

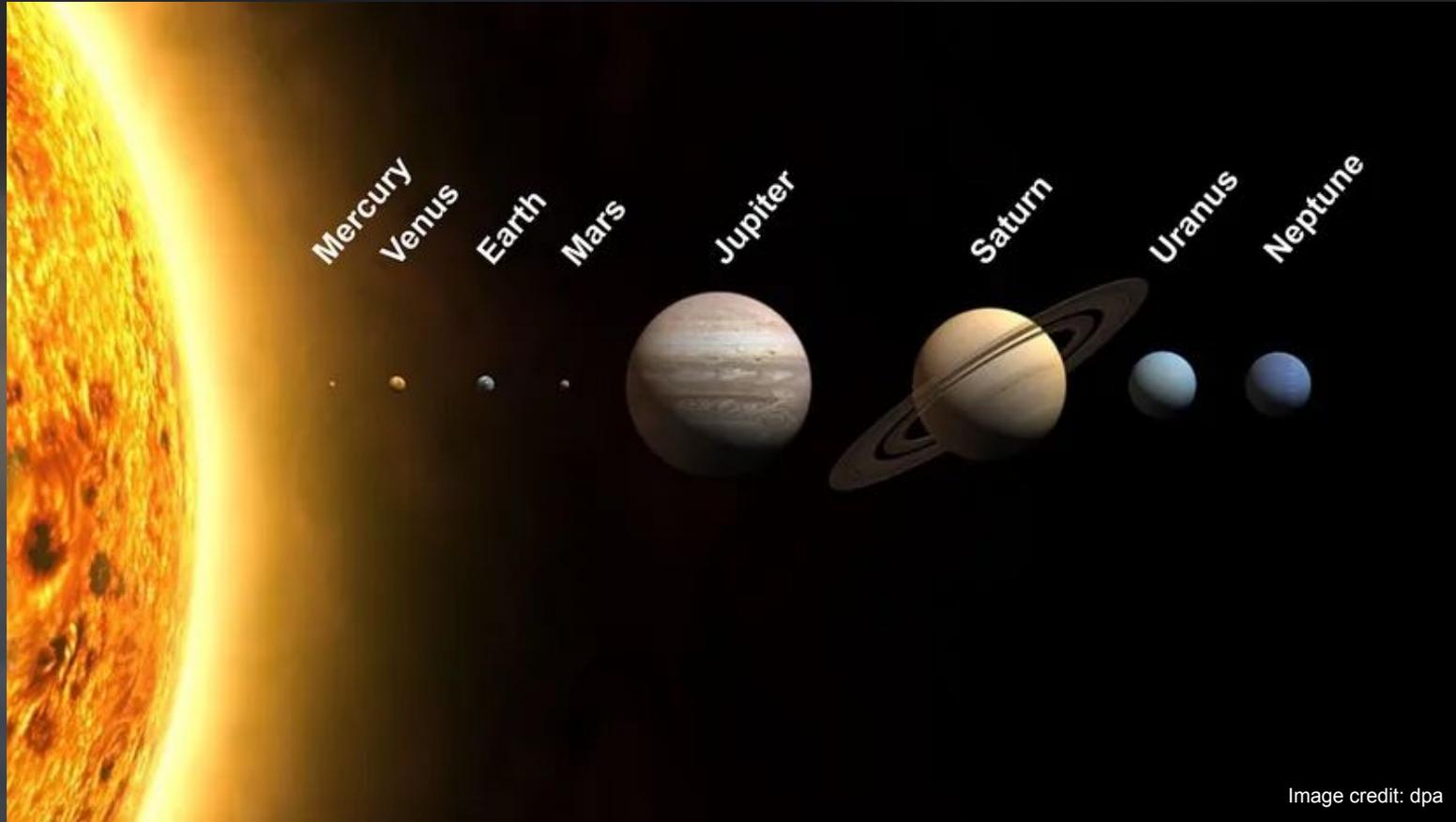
Exoplanets and Life Beyond Earth

Lecture 1



Our Solar System

Today's Topic: the Solar System



