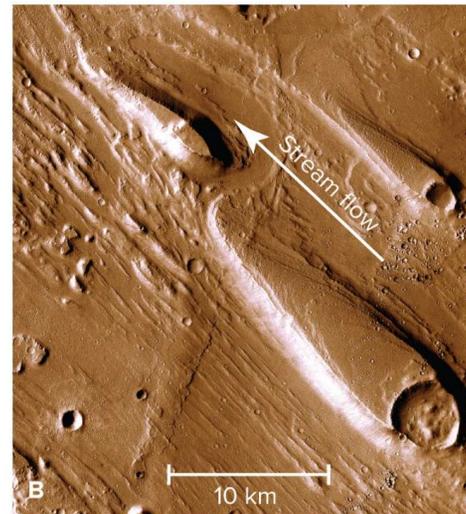
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Ancient Atmosphere of Mars

- Dry river beds indicate liquid water flowed in Mars's past.
- This implies that Mars had to have a denser atmosphere (higher pressure) to prevent the fast vaporization of surface water into the atmosphere.
- Cratering indicates that this thicker atmosphere disappeared about 3 billion years ago.

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Where did the Atmosphere Go?

- 2 ways Mars lost its thick atmosphere.
- Mars was struck by a huge asteroid that blasted the atmosphere into space.
- Mars's low gravity coupled with low volcanic activity produced a net loss of gas molecules into space over the first 1 to 2 billion years of its existence, decreasing the effectiveness of the greenhouse effect to maintain a warm atmosphere.

The Martian Interior

- Differentiated like Earth's interior into a crust, mantle, and iron core.
- Having a mass between that of dead Mercury and lively Earth/Venus implies Mars should be intermediate in tectonic activity.
- Numerous volcanic peaks and uplifted highlands exist.
- Olympus Mons and other volcanoes do not show any craters on their slopes indicating they may still occasionally erupt.

The Martian Moons

- Phobos and Deimos are about 20 km across and are probably captured asteroids.
- Their small size prevents gravity from pulling them into spherical shapes.
- Both are cratered, implying bombardment by smaller objects.

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Wednesday / Thursday (Jan 14 & 15)

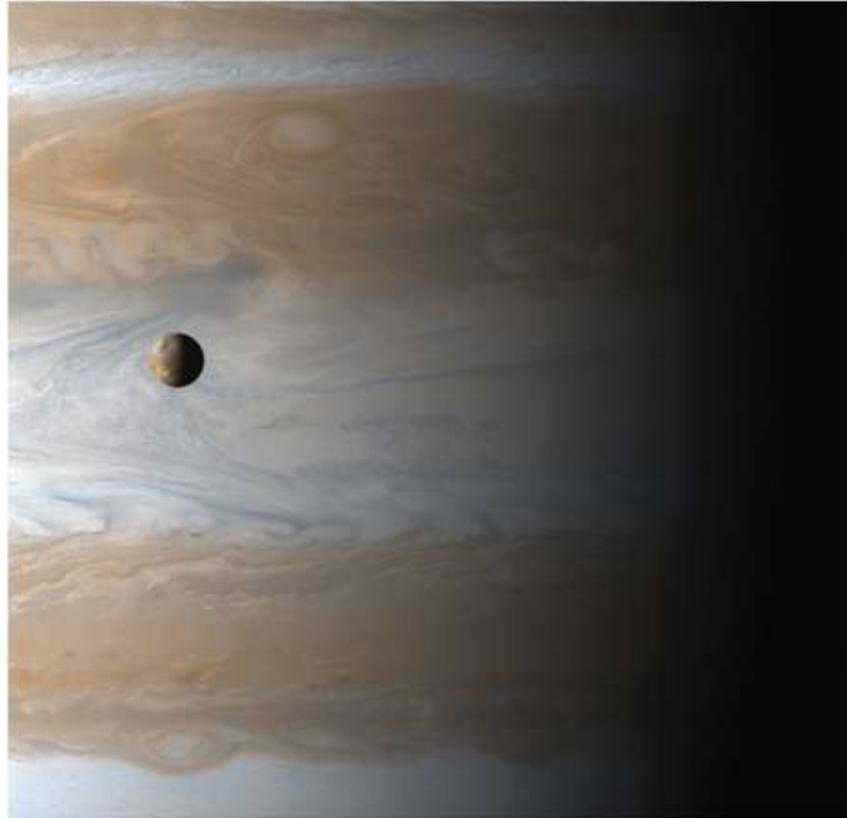
Journal 4.2

- What are some things you can do to ensure success in all of your classes?

- **T: (11) Science concepts. The student uses models to explain the formation, development, organization, and significance of solar system bodies. The student is expected to:**
- **11A** relate Newton's law of universal gravitation and Kepler's laws of planetary motion to the formation and motion of the planets and their satellites;
- **11B** explore and communicate the origins and significance of planets, planetary rings, satellites, asteroids, comets, Oort cloud, and Kuiper belt objects;
- **O:** I will continue my exploration of the planets
- **D:** by participating in a group discussion, taking notes, watching a video, and completing a Stellarium assignment.
- **A:** Saturn, Jupiter
- **Y:** How are the outer planets different from the inner planets?

