

The Solar System and its Planets



The milky way
(seen from Bryce Canyon, UT)

The Solar System



?

“A **system** is a set of **interacting** or interdependent **components** forming an integrated whole” (Wikipedia)

The Solar System



The sun (a star)

The planets

Asteroids

Kuiper Belt Objects

Comets

Dust (zodiacal light)

Interactions: Gravity causes planets to orbit around the sun

Heat created via fusion in the sun heats the planets

Occasionally, objects in the solar system can collide

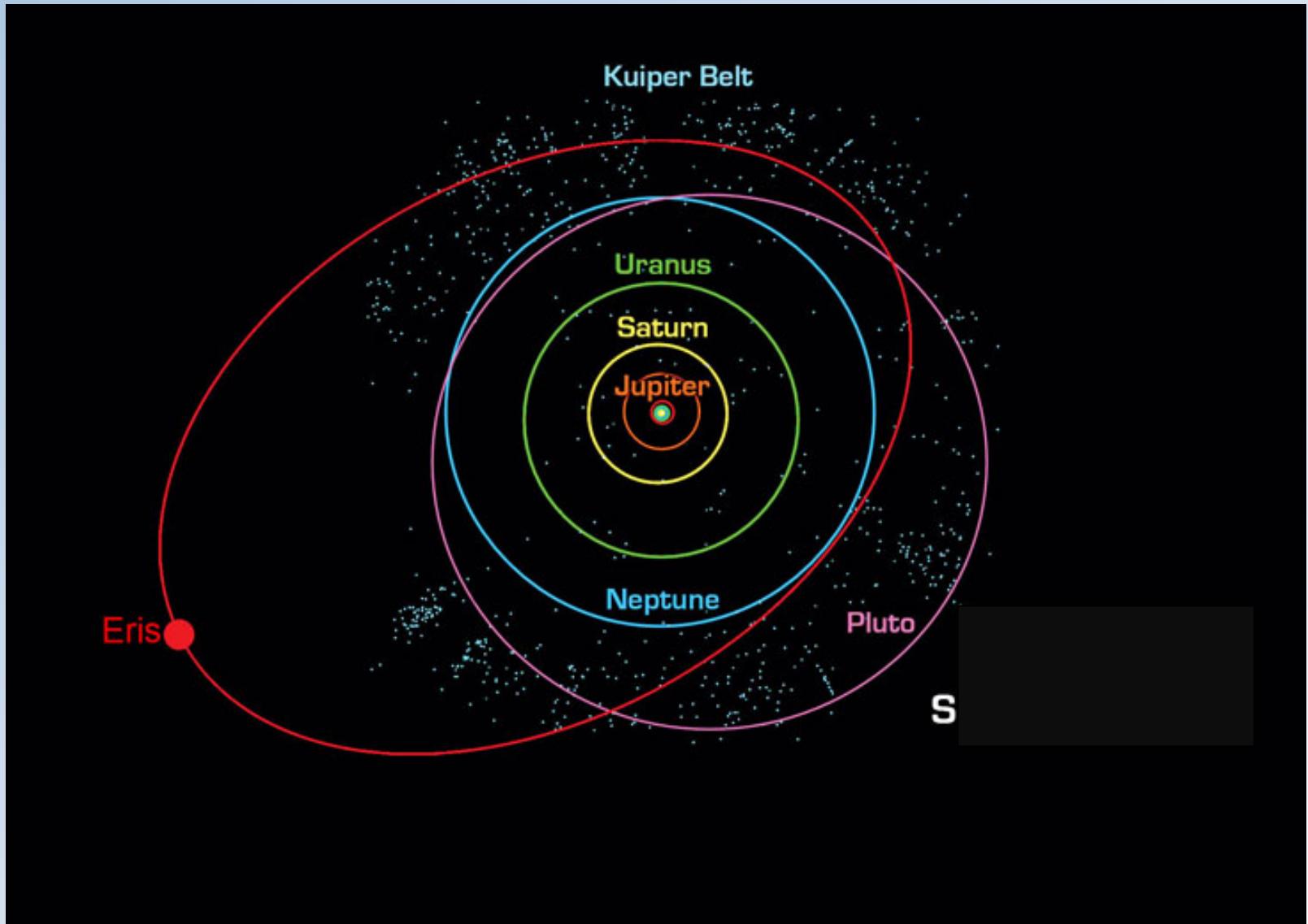


Zodiacal light =
Dust in the plane of the solar system

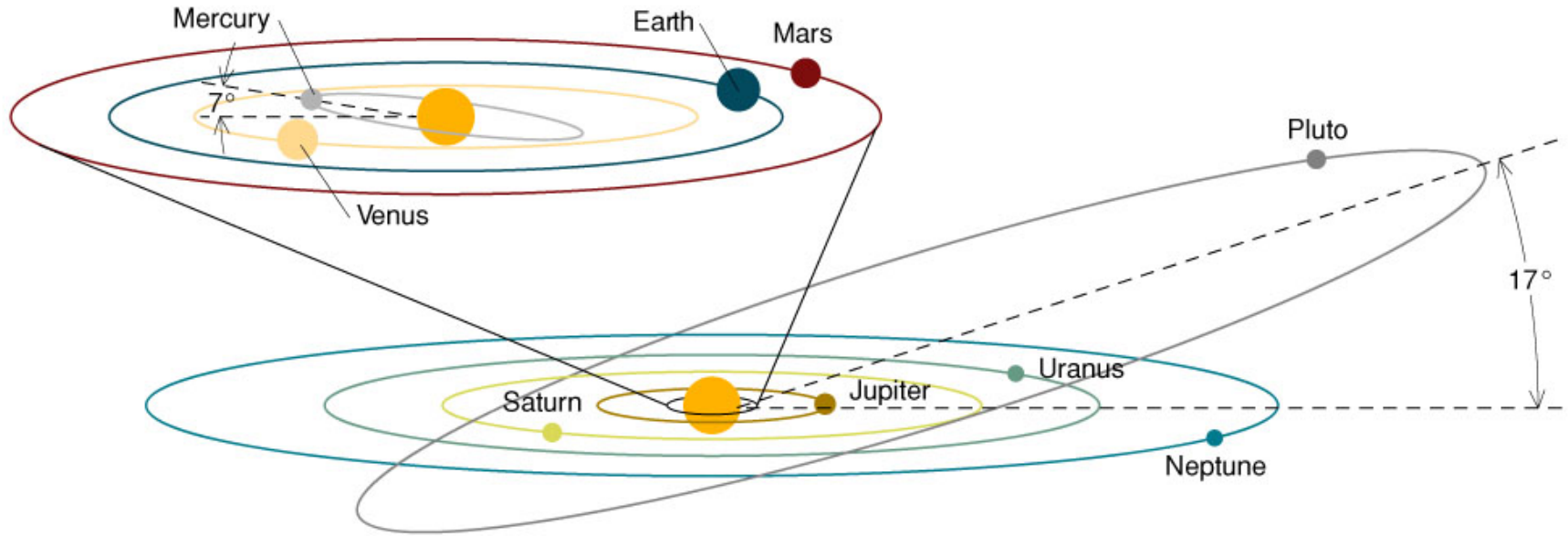


Daniel López
Observatorio del Teide, IAC