What is the biggest object in the Solar System?

The Sun

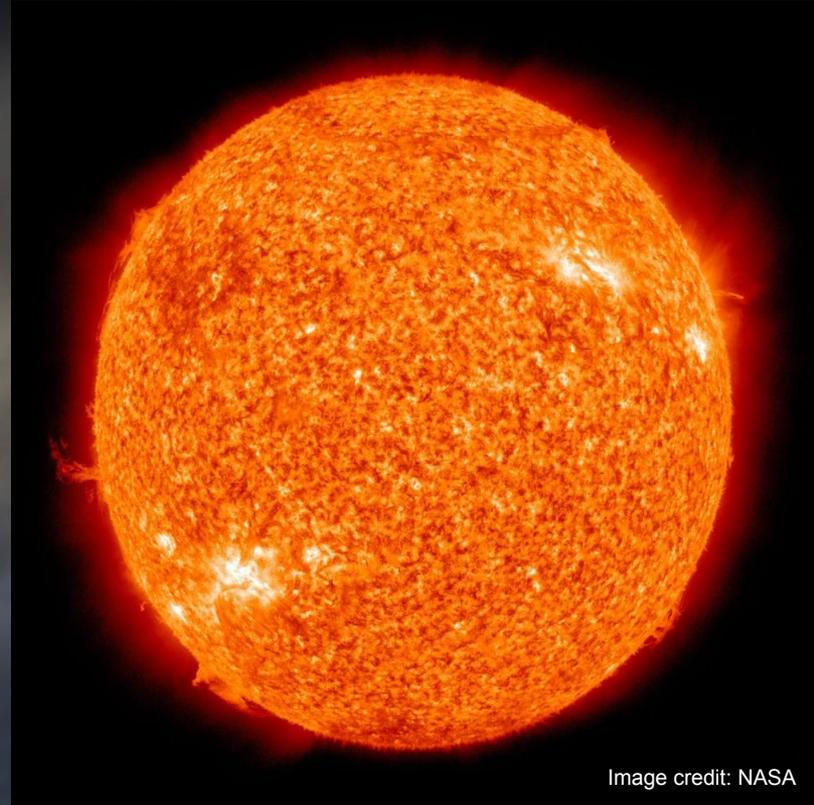
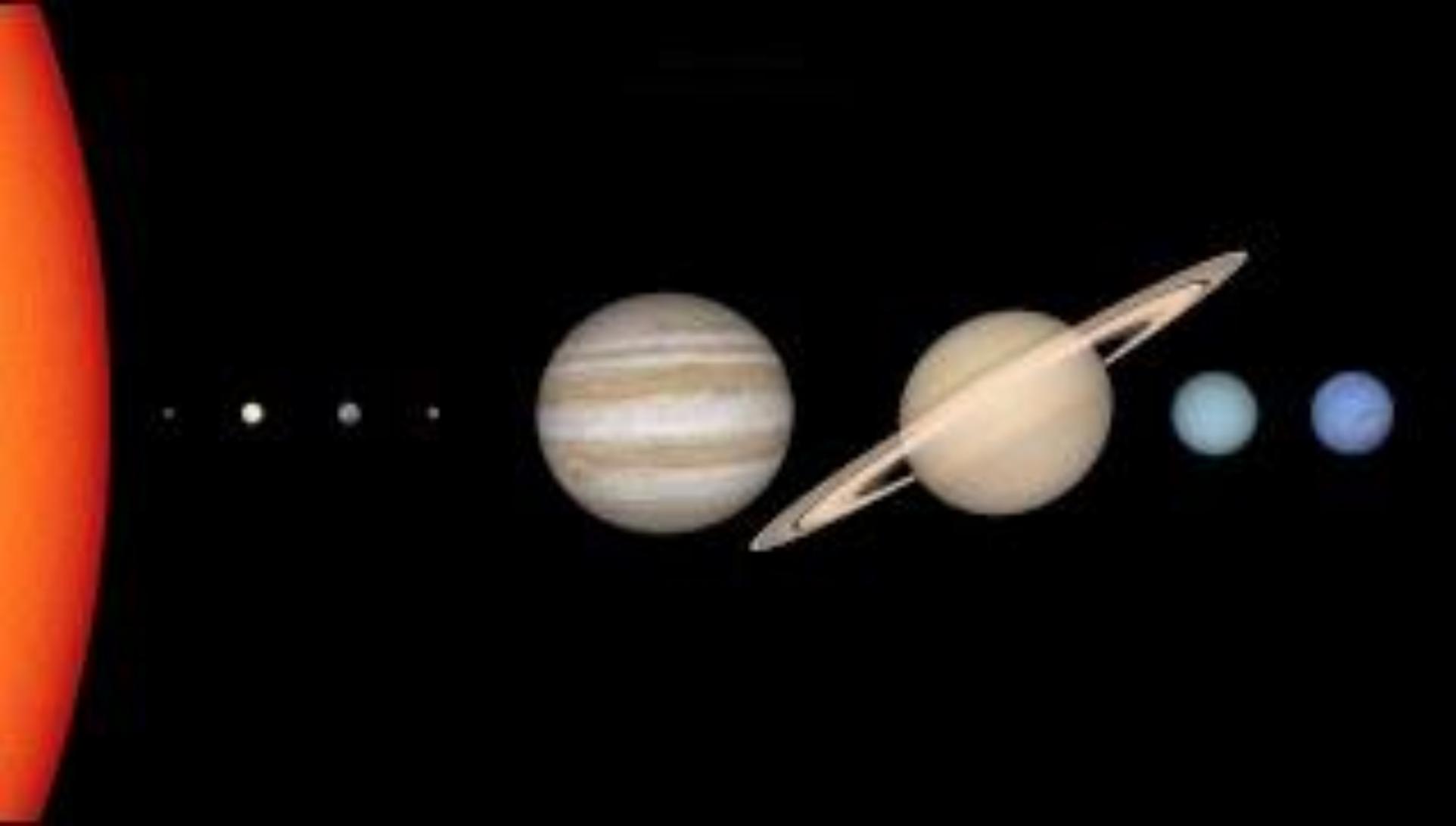
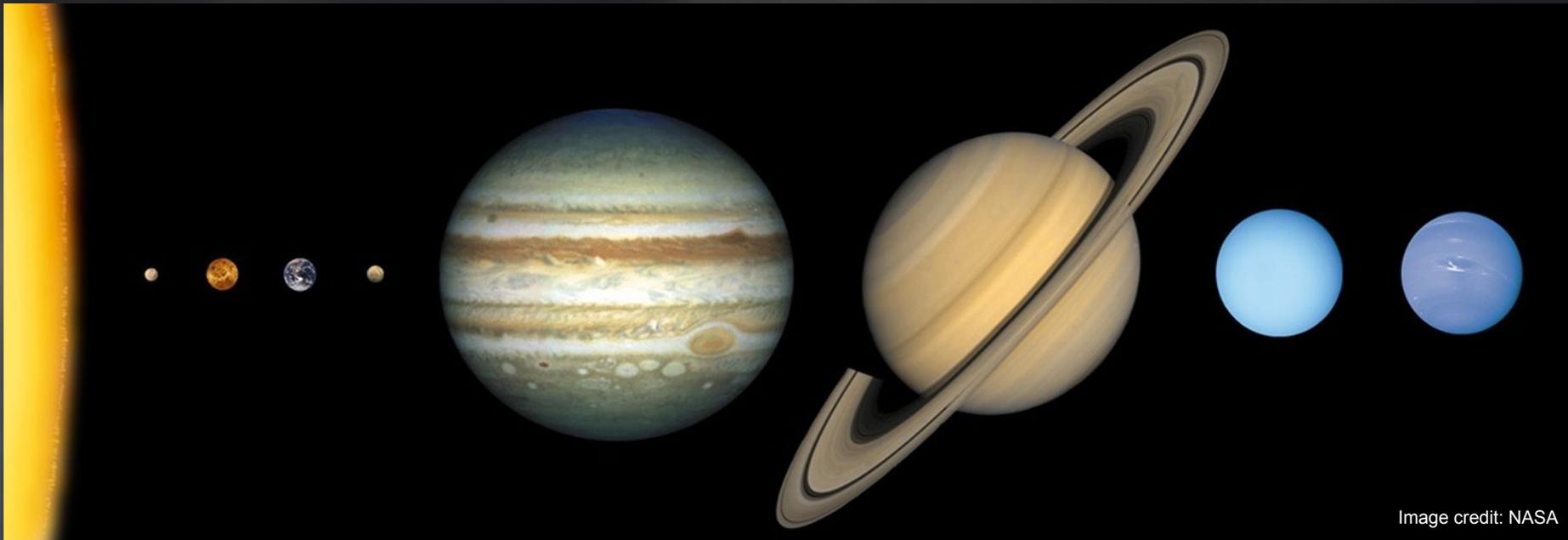