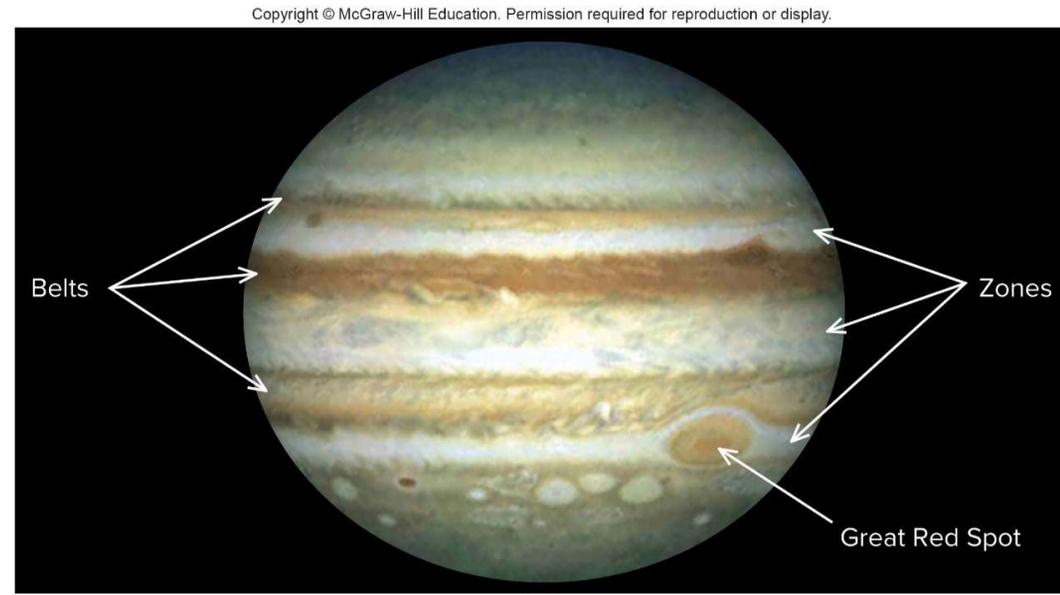
The Outer Planets

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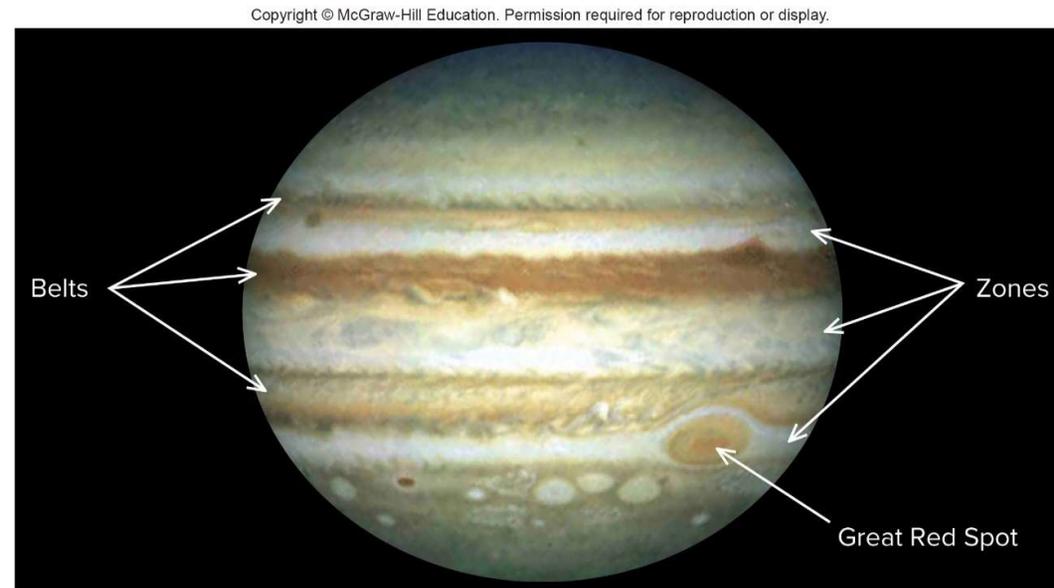
Jupiter

- Jupiter is the largest planet both in diameter and mass: more than $10\times$ Earth's diameter and $300\times$ Earth's mass!
- Dense, richly colored parallel cloud bands cloak the planet.
- Atmosphere is mainly H, He, CH_4 , NH_3 , and H_2O .



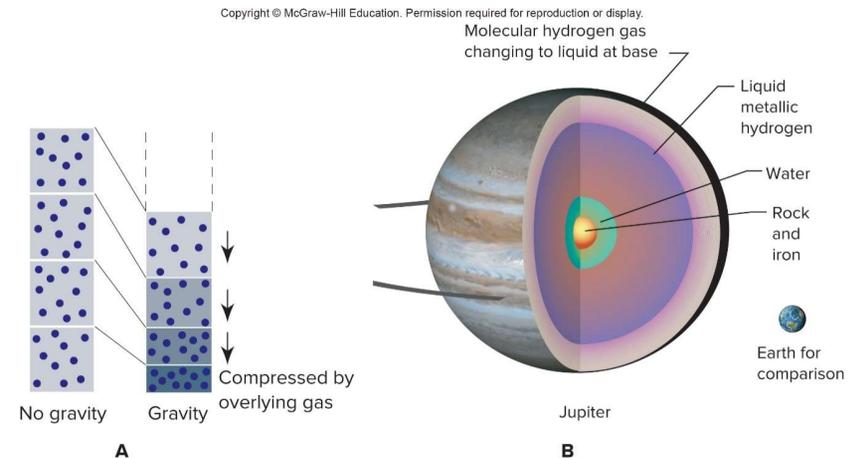
Cloud Tops

- Clouds made from water, ice, and ammonia compounds.
- Bright colors from complex organic molecules or compounds of sulfur or phosphorous.
- 1 day on Jupiter is 10 hours
- Fast spin causes large middle bulge