A top view of the solar system's orbits

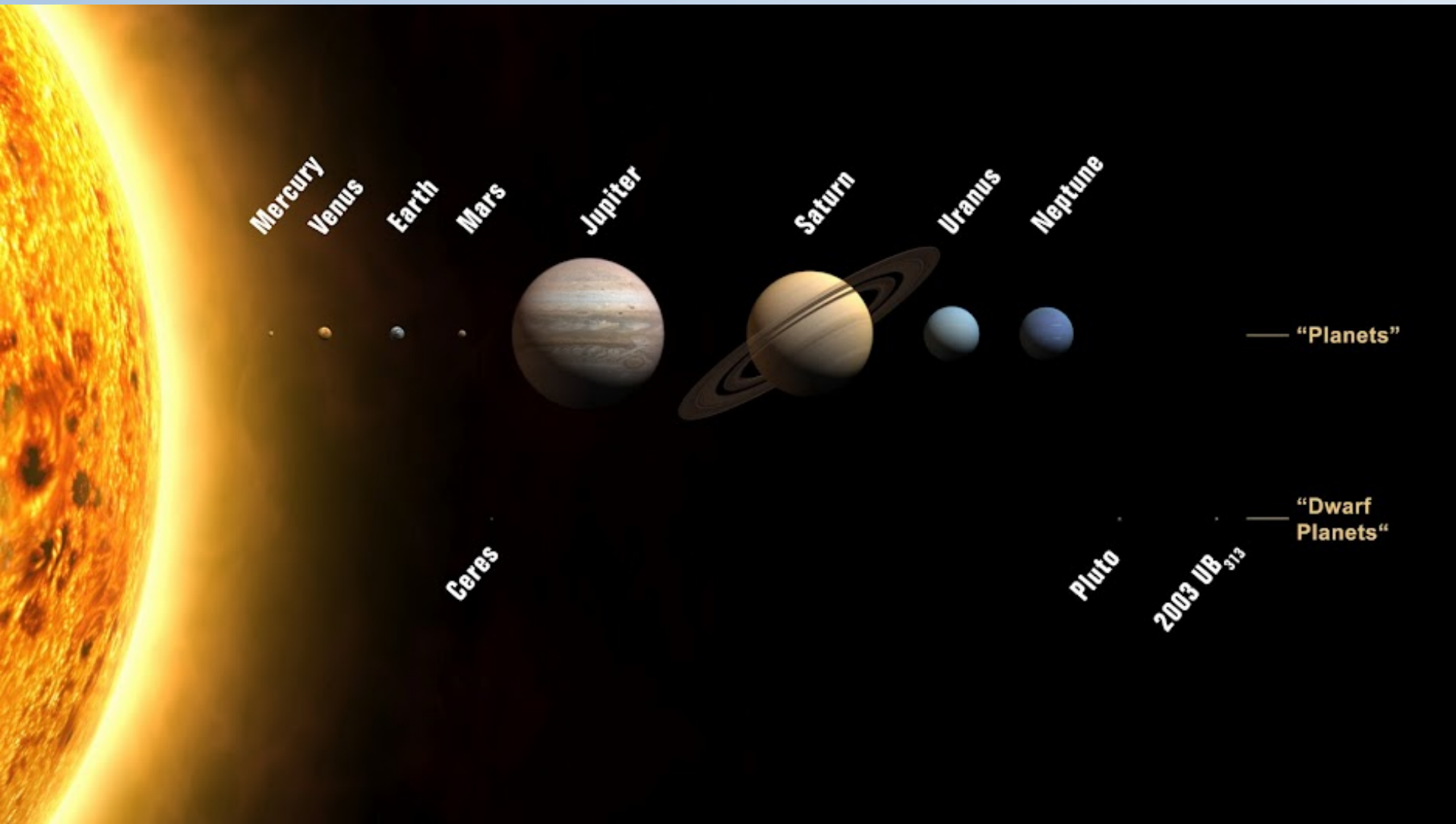


A side view of the Solar System's orbits



- Most planets orbit in the same plane
- Which objects are not orbiting in the same plane?

The solar system components, to scale



In the last few weeks we learned about stars.
What are some characteristics of stars?

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What are some characteristics of stars?

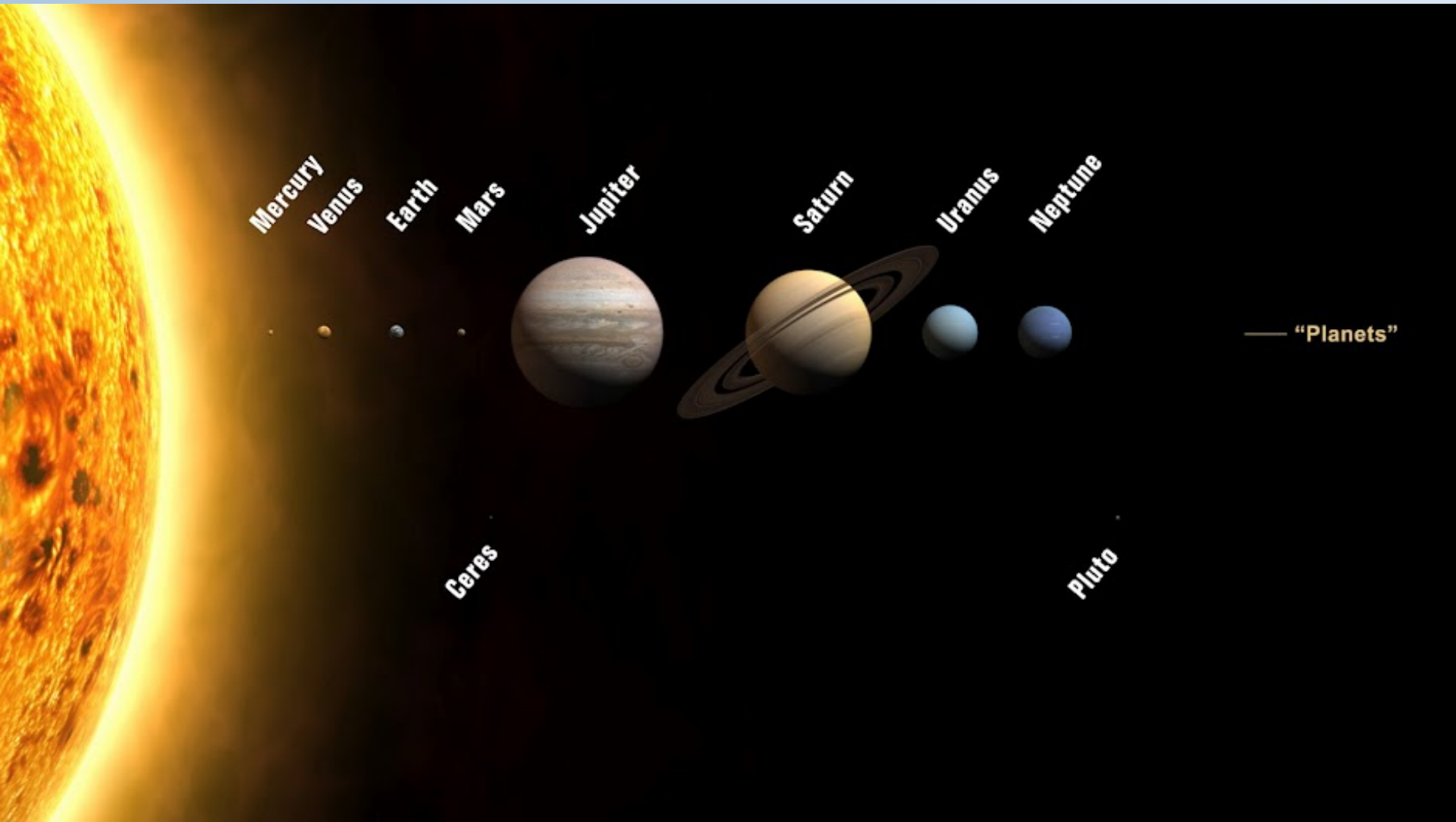
What is a planet?

Make 2 lists: planets and not planets

What is *your* definition of a planet?

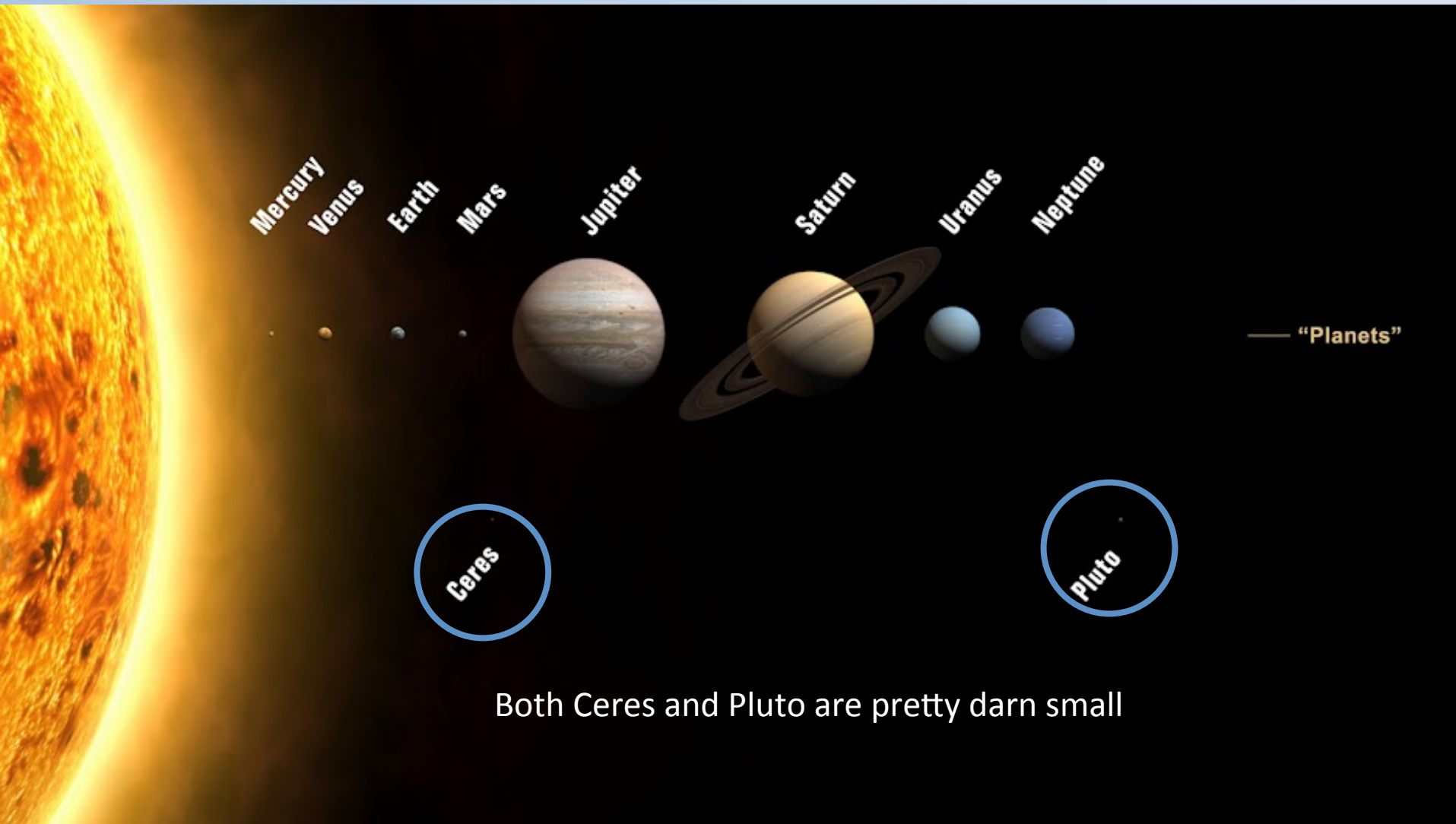
Why did the number of planets change in 2006?