Image credit: NASA

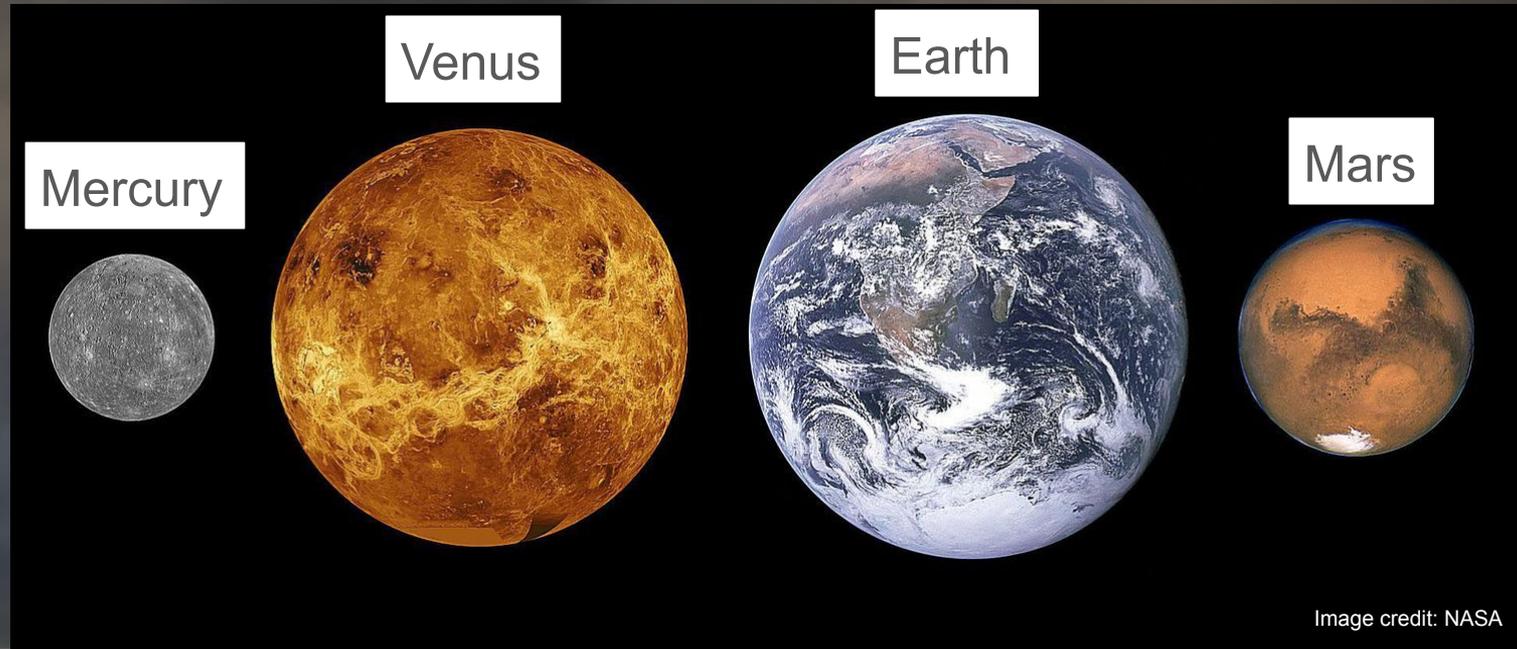


The Planets



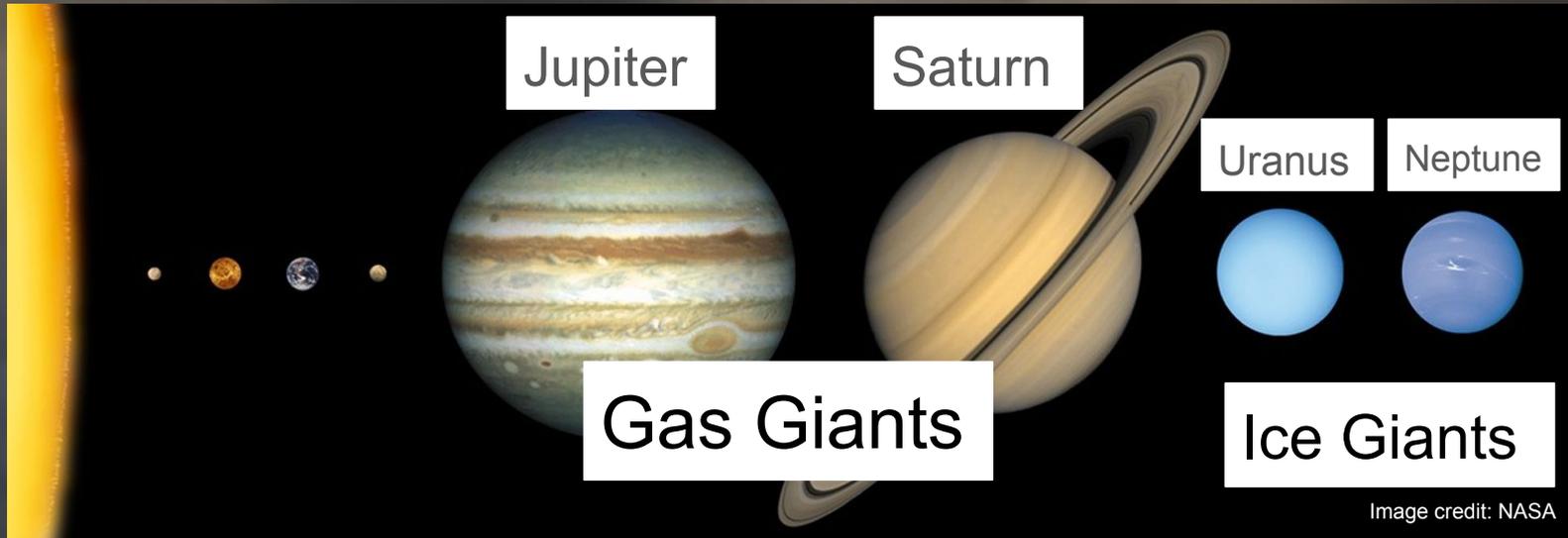
Terrestrial Planets (Rocky Planets)

- The four closest planets to the Sun are all rocky
- Some have atmospheres (air around the planet)
- All have water
- Earth is the only planet we know to have life!



Gas Giants and Ice Giants

- The four planets farthest from the Sun are giant planets
- They are all much bigger and more massive than the rocky planets
- Gas giants are mostly hydrogen and helium
- Ice giants are mostly “ices” like methane or ammonia



Mercury

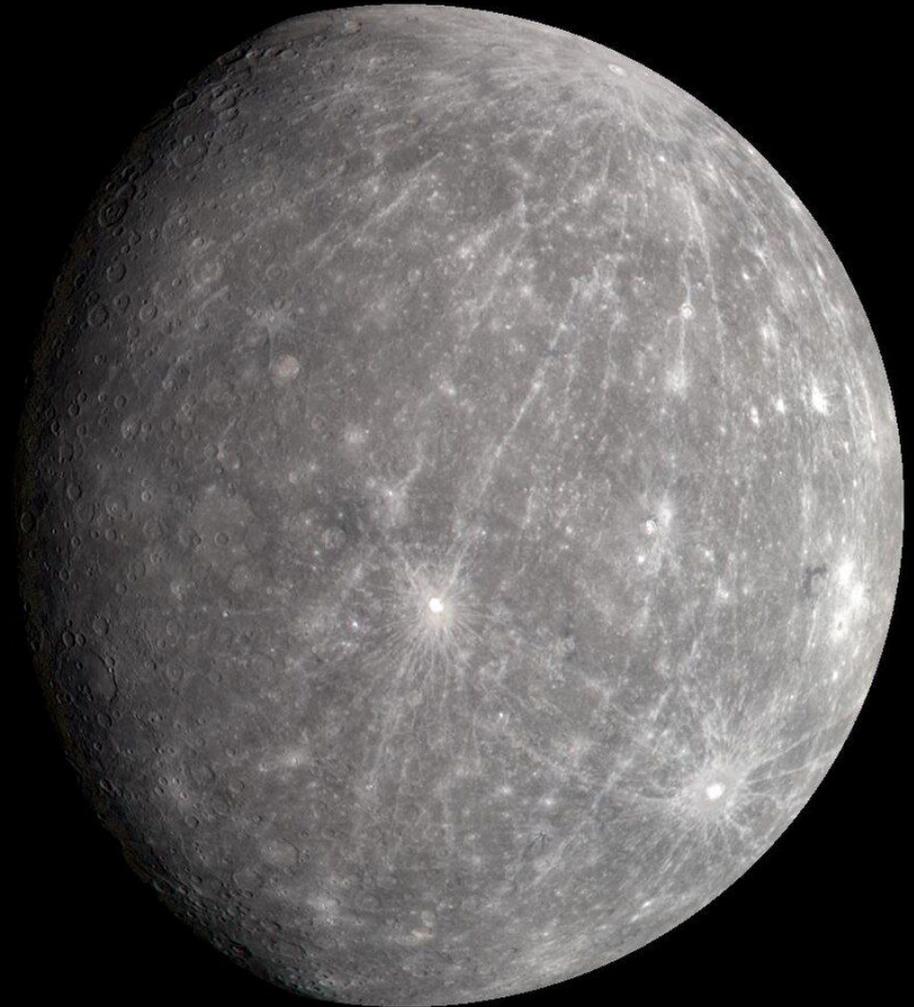
Smallest planet in solar system

Closest to the Sun

No moons

Very thin atmosphere caused by solar wind knocking material off the surface

Used to have active volcanoes



Venus

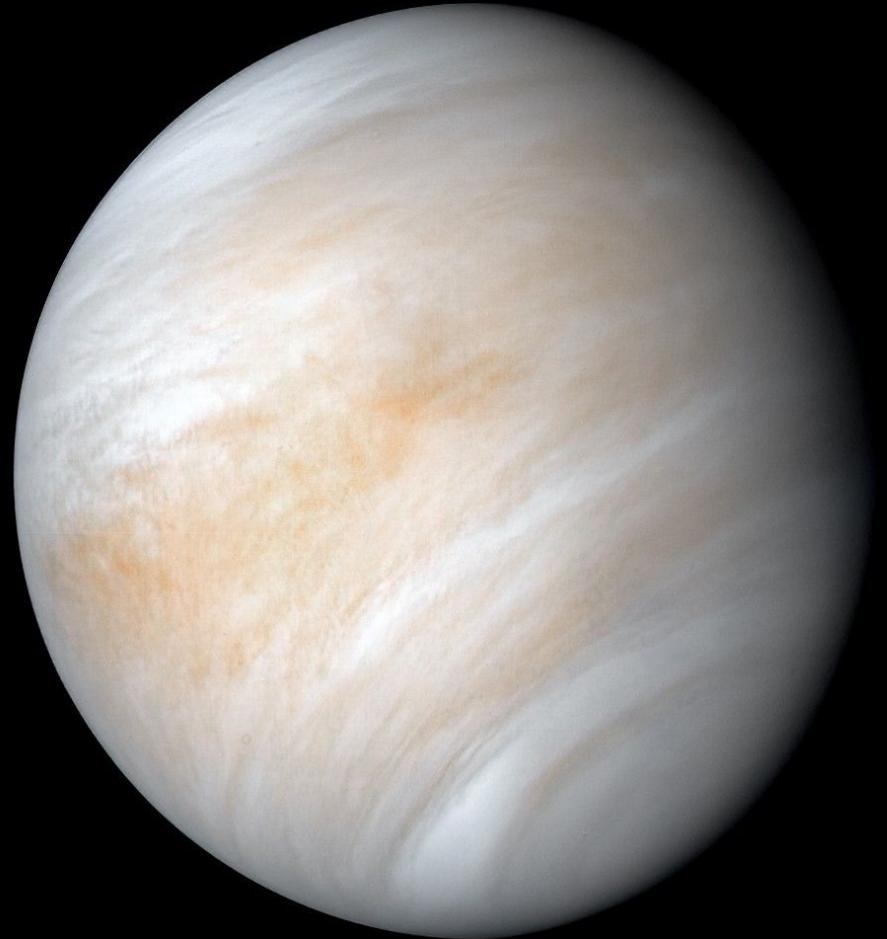
Second closest to the Sun

Basically same size and mass of Earth

No moons

Very thick atmosphere (92 times greater than Earth) made of mostly carbon dioxide