Jupiter's Interior Structure

- Jupiter's average density is 1.3 g/cm^3
- Density increases as you go inward

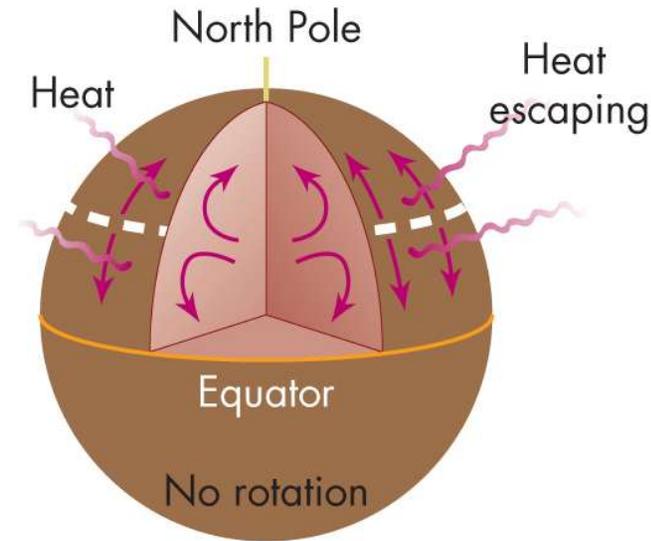


- Deeper still, liquid hydrogen compresses into liquid metallic hydrogen, a material scientists only recently created in tiny high-pressure chambers.
- An iron rocky core, a few times bigger than Earth, probably resides at the center.

Jupiter's Atmosphere

- General convection pattern:
- Heat within Jupiter carries gas to the top of the atmosphere, forming white zones.
- High altitude gas radiates into space, cools and sinks, becoming transparent (belts).

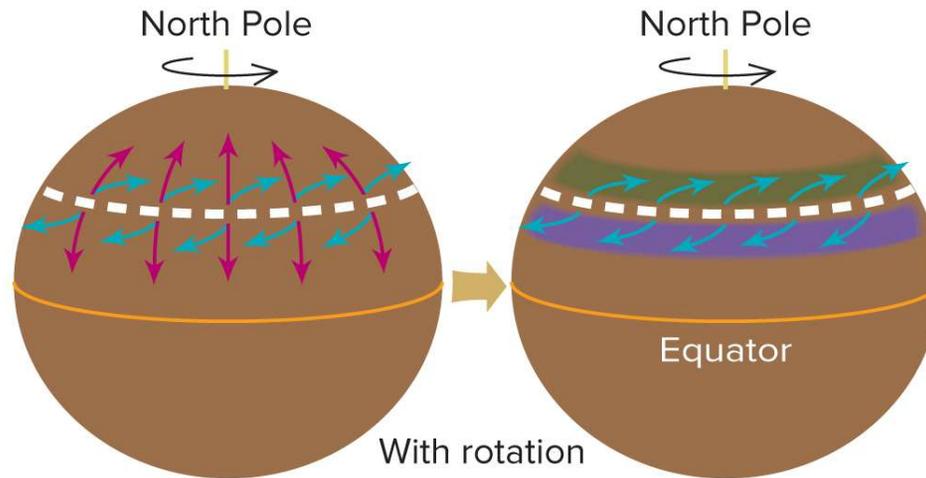
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- A** Hot material rises to top of atmosphere and spreads toward pole and equator.

Jupiter's Jet Streams

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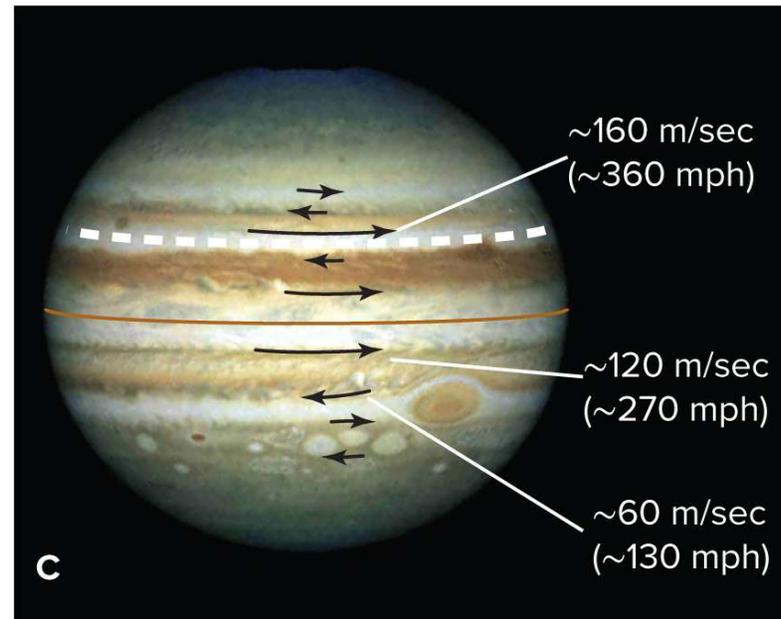


B Coriolis effect deflects gas moving away from zones toward pole toward the east, and deflects gas moving toward equator toward the west.

- Coriolis effect turns rising and sinking gases into powerful jet streams (about 300 km/hr) that are seen as cloud belts.