Scaled view of solar system sizes (distances NOT to scale)

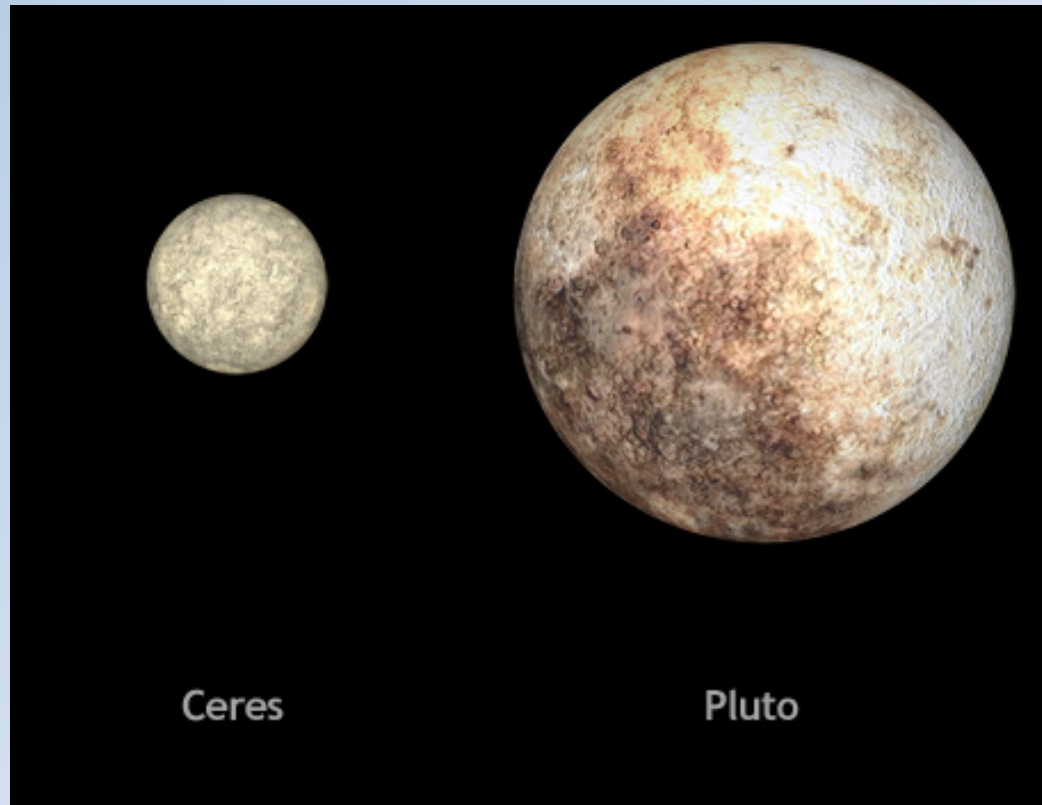


Why did the number of planets change in 2006?

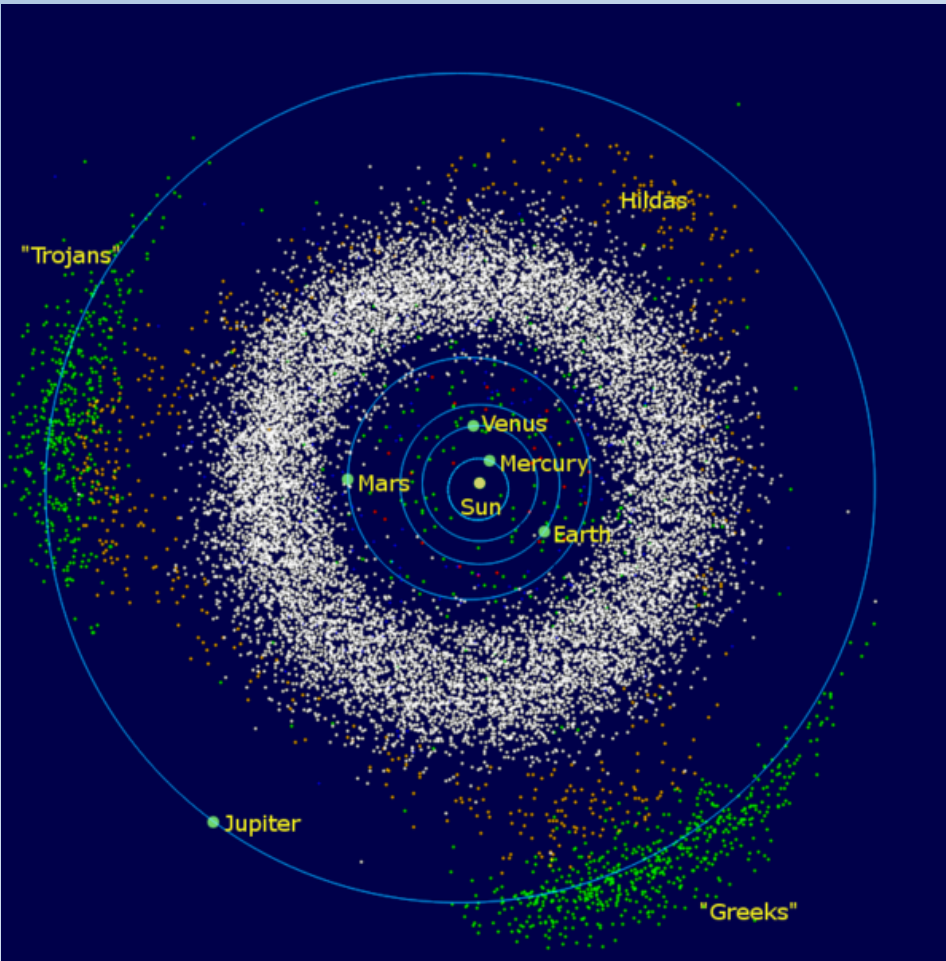
Scaled view of solar system sizes (distances NOT to scale)



Scaled view of Pluto and Ceres
(drawings, *not* photos!)



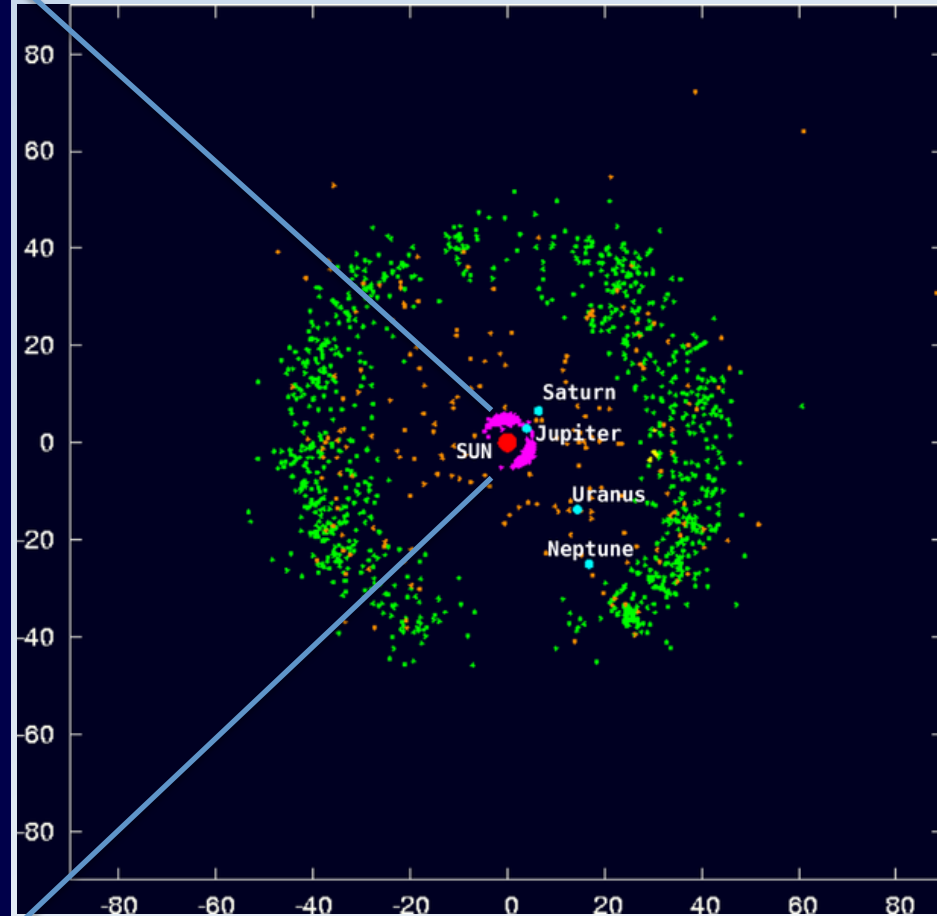
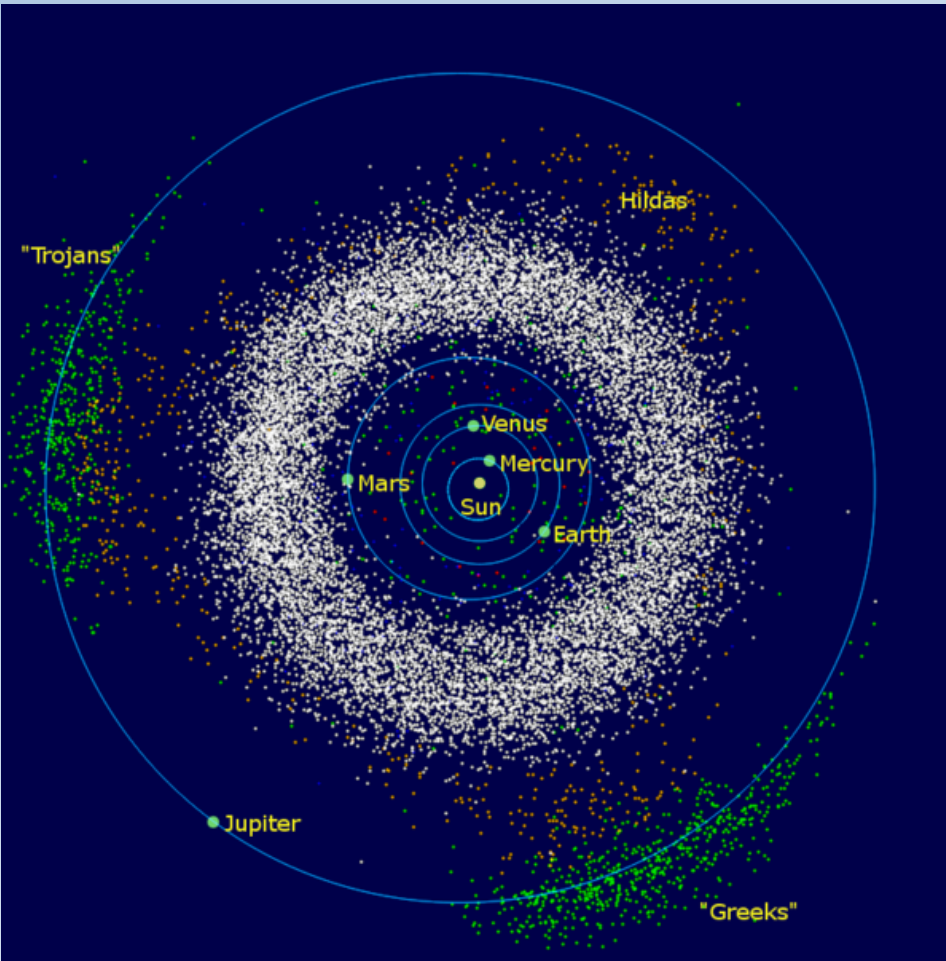
Ceres is part of the asteroid belt