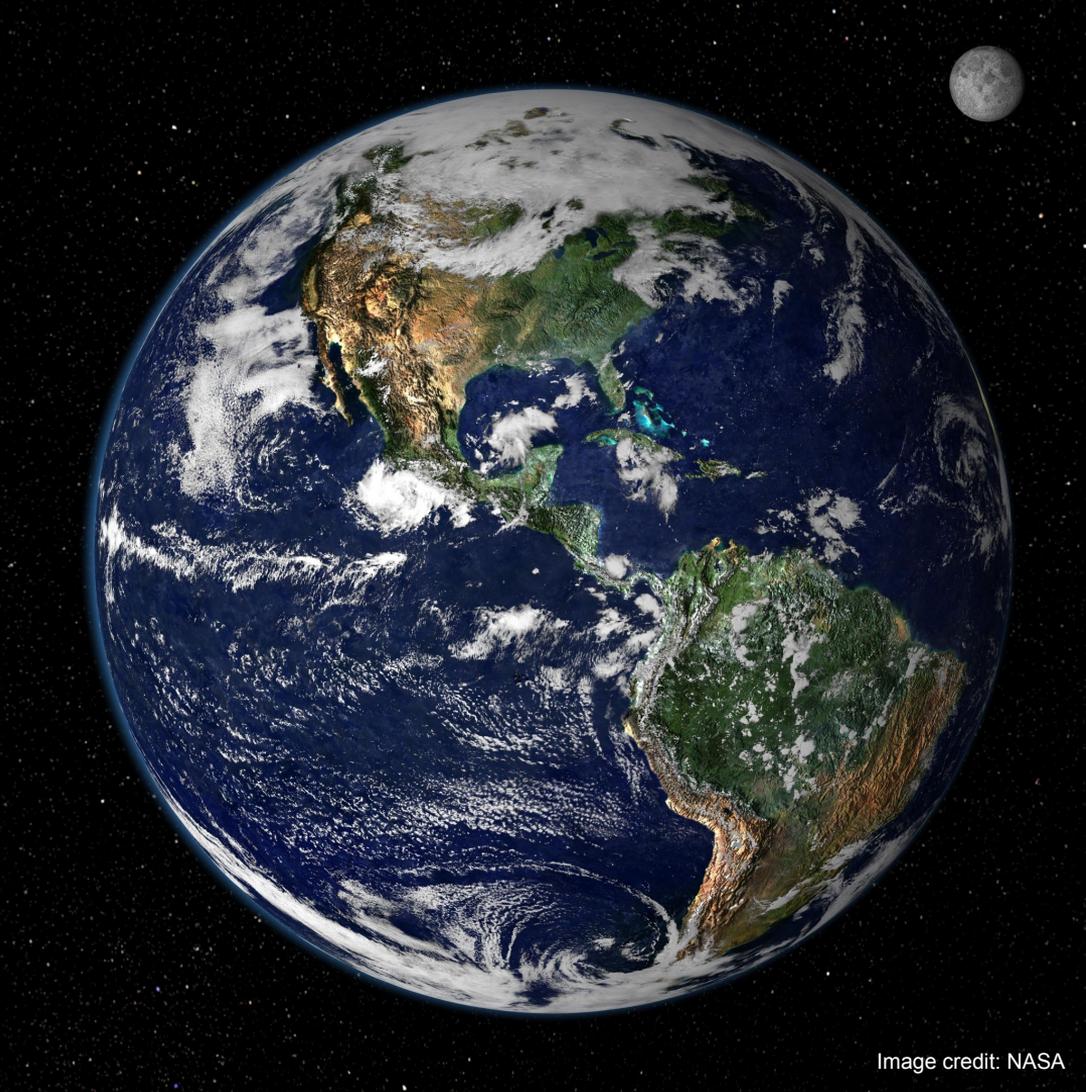
Has active volcanoes



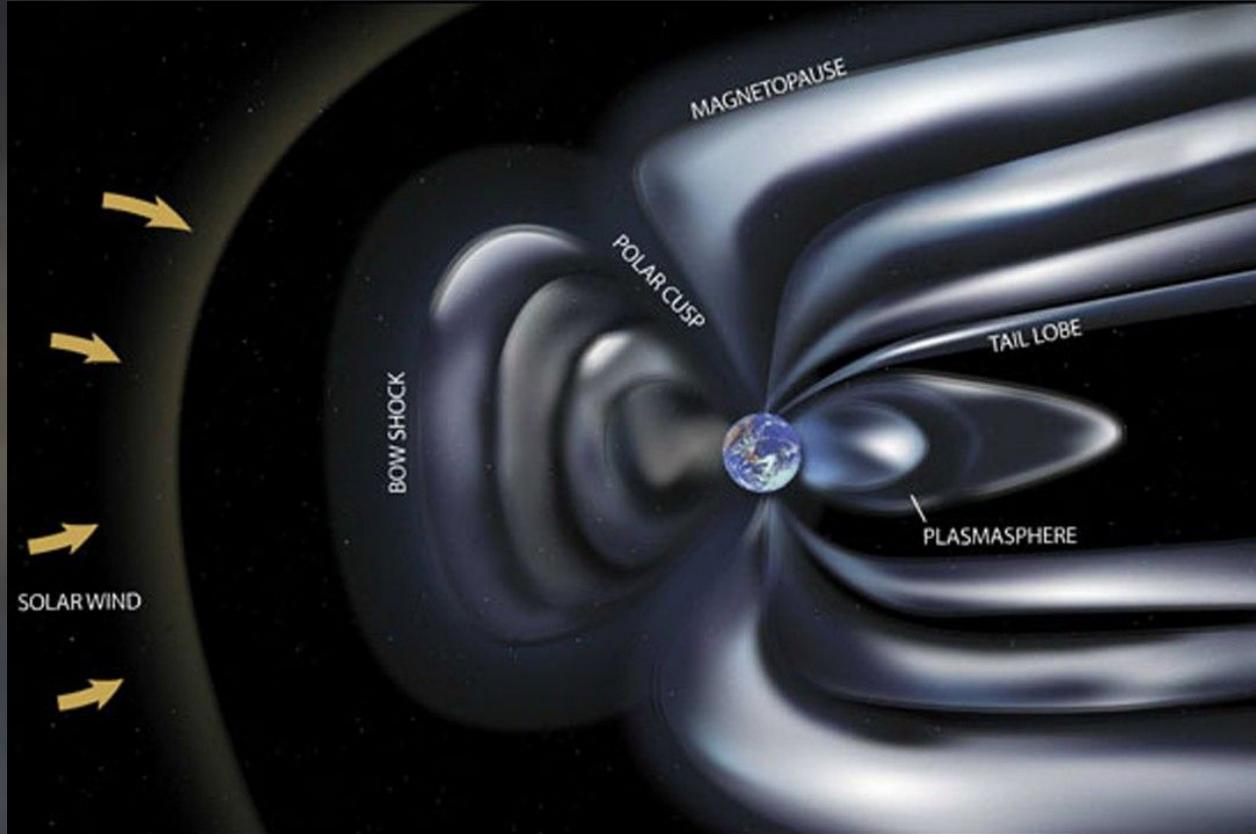
Earth

Only planet in the universe that we know has life (so far).

What's your favorite thing about Earth!?



Earth has a Strong Magnetic Field that Protects Us!