Jupiter's Winds

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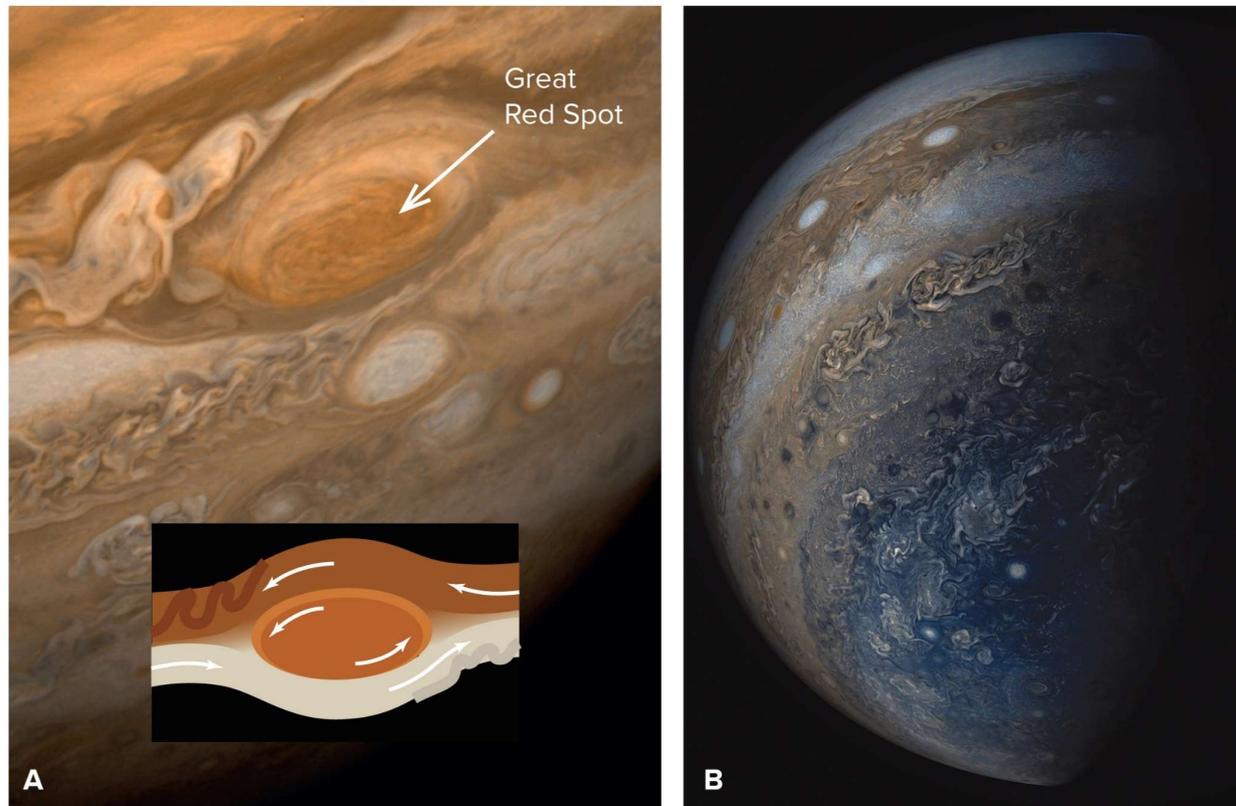


• c: NASA

- Great Red Spot has persisted for over 300 years.

Storms on Jupiter

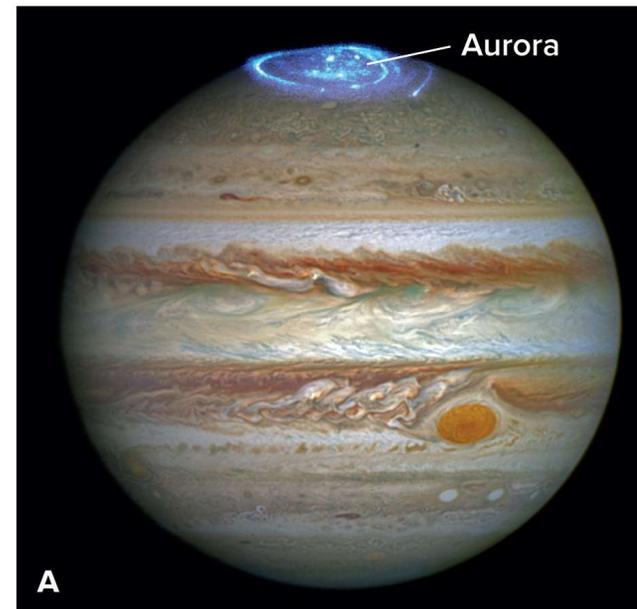
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Jupiter's Magnetic Field

- 20,000× stronger than Earth's field, it is the largest planetary magnetic field.

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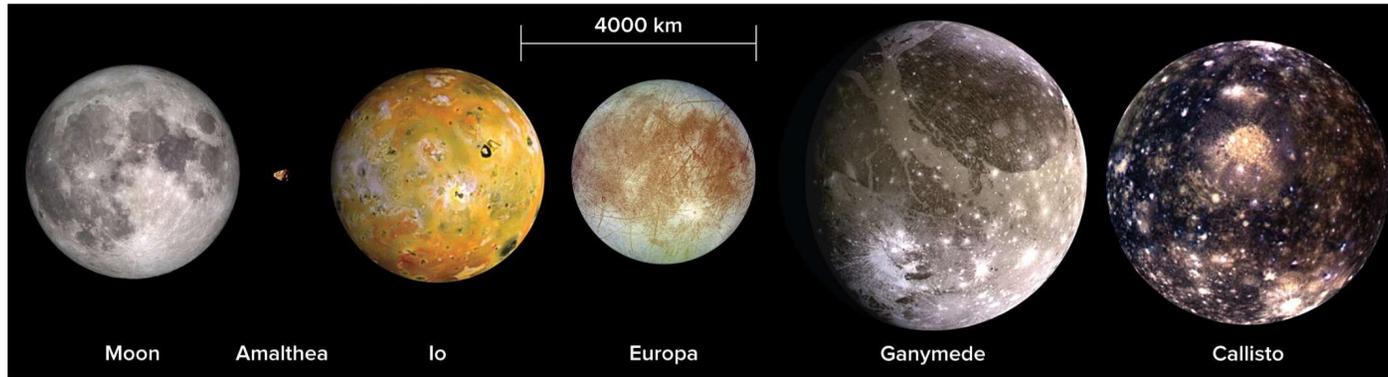
Jupiter's Rings

- Jupiter has a system of rings made of tiny particles of rock dust
- A friction on the ring dust that will eventually cause the dust to drift into the atmosphere.
- To maintain the rings, new dust must be provided – possibly from collision fragments ejected from the Jovian moons.