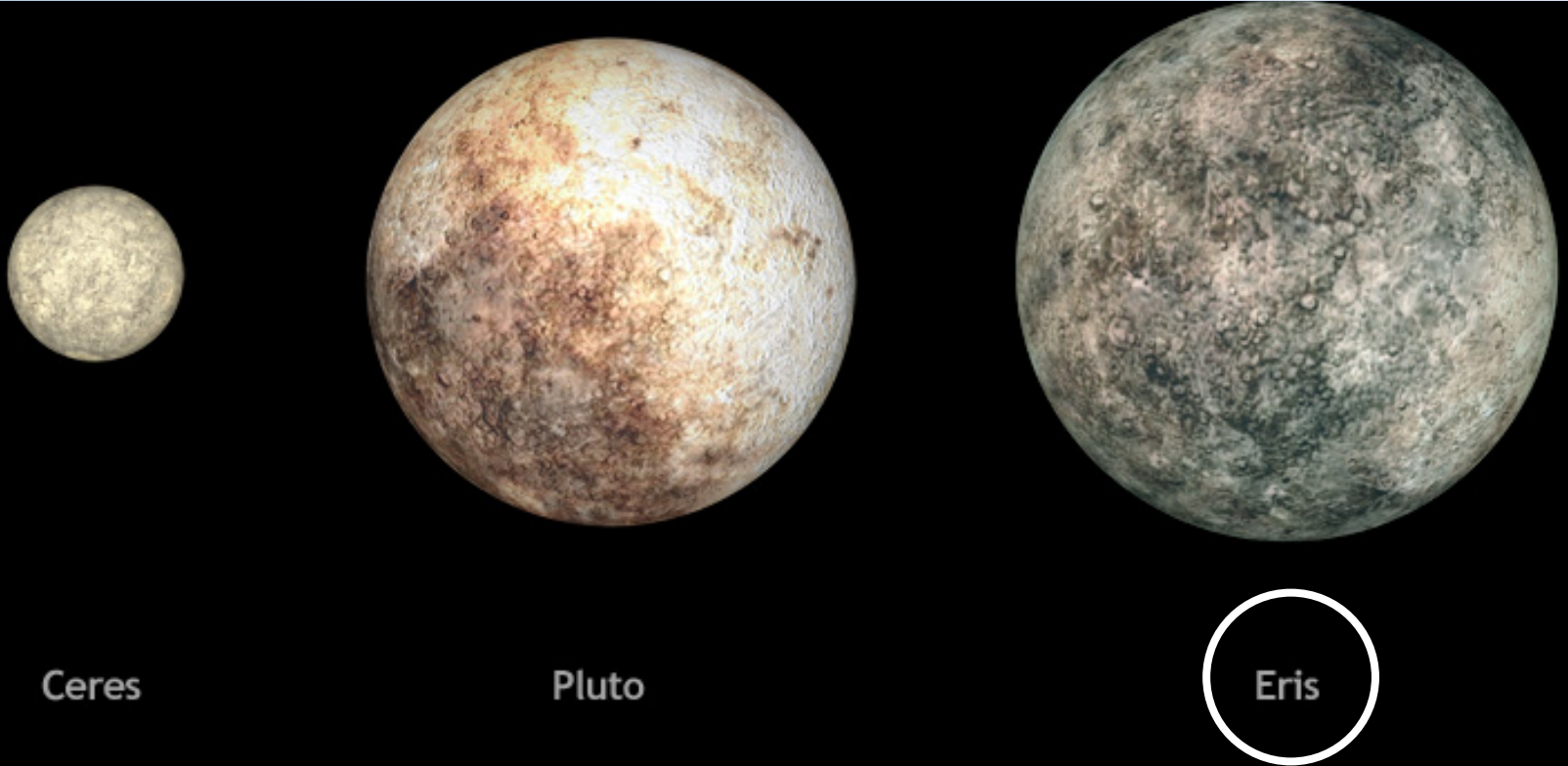
First Kuiper belt object discovered in 1992

Ceres is part of the asteroid belt

Pluto is part of the Kuiper belt



Kuiper belt object Eris discovered in 2005



Bigger than Pluto! Is Eris also a planet?

"Dwarf planets Ceres, Pluto, & Eris"

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<http://www.arcadiastreet.com>

IAU* definition of a **planet**

is in orbit around the Sun

has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape

has cleared the neighbourhood around its orbit

*International Astronomical Union

Which part of the IAU **planet** definition does Pluto *not* satisfy?

(A) is in orbit around the Sun

(B) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape

(C) has cleared the neighbourhood around its orbit

IAU definition of a **dwarf** planet:

(A) is in orbit around the Sun

(B) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape

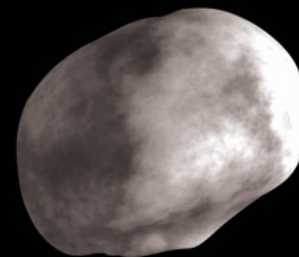
(C) has **not** cleared the neighbourhood around its orbit

(D) is not a satellite (moon)

Which part of the IAU definition of a **dwarf planet** does asteroid Vesta *not* satisfy?

- (A) is in orbit around the Sun
- (B) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape
- (C) has **not** cleared the neighbourhood around its orbit
- (D) is not a satellite (moon)

Vesta



The solar system has two types of planets:

terrestrial (or “rocky”) planets
and

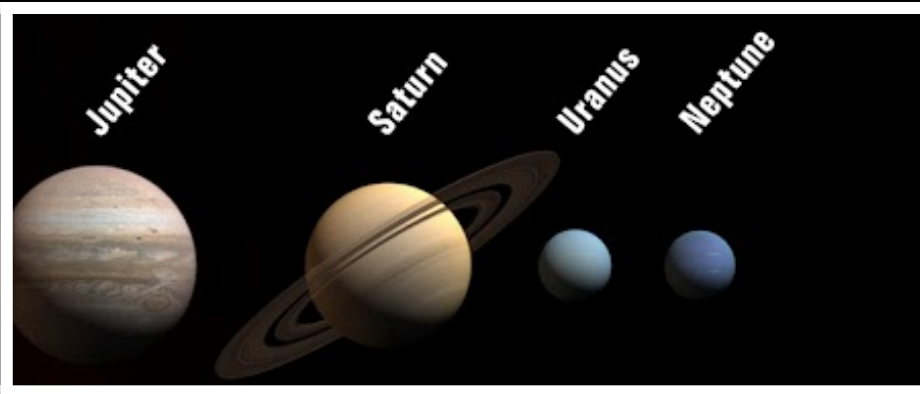
gas giant planets

What are the characteristics of terrestrial and gas giant planets?