Mars

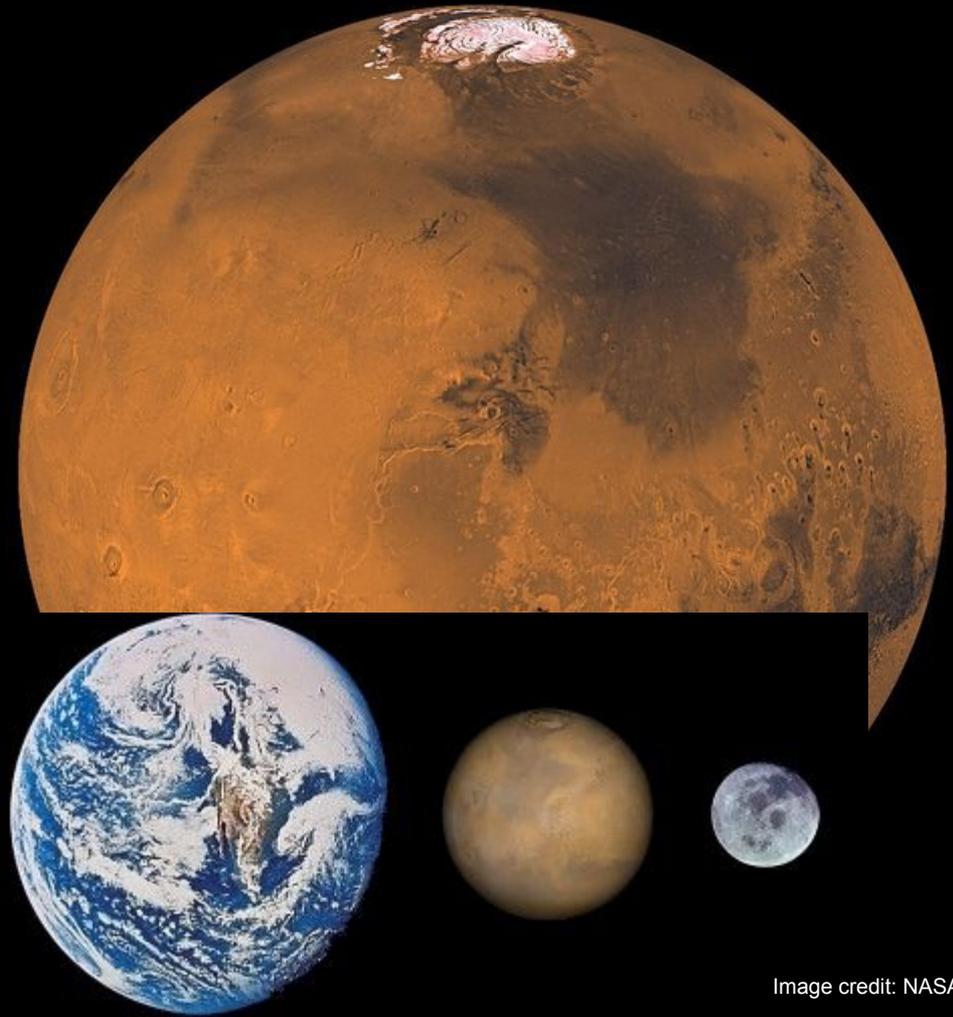
Fourth closest planet to the Sun

10% mass of Earth

50% radius of Earth, 2x radius of Moon

Has some liquid water on surface, also has water ice

Could life have existed there? MAYBE

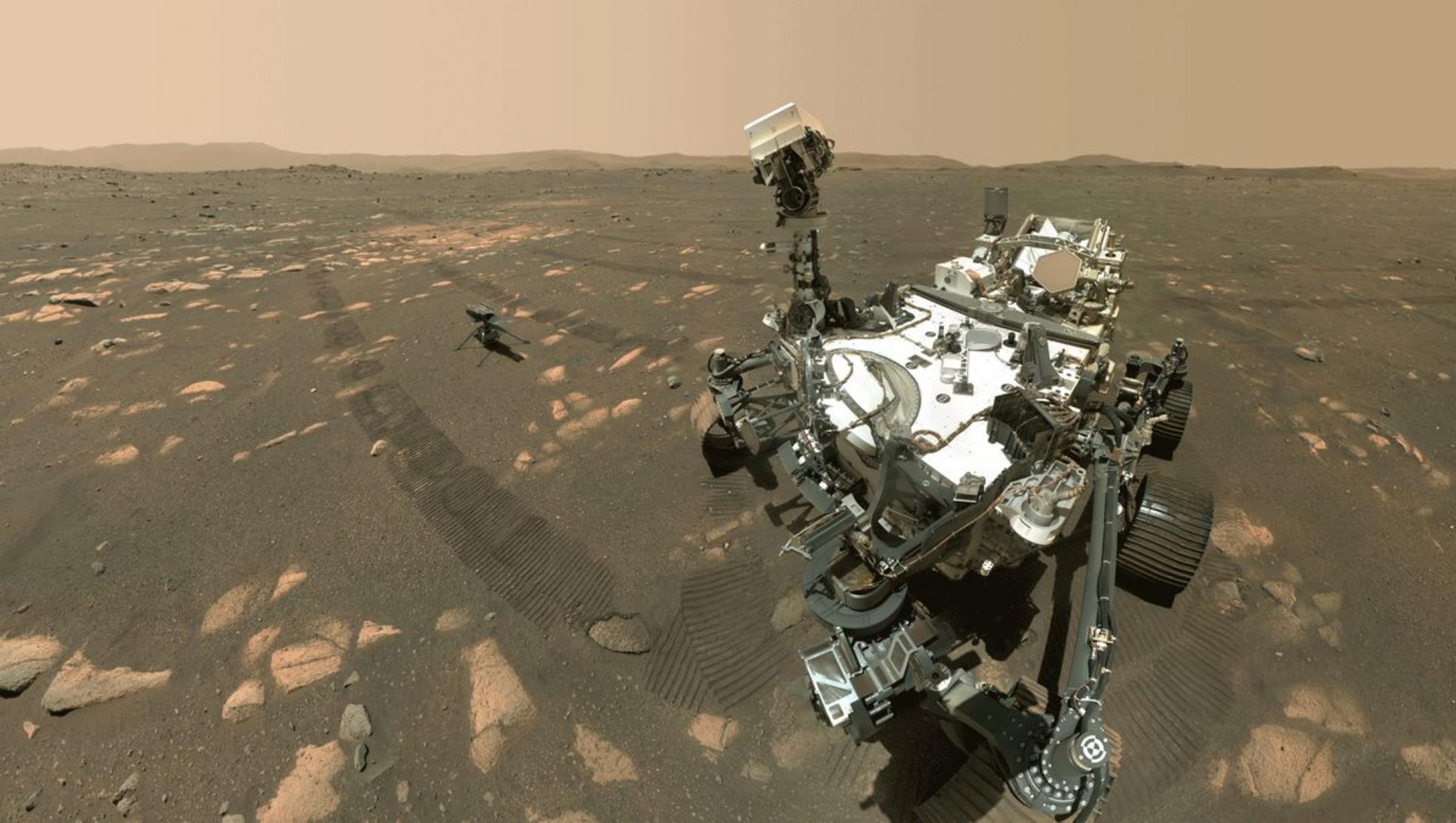


A photograph of a Mars rover on the surface of Mars. The rover is on the right side of the frame, with its solar panels and various instruments visible. The background shows a vast, reddish-brown landscape with a prominent, winding riverbed or channel that has dried up. The sky is a pale, hazy orange.

EXPLORING AN ANCIENT RIVER ON MARS



Jet Propulsion Laboratory
California Institute of Technology



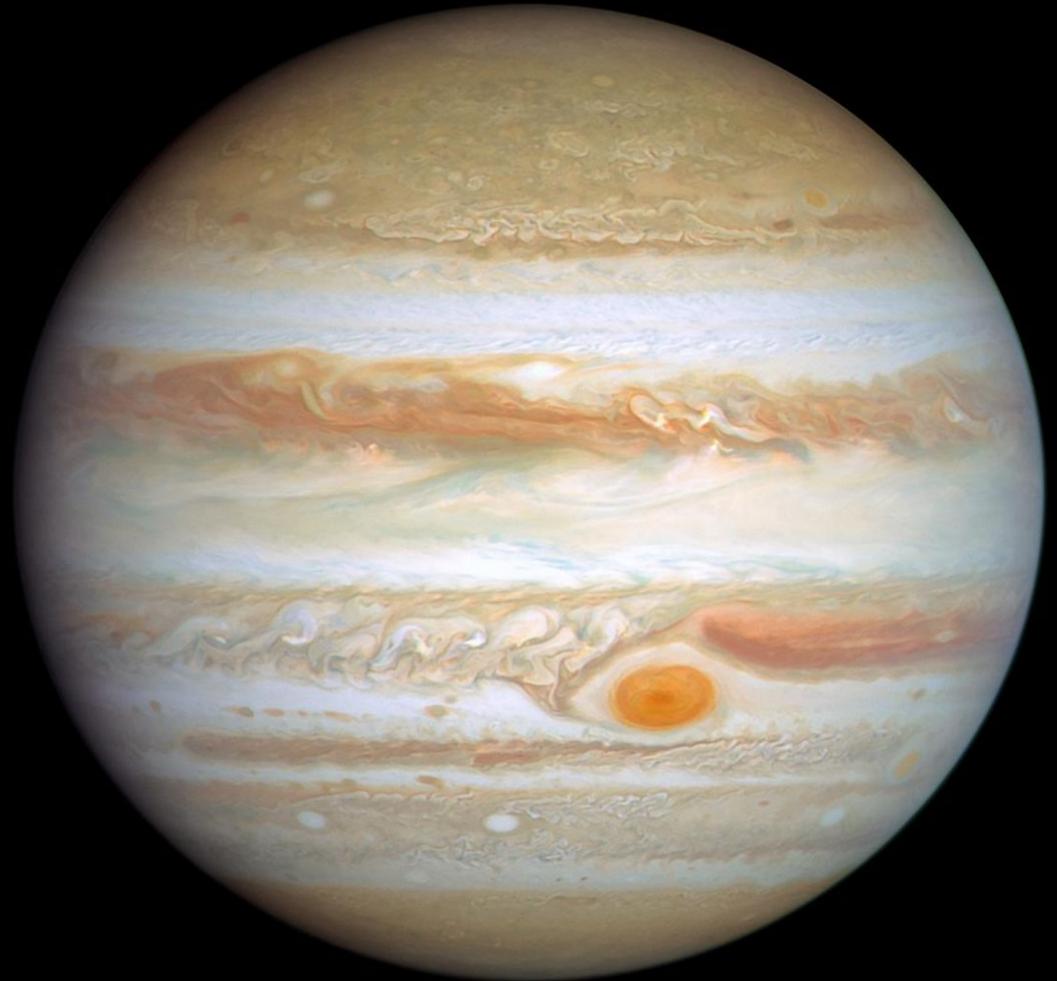
Jupiter

Gas giant, biggest planet in solar system

0.1% the mass of the Sun, 318x the mass of Earth, 11x the radius of Earth

97 moons, 4 found by Galileo and visible with small telescopes

It's moons could host life!