The Moons of Jupiter

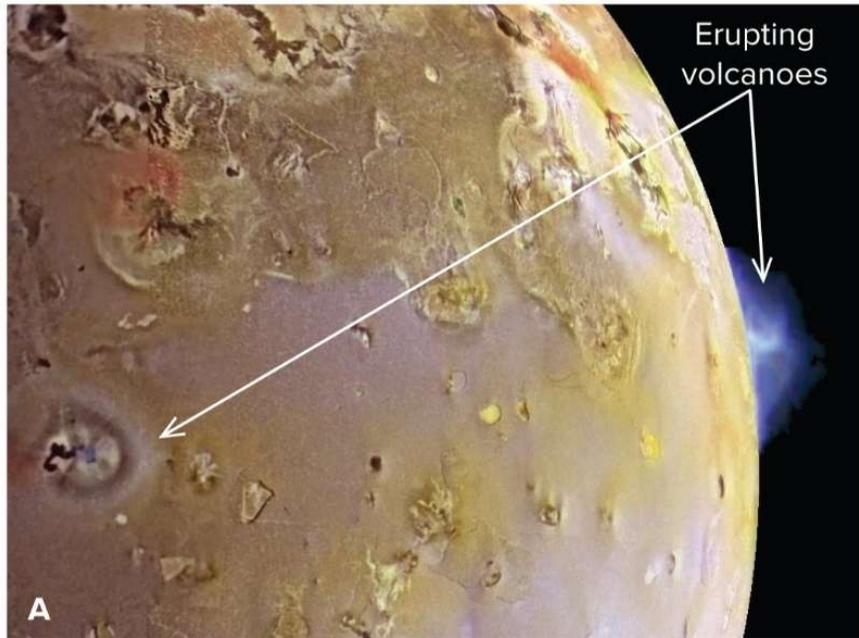
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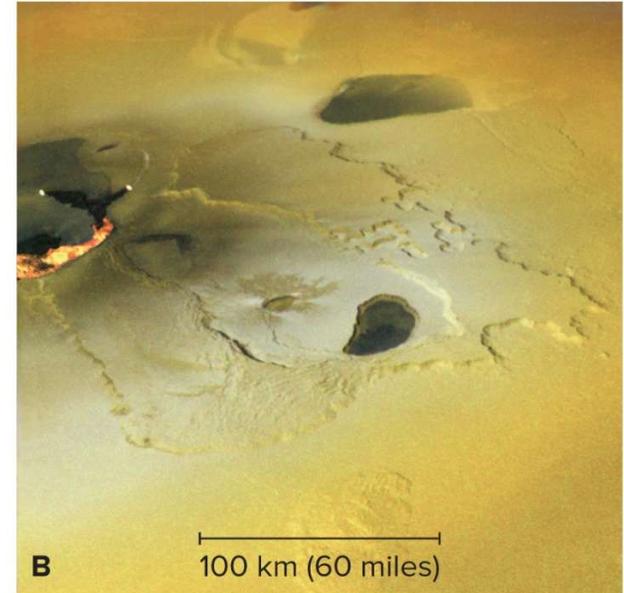
- Jupiter currently has 63 natural satellites or moons.
- Four innermost moons are called the Galilean Moons.

Io

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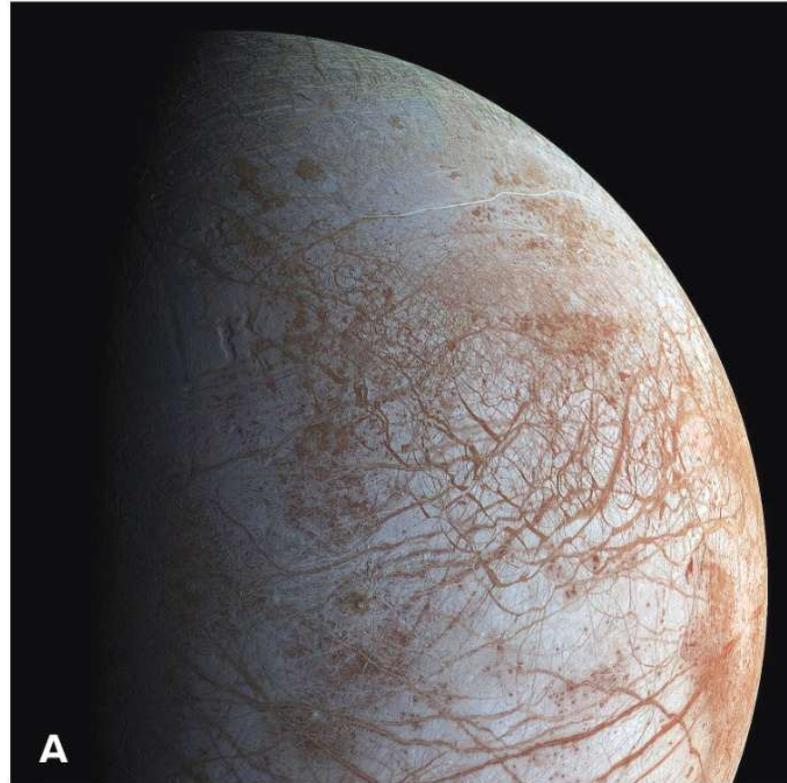