Terrestrial planets



Gas giant (Jovian) planets



- Are made of solids like rocks, metal
- Have solid surfaces
- A spaceship could land on it

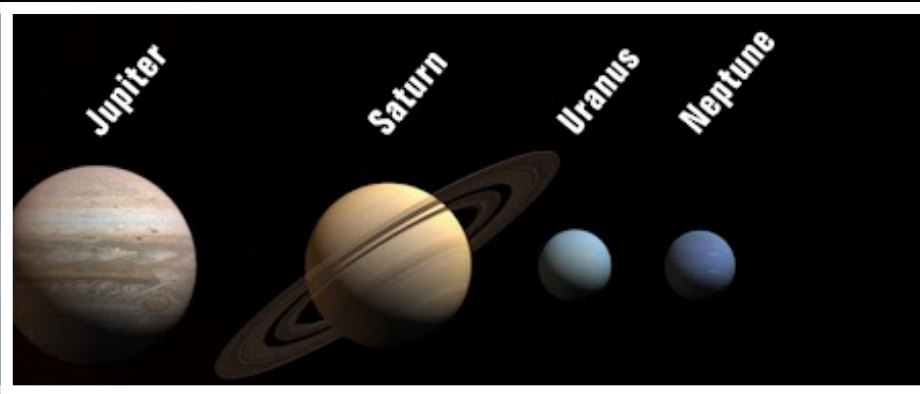
- Are made primarily of gas, mostly hydrogen
- Do not have solid surfaces
- A space ship can not land on it (but it can crash through its atmosphere)

What are the characteristics of terrestrial and gas giant planets?

Terrestrial planets



Gas giant (Jovian) planets

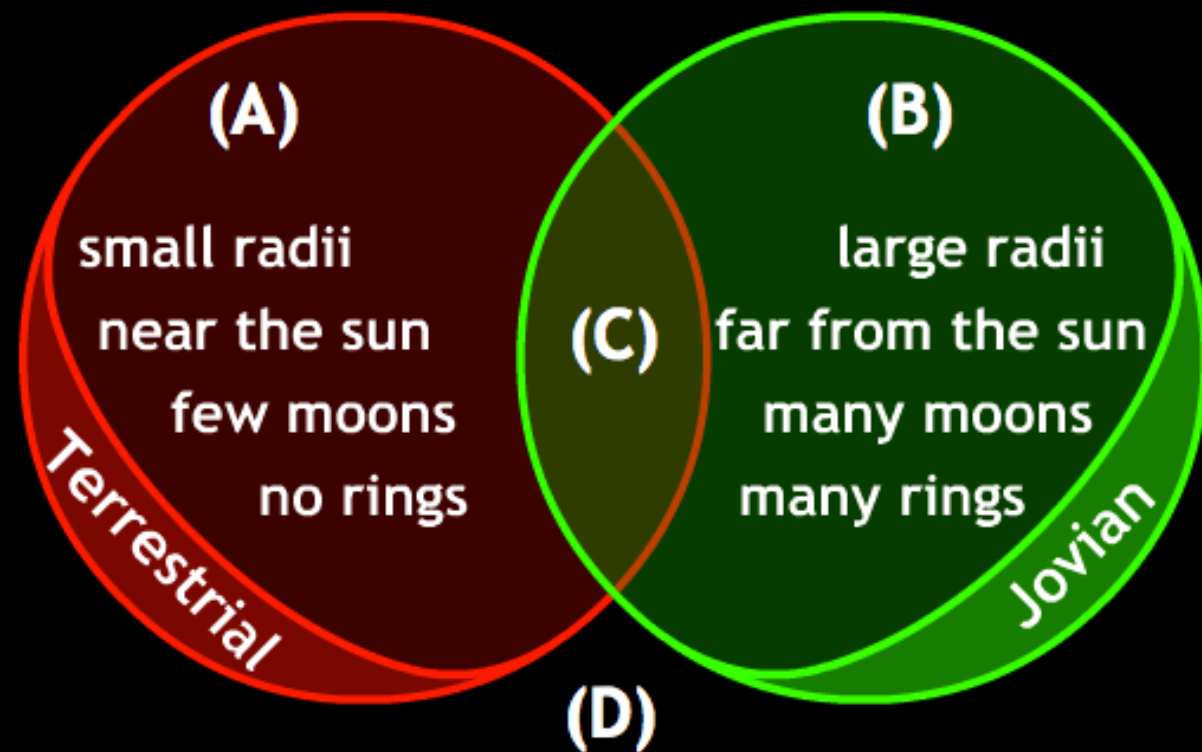


— “Planets”

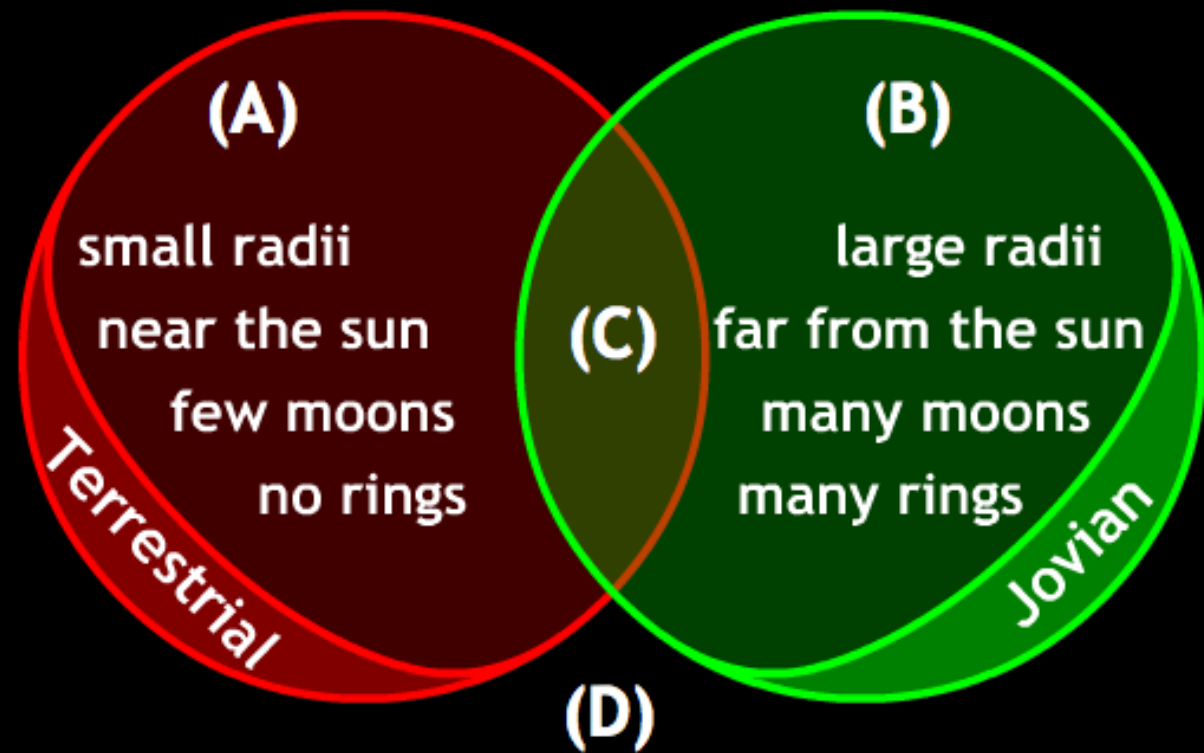
- Are made of solids like rocks, metal
- Have solid surfaces
- A spaceship could land on it
- Are relatively small
- Are closer to the sun
- Are relatively warmer
- Do not have rings

- Are made primarily of gas, mostly hydrogen
- Do not have solid surfaces
- A space ship can not land on it (but it can crash through its atmosphere)
- Are relatively large
- Are farther from the sun
- Are relatively cooler
- Have rings

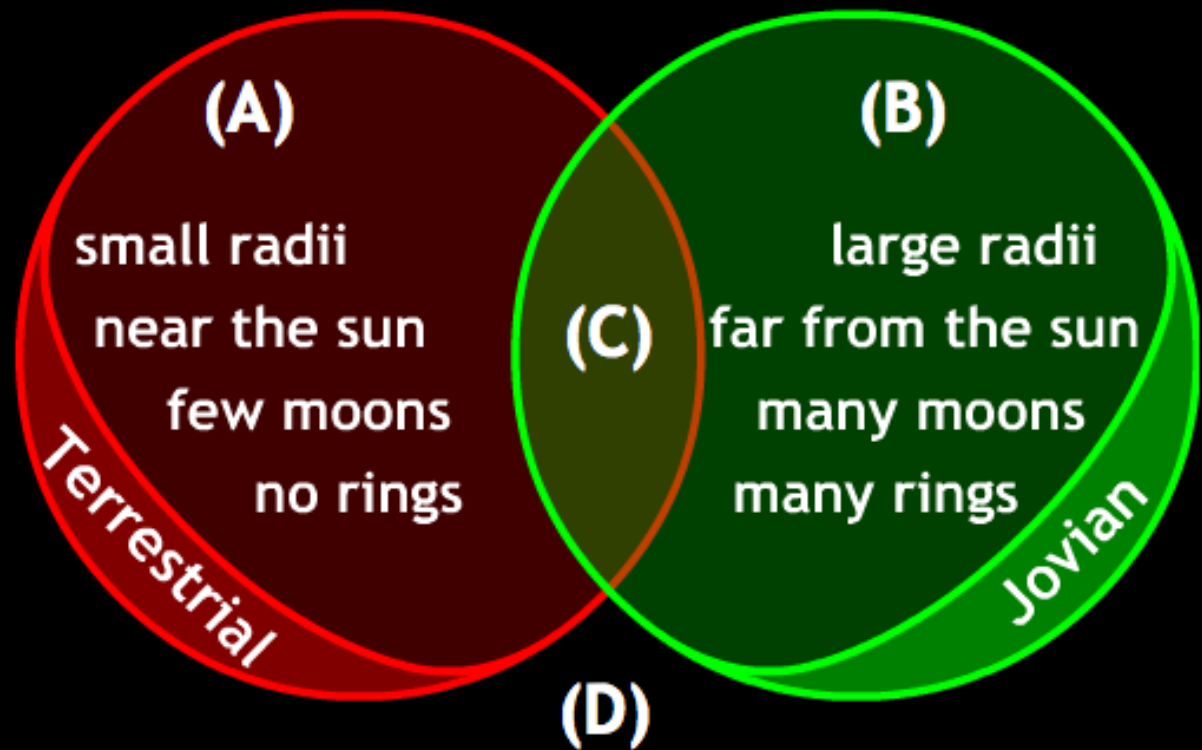
The Venn diagram shown describes the characteristics of Terrestrial and Jovian planets. At which lettered location would the characteristic **small masses** best be placed?