Saturn



Image credit: NASA

Gas giant, second largest planet in the solar system, sixth furthest from the Sun

95x more massive than Earth, $\frac{1}{3}$ the mass of Jupiter, 9x radius of Earth

Has the most moons in the solar system! 274 in total, some could host life (e.g. Titan, Enceladus)

Has many rings (mostly water ice), could be made of destroyed moons

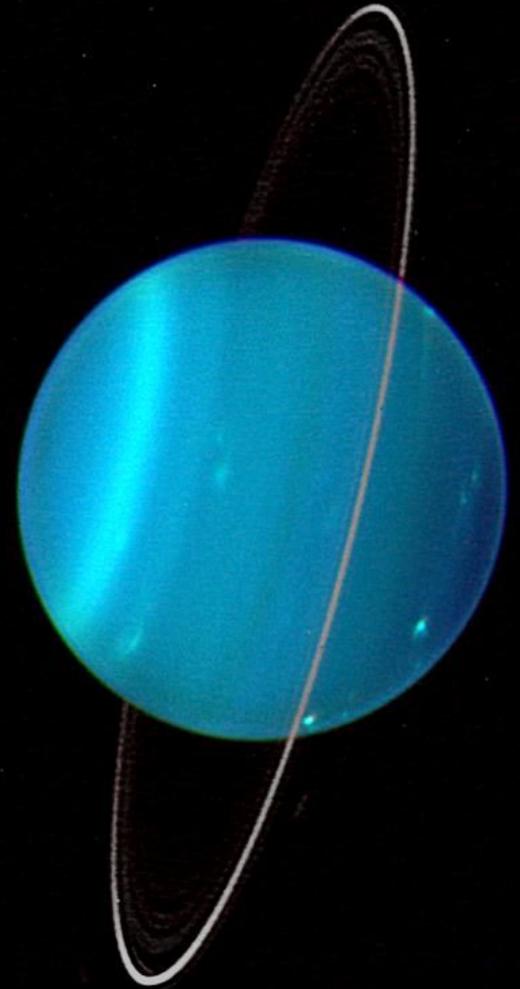
Uranus

Ice giant, 4x the radius of Earth, 14x mass of Earth

Has a ring system, fainter than Saturn's, probably from moon collisions

Has 28 moons

Funniest name



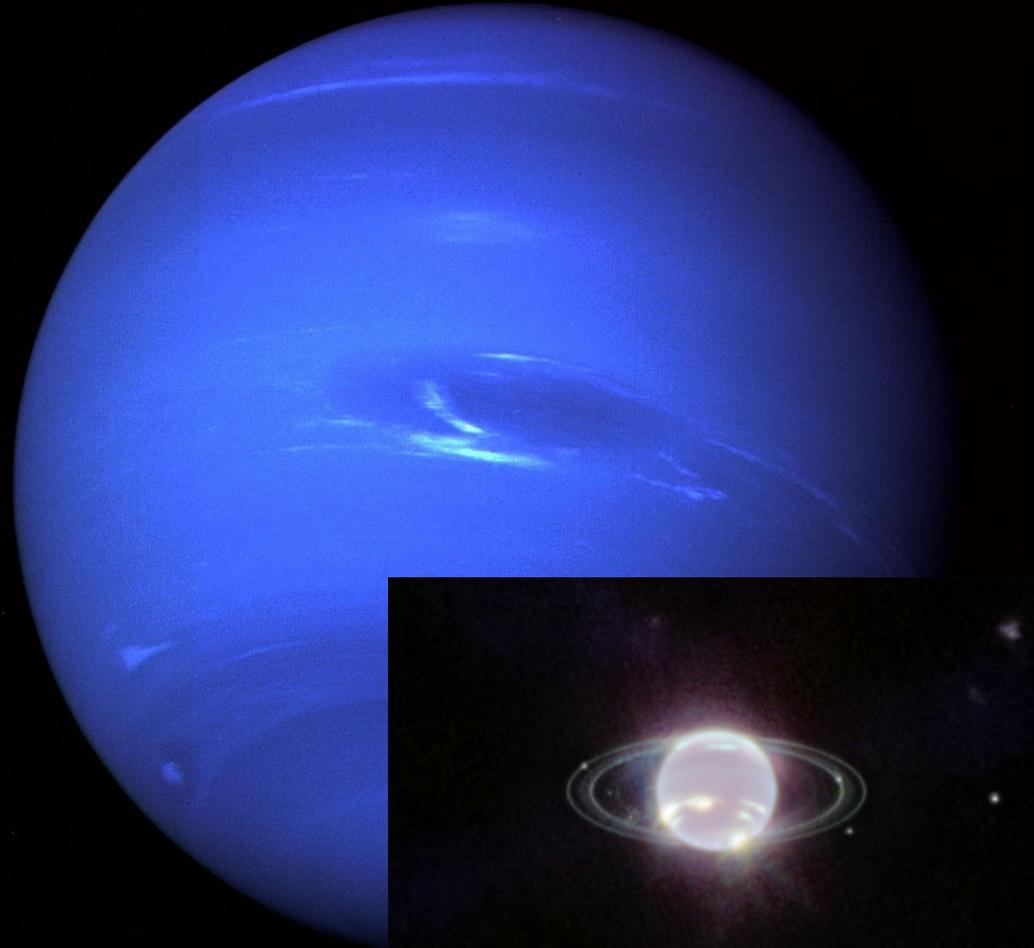
Neptune

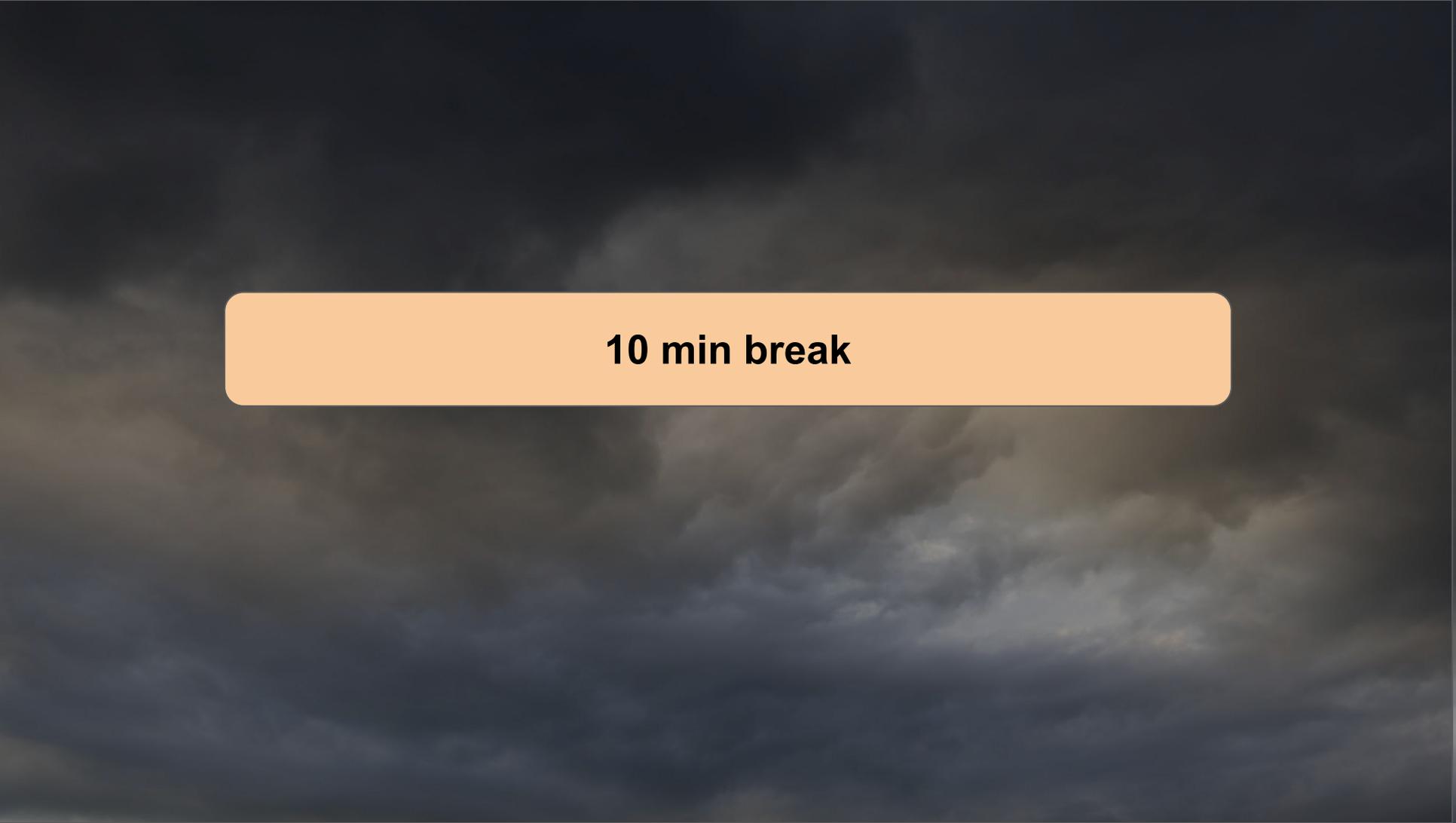
Ice giant, farthest planet from Sun

17x mass of Earth, 3.8x radius of Earth

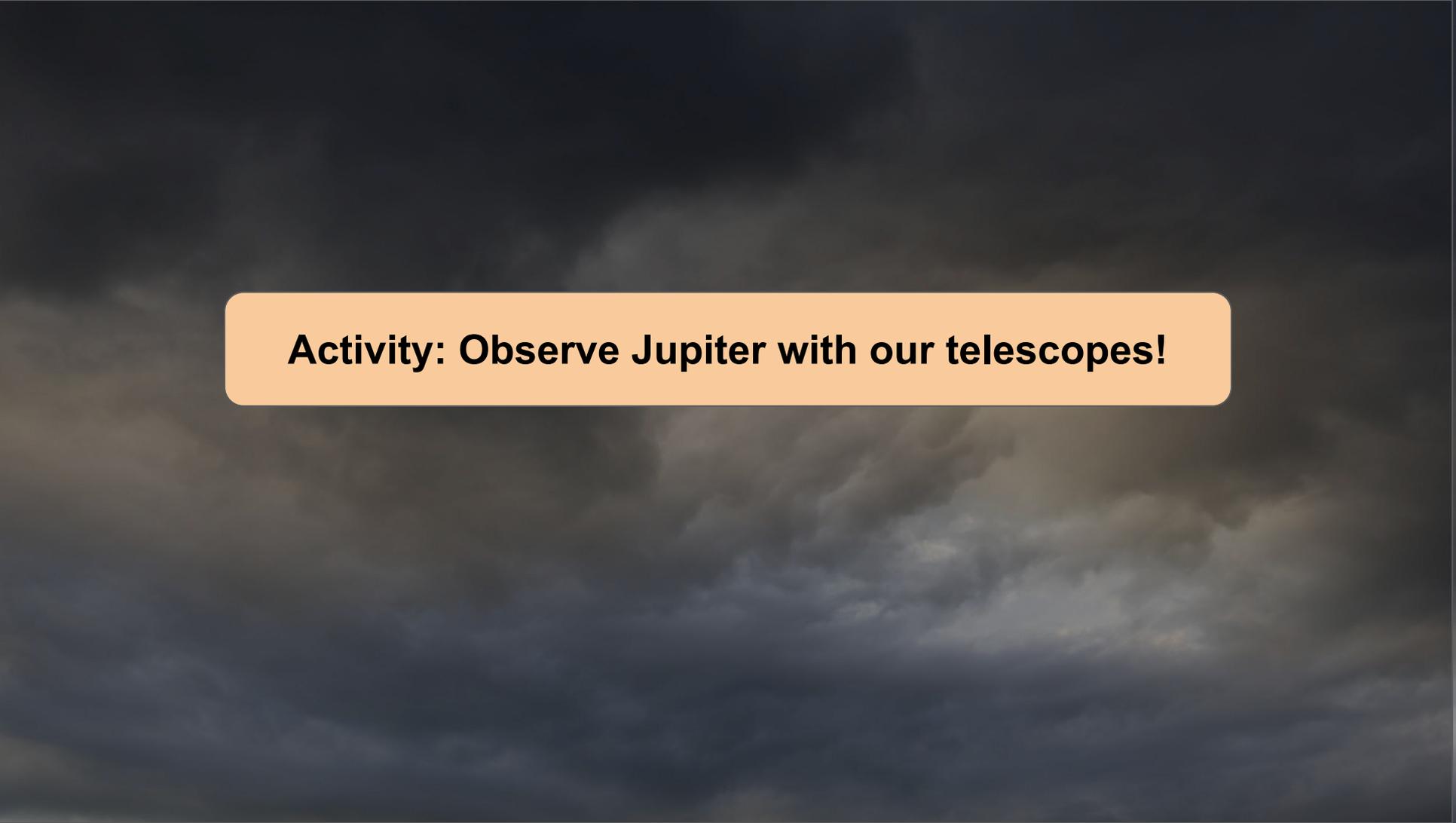
Has 16 moons

Has rings that are very faint





10 min break

The background of the image is a dark, moody sky filled with heavy, grey clouds. The lighting is dim, creating a sense of an overcast or stormy day. In the center of the image, there is a horizontal, rounded rectangular box with a solid orange color. Inside this box, the text "Activity: Observe Jupiter with our telescopes!" is written in a bold, black, sans-serif font.