Io has active volcanoes on it

Europa

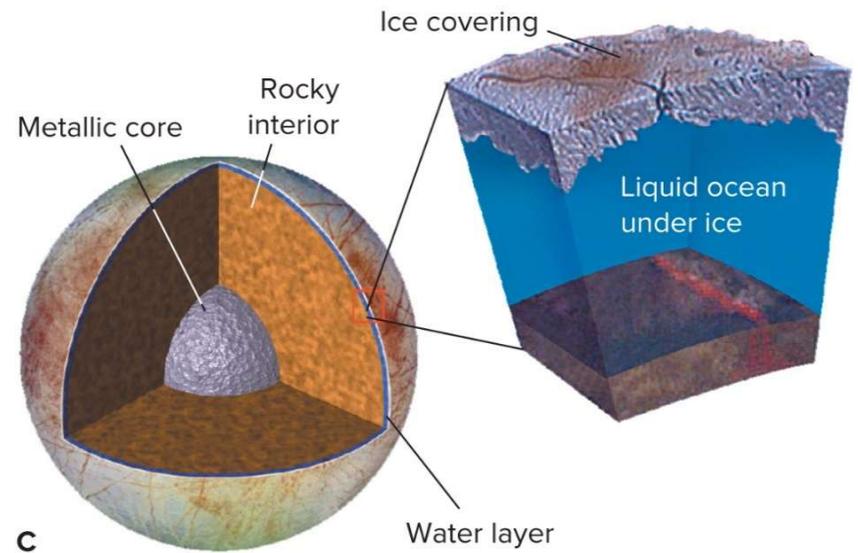
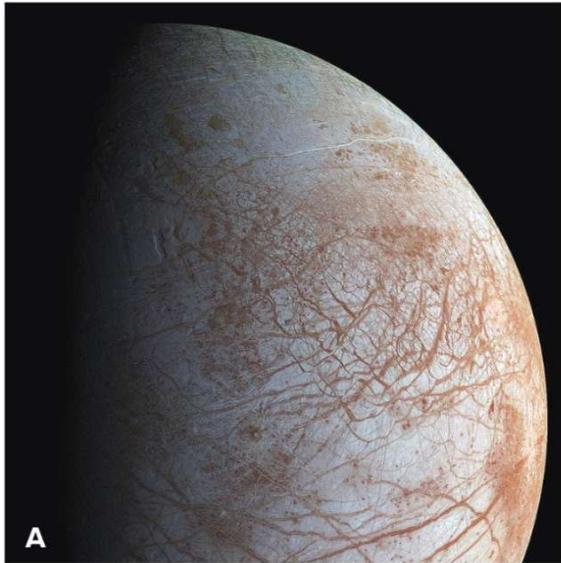
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- Surface looks like a cracked egg indicating a “flow” similar to glaciers on Earth.



Liquid Water Ocean on Europa?

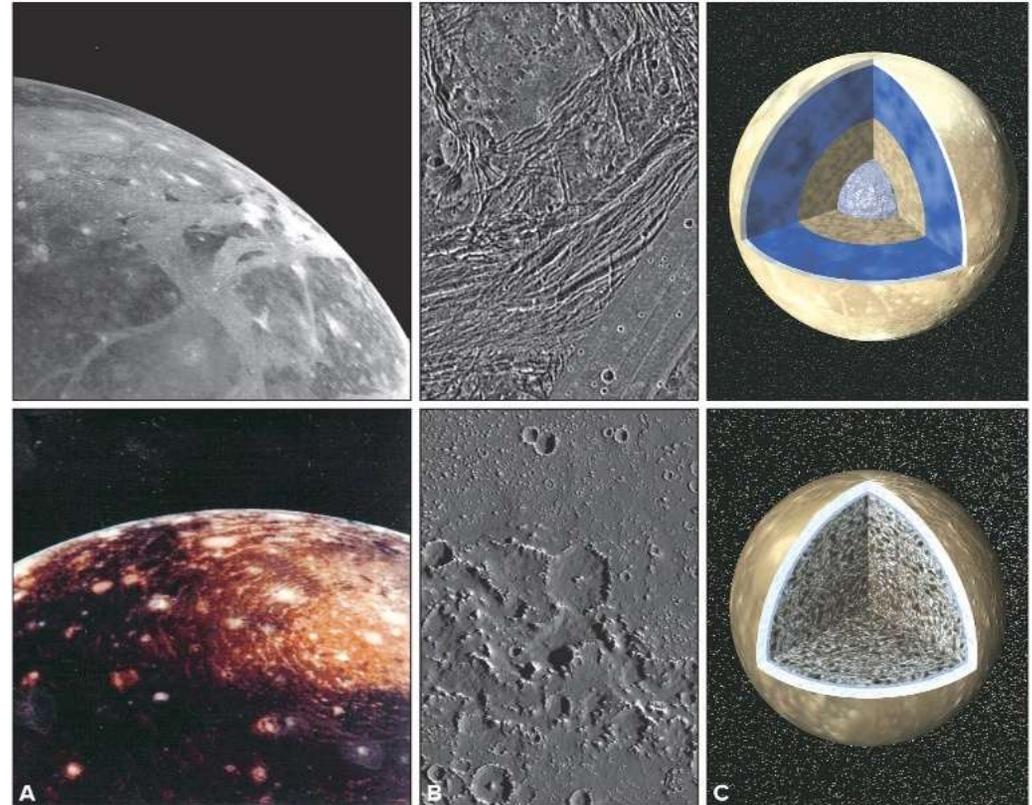
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Ganymede and Callisto