The Venn diagram shown describes the characteristics of Terrestrial and Jovian planets. At which lettered location would the characteristic **no solid surfaces** best be placed?



The Venn diagram shown describes the characteristics of Terrestrial and Jovian planets. At which lettered location would the characteristic **nearly coplanar orbits** best be placed?



Lecture Tutorial: Terrestrial and Jovian planets vs. Pluto

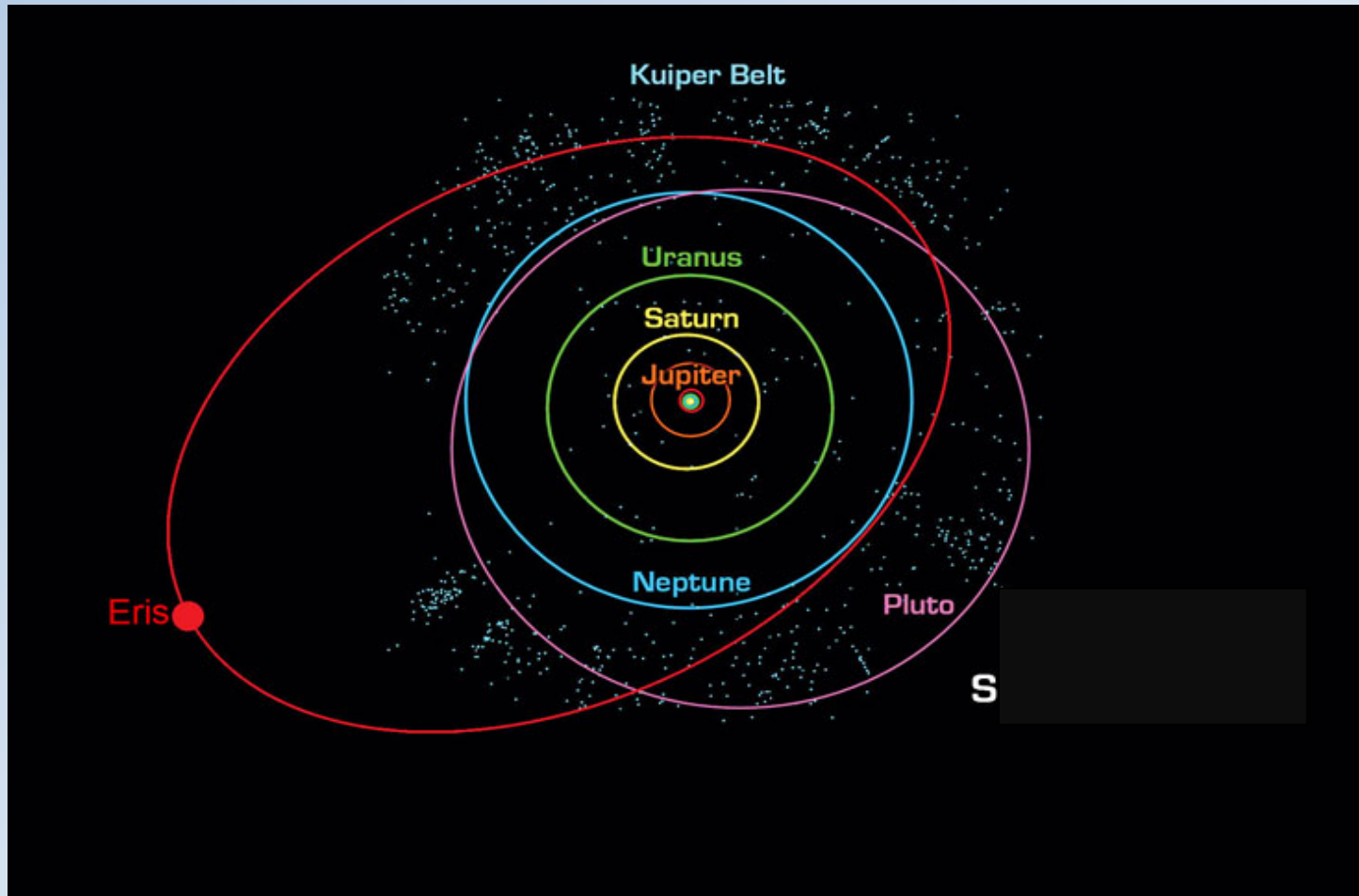
Lecture Tutorial: Sun size

The naming of Eris

Eris (Ancient Greek: "Ερις, "Strife") is the Greek goddess of chaos, strife and discord. Her name is translated into Latin as Discordia, which means "discord." Eris' Greek opposite is Harmonia, whose Latin counterpart is Concordia. Homer equated her with the war-goddess Enyo, whose Roman counterpart is Bellona. The dwarf planet Eris is named after the goddess, as is the religion Discordianism. *(from Wikipedia entry about the Goddess)*

IAU regulations require a name from creation mythology for objects with orbital stability beyond Neptune's orbit. *(from Wikipedia entry about the dwarf planet)*

Some planets are closer to the sun*
than others...



*the solar system's "heater"

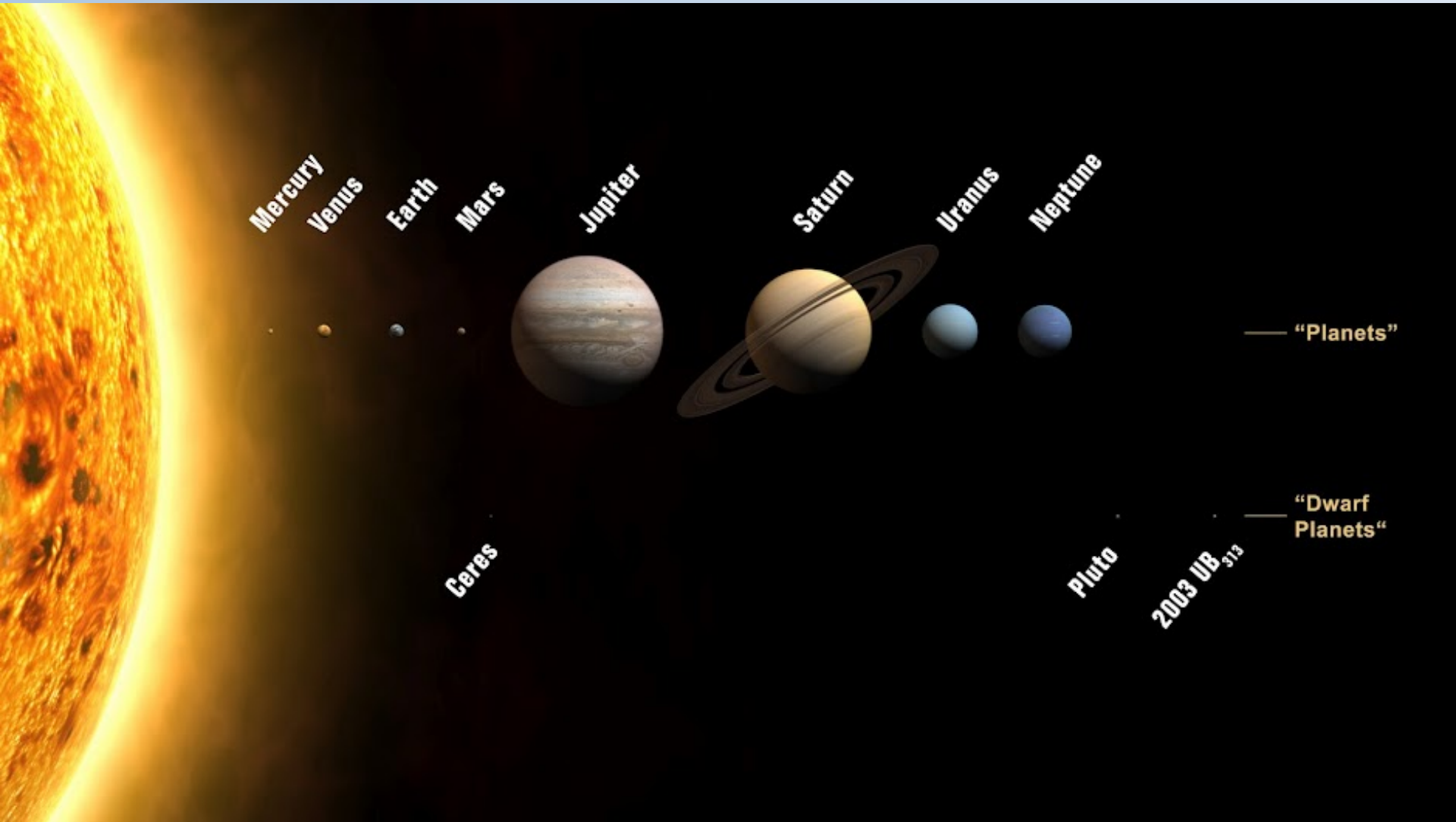
Effective Temperature :