Activity: Observe Jupiter with our telescopes!



The moons of our Solar System

Other Important Places in the Solar System: Moons

Habitable Worlds?

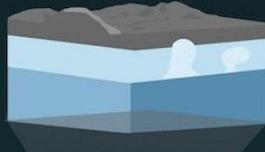
Increasing knowledge of other worlds in our solar system helps drive the search for life beyond Earth
– so far, the only living world we know of.

Mars



Mars' surface – frozen and bombarded by radiation – is likely inhospitable to life, but subsurface ice or even water could provide a home for microorganisms.

Europa



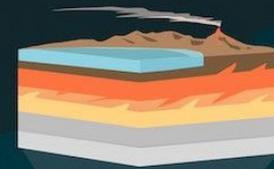
A vast interior ocean lies beneath the surface of this moon of Jupiter, encased in a shell of ice. The ocean water itself, and even upper ice layers, could be potentially habitable.

Enceladus



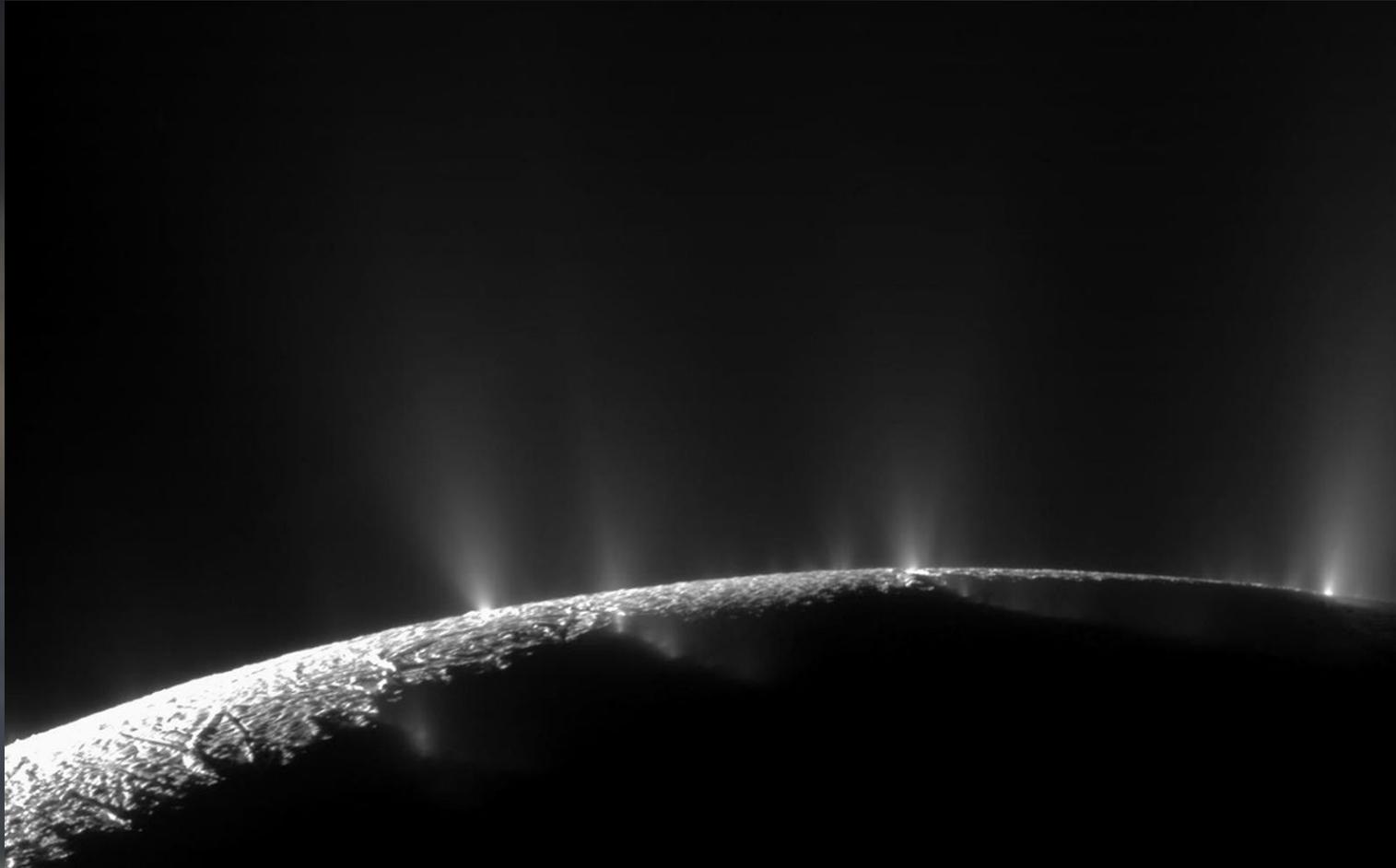
Jets erupting from this Saturn moon suggest active hydrothermal vents on the floor of its subsurface ocean – dynamics similar to Earth's when life originated billions of years ago.