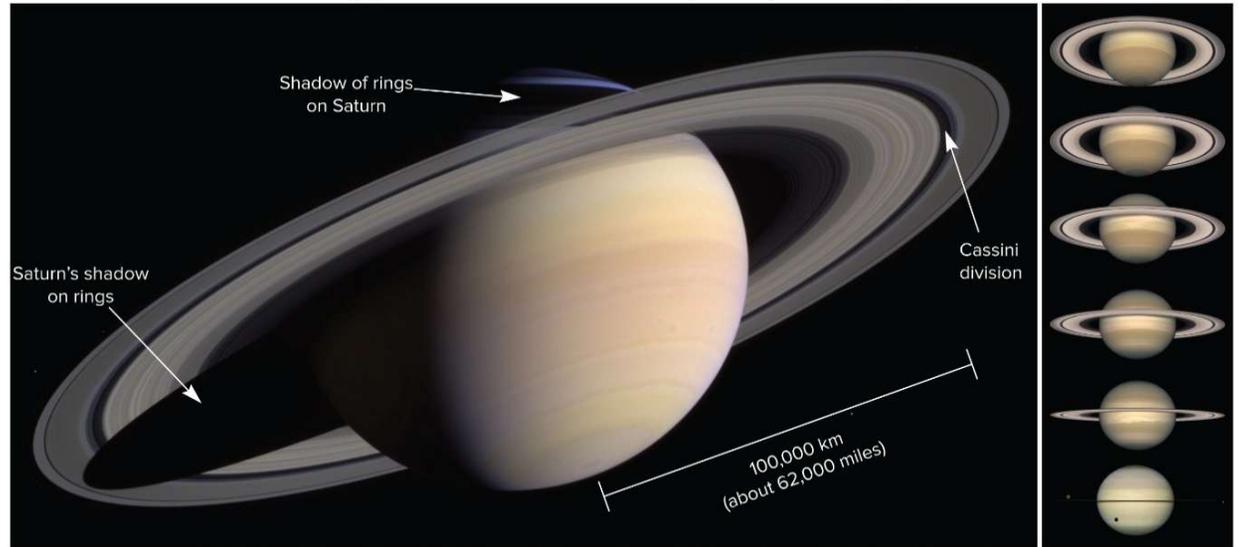
- Look like our Moon with grayish brown color and covered with craters.
- However, their surfaces are mostly ice – whitish craters a very good indication of this.

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Saturn

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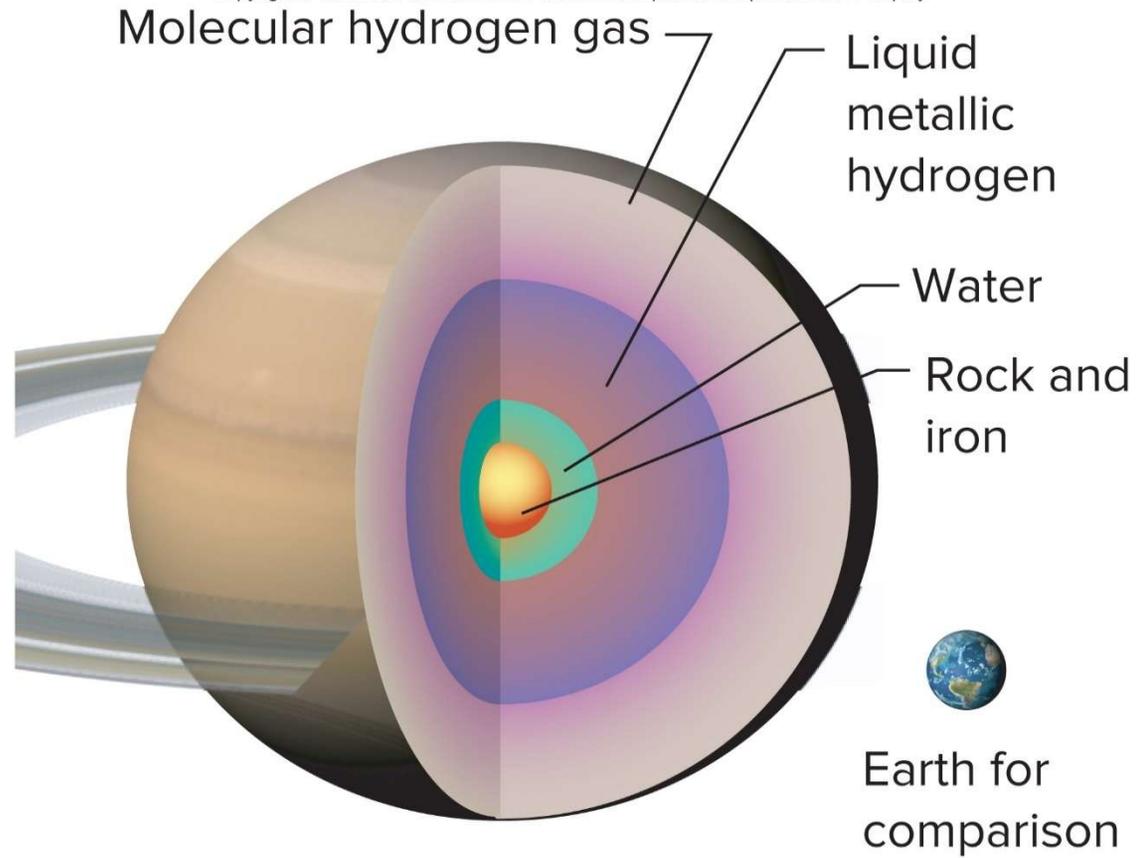


- Saturn is the second largest planet, $10\times$ Earth's diameter and $95\times$ Earth's mass with a density of 0.7 g/cm^3
- Low density, like Jupiter, suggests a composition mostly of hydrogen & its compounds.