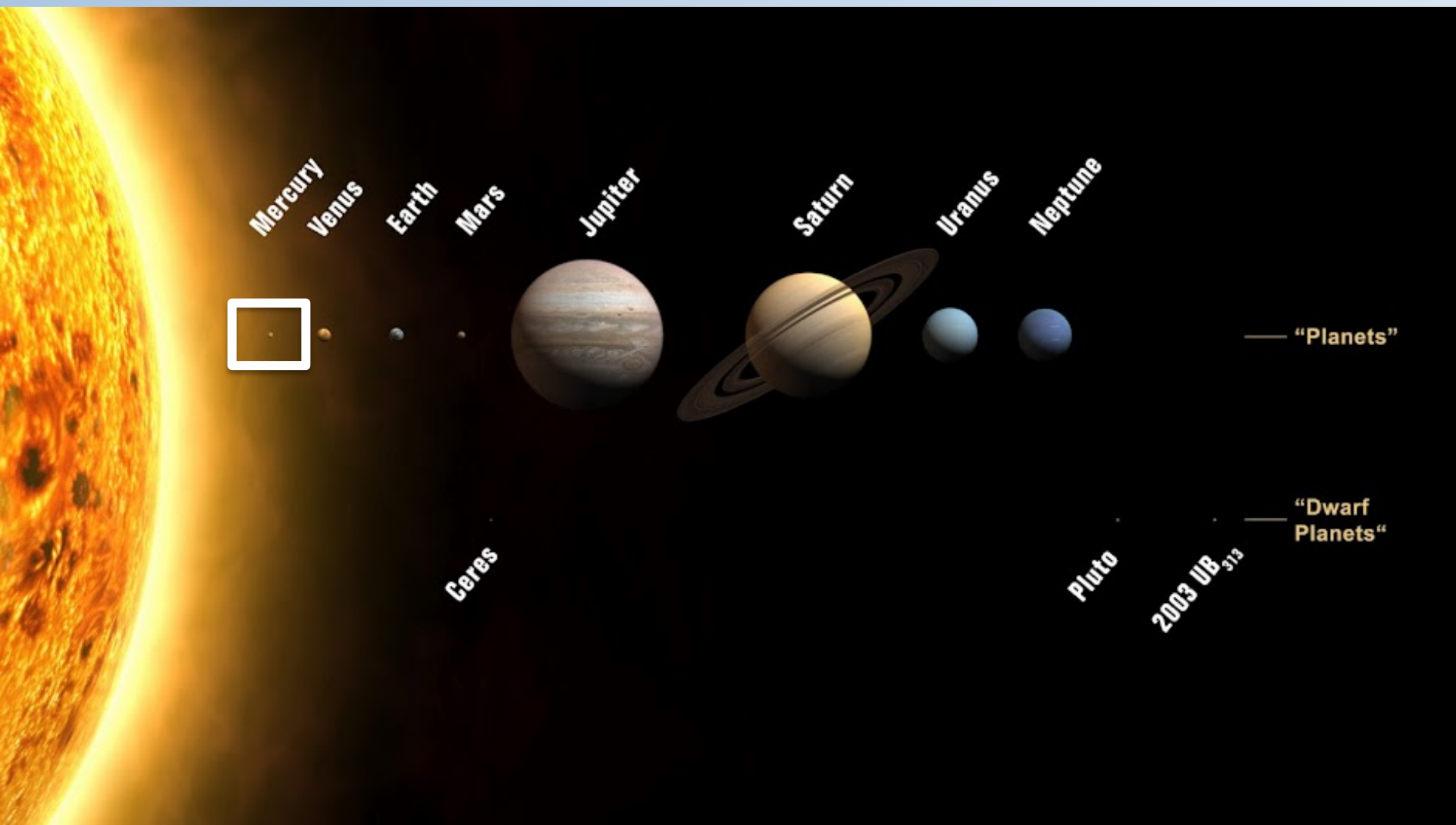
An estimate of the surface temperature of a planet, based only on its distance from the sun

Order the planets from highest to lowest
by effective temperature

hottest

coldest





Mercury

Venus

Earth

Mars

Jupiter

Saturn

Uranus

Neptune

— "Planets"

— "Dwarf Planets"

Ceres

Pluto

2003 UB₃₁₃

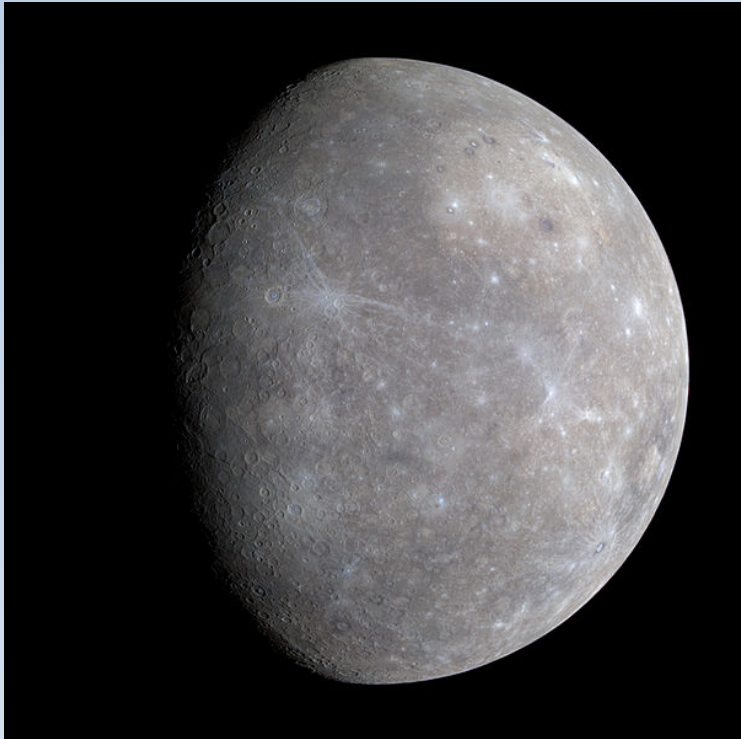
Effective temperature and actual temperature of terrestrial planets

Planet	Eff. Temp.	Actual Surf Temps
Mercury	350° F	-333-746° F
Venus	134° F	800-900° F
Earth	44° F	26-80° F
Mars	-45° F	-190- -10° F

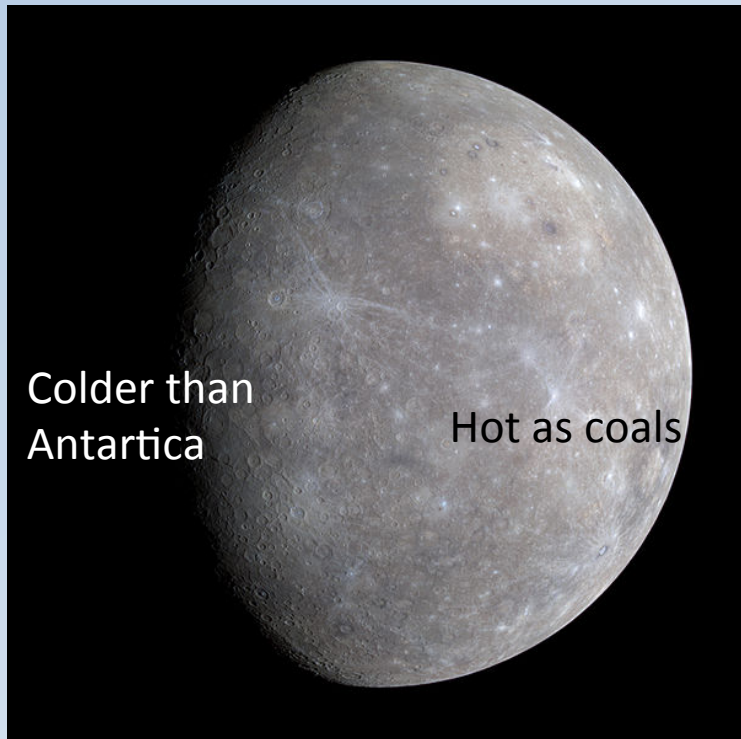
Night on Mercury - animation

Although Mercury is close to the sun, the long night means some parts are very hot, and other parts are cold!

Which side of the planet is the sun on in this photo?

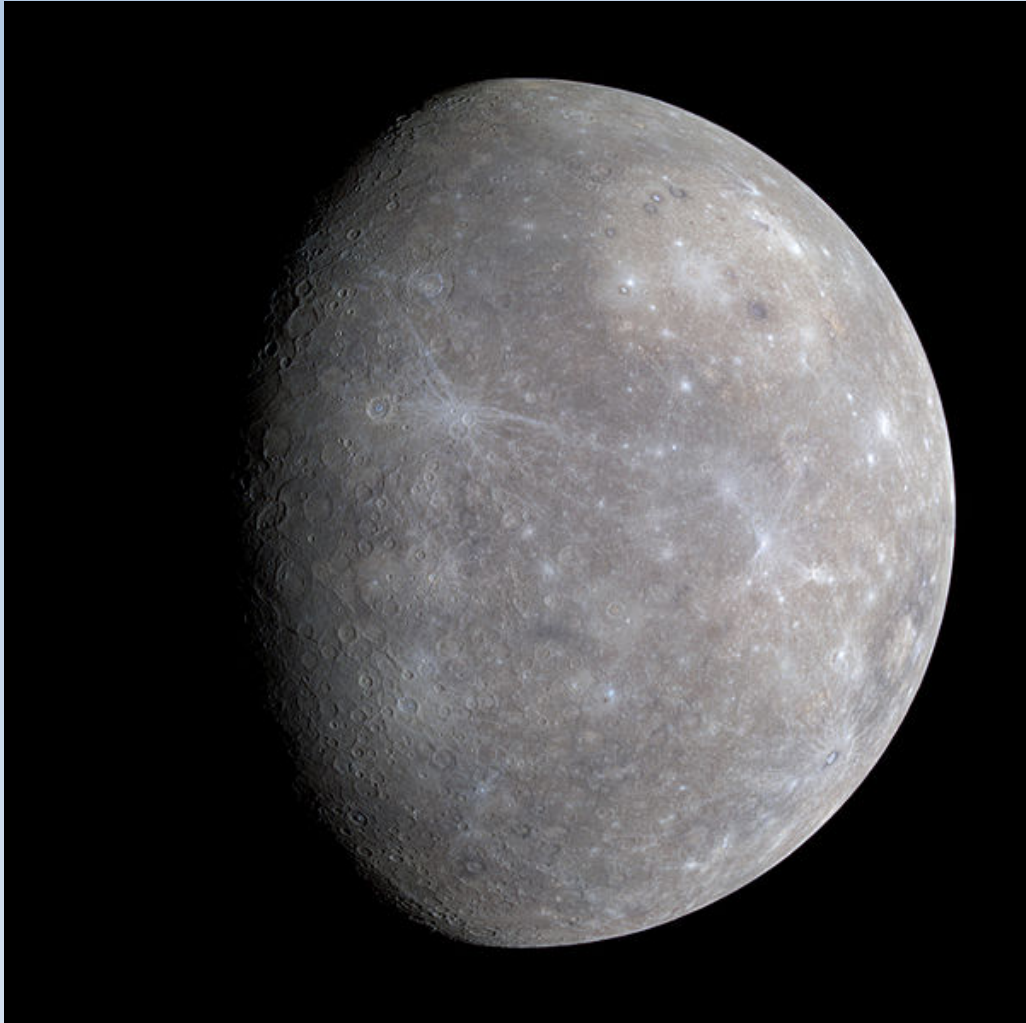


Although Mercury is close to the sun, the long night means some parts are very hot, and other parts are cold!



Not to scale!

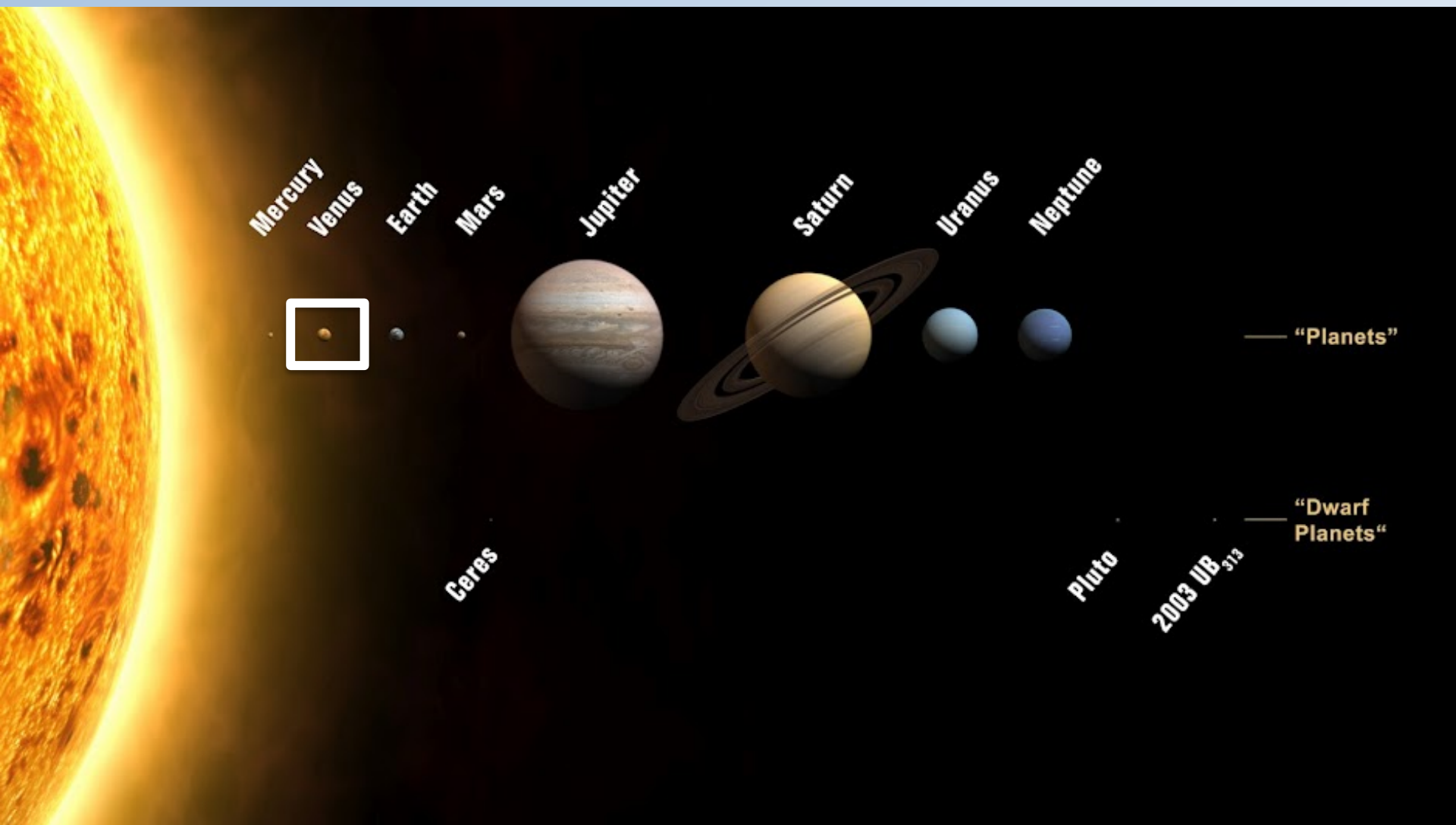
Mercury



Closest planet to sun

Cratered surface

Almost no atmosphere



Mercury
Venus

Earth

Mars

Jupiter

Saturn

Uranus

Neptune

— “Planets”

— “Dwarf Planets”

Ceres

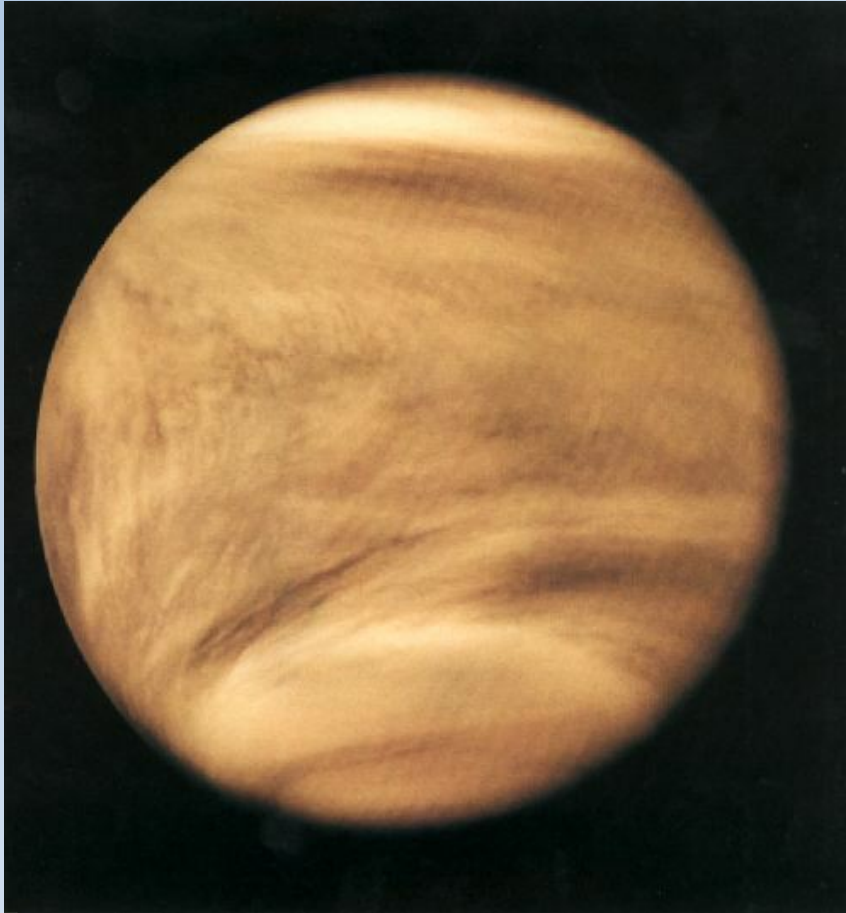
Pluto

2003 UB₃₁₃

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Venus – Earth's evil twin sister