Earth

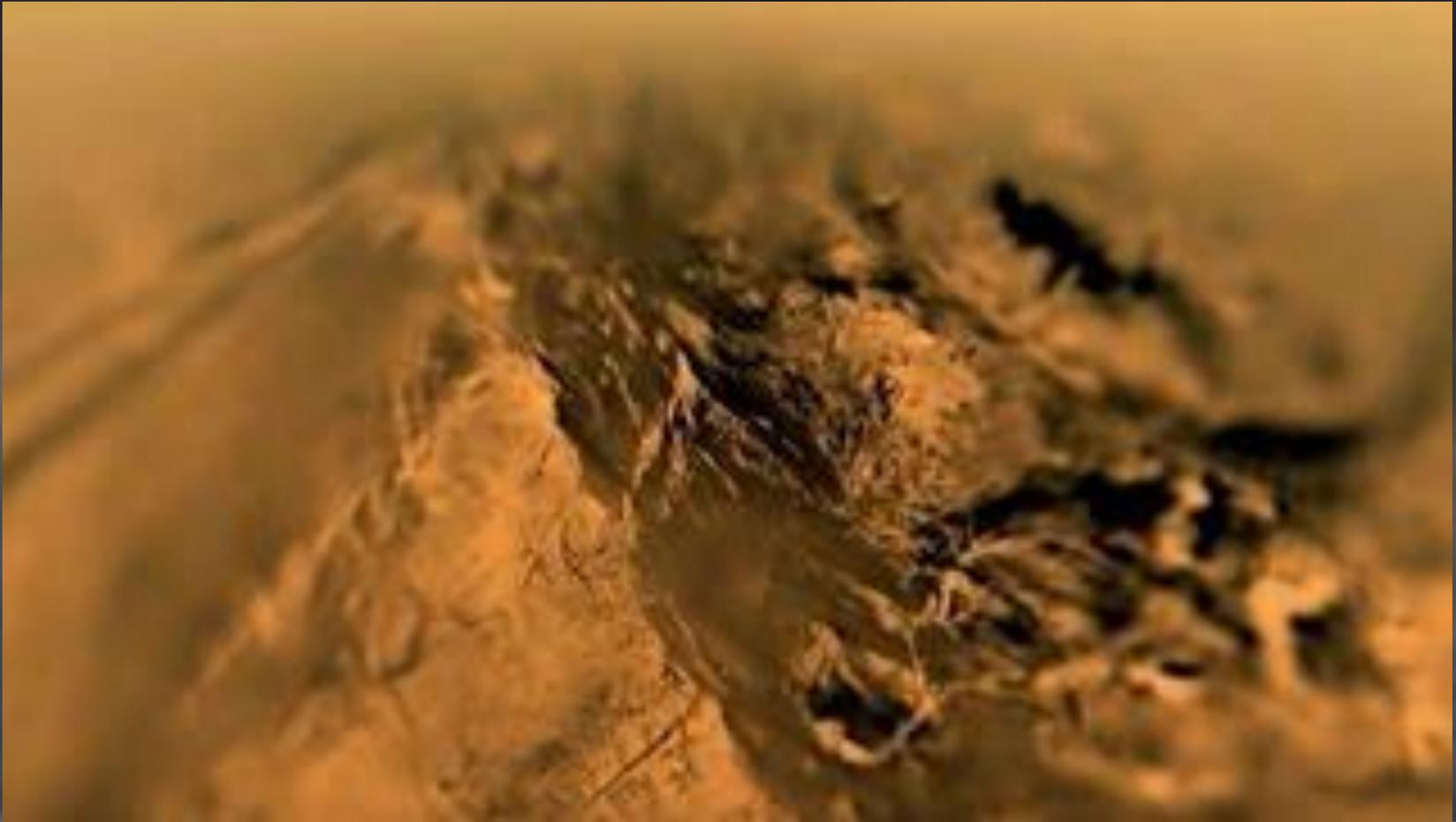


Our planet's so-far-unique combination – plate tectonics and abundant water – are considered key factors to sustain life.

Some Important Moons: Enceladus (Moon of Saturn)



Some Important Moons: Titan (Moon of Saturn)





Some Important Moons: Europa (Moon of Jupiter)



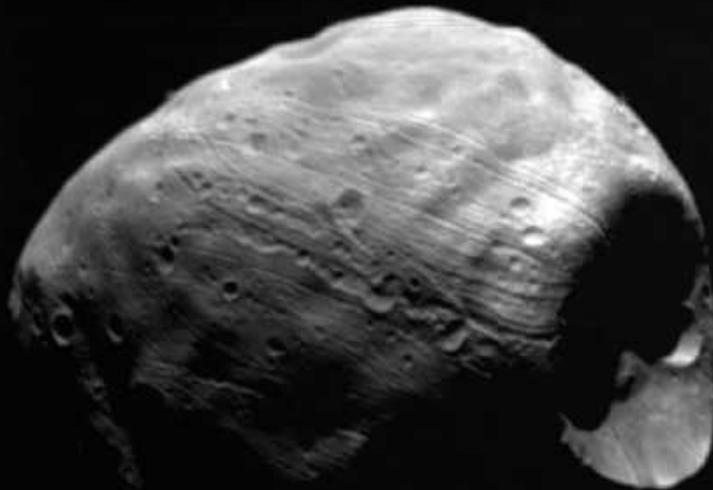
OCEAN
WORLD EUROPA

Some Important Moons: Moons of Mars

Deimos



Phobos



To Scale



Earth



Moon

Mars

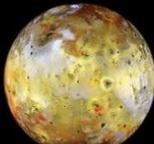
Phobos

Deimos

**Asteroid
Ida**

Dactyl

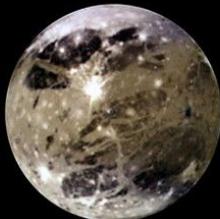
Jupiter



Io



Europa



Ganymede



Callisto

Saturn

Mimas

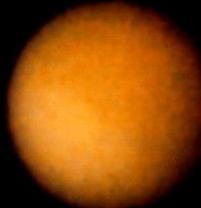
Enceladus

Tethys

Dione



Rhea



Titan

Hyperion

Iapetus

Phoebe

Uranus

Puck

Miranda

Ariel

Umbriel



Titania



Oberon

Neptune

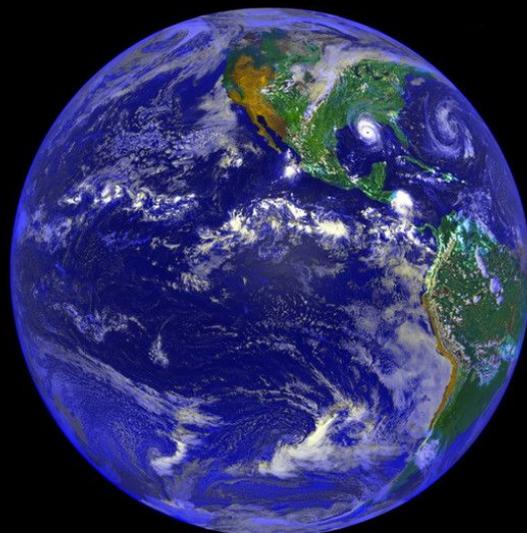


Triton

Nereid

Pluto

Charon



Earth

Optional Homework

- Research where in the Solar System life might be able to form and survive. (Hint: Look at moons!)
- Check out the Solar Dynamics Observatory website that displays up to date images of the Sun across a broad range of colors. Some emphasize sunspots, solar flares, and magnetic fields.
<https://sdo.gsfc.nasa.gov/data/>
- Use NASA's Eyes on the Solar System to see where the planets, moons, comets, asteroids, and spacecraft are right now:
<https://eyes.nasa.gov/apps/solar-system/#/home>