• (left): NASA/JPL/Space Science Institute; (right): NASA and The Hubble Heritage Team (STScI/AURA) Acknowledgement: R.G. French (Wellesley College), J. Cuzzi (NASA/Ames), L.Dones (swRI) and J.Lissauer (NASA/Ames), adapted by S.E.Schneider

Interior of Saturn

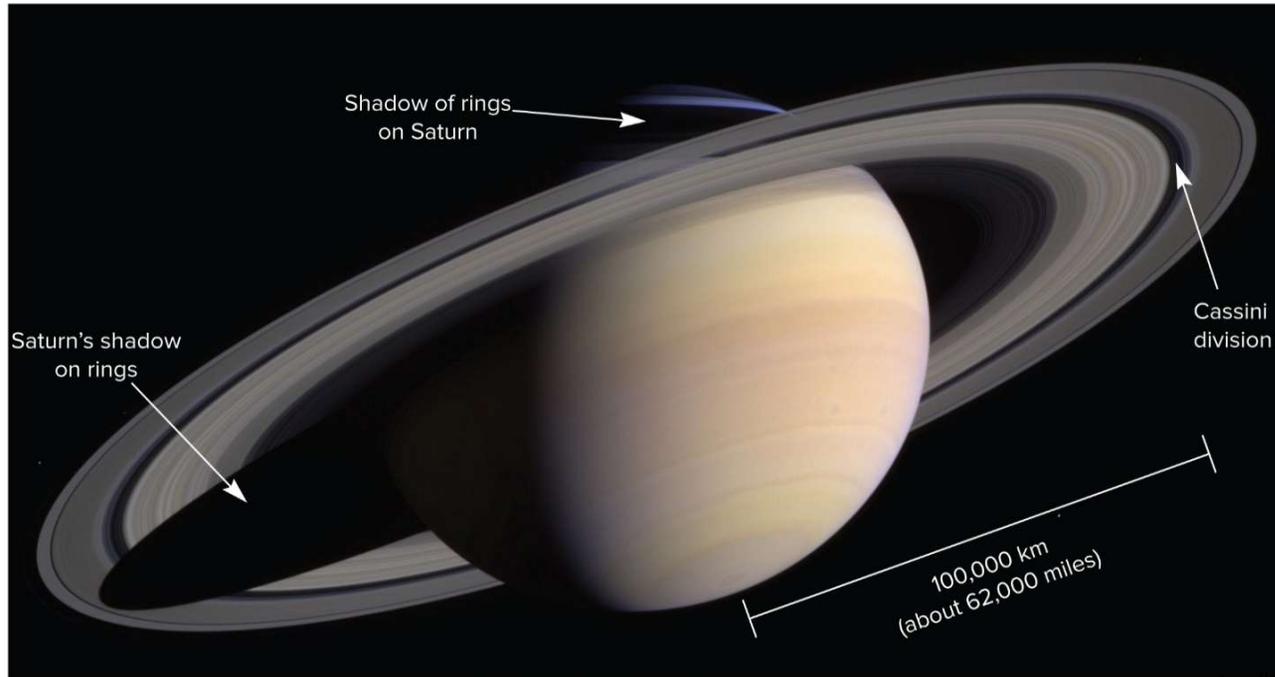
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The Rings of Saturn

- Rings are wide but thin.
- Main band extends from about 30,000 km above its atmosphere to about twice Saturn's radius (136,000 km).

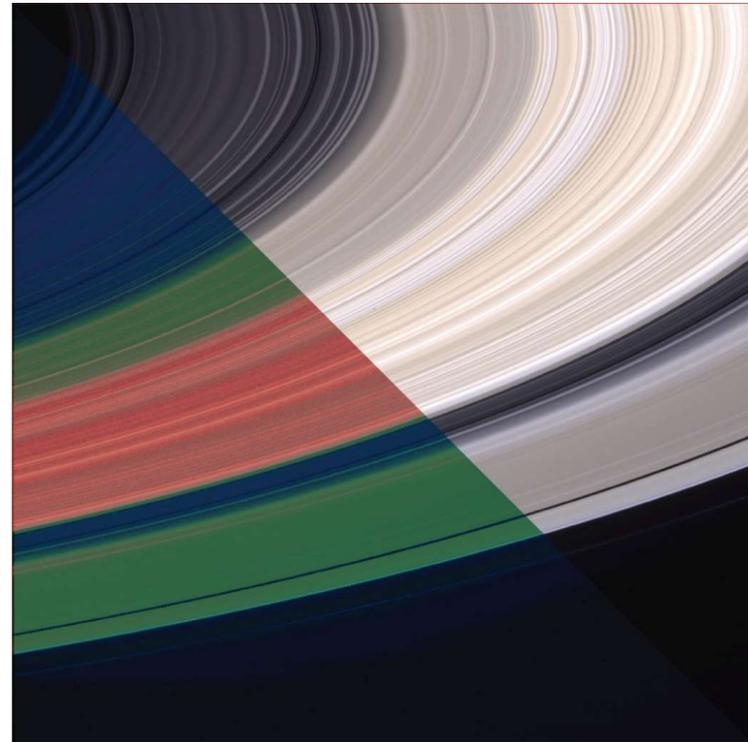
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Ring Structure

- Rings not solid, but made of a swarm of individual bodies.
- Sizes range from centimeters to meters.
- Composition mainly water, ice, and carbon compounds and is not uniform across rings.

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Saturn's Moons

- Saturn has a record-breaking **274 confirmed moons**
- In March 2025 128 new smaller moons were discovered
- Titan is the giant moon
 - 50% wider in diameter than our moon
 - Second-largest moon in the Solar System (behind Ganymede)
 - Bigger than Mercury

Friday (C-day, Jan 16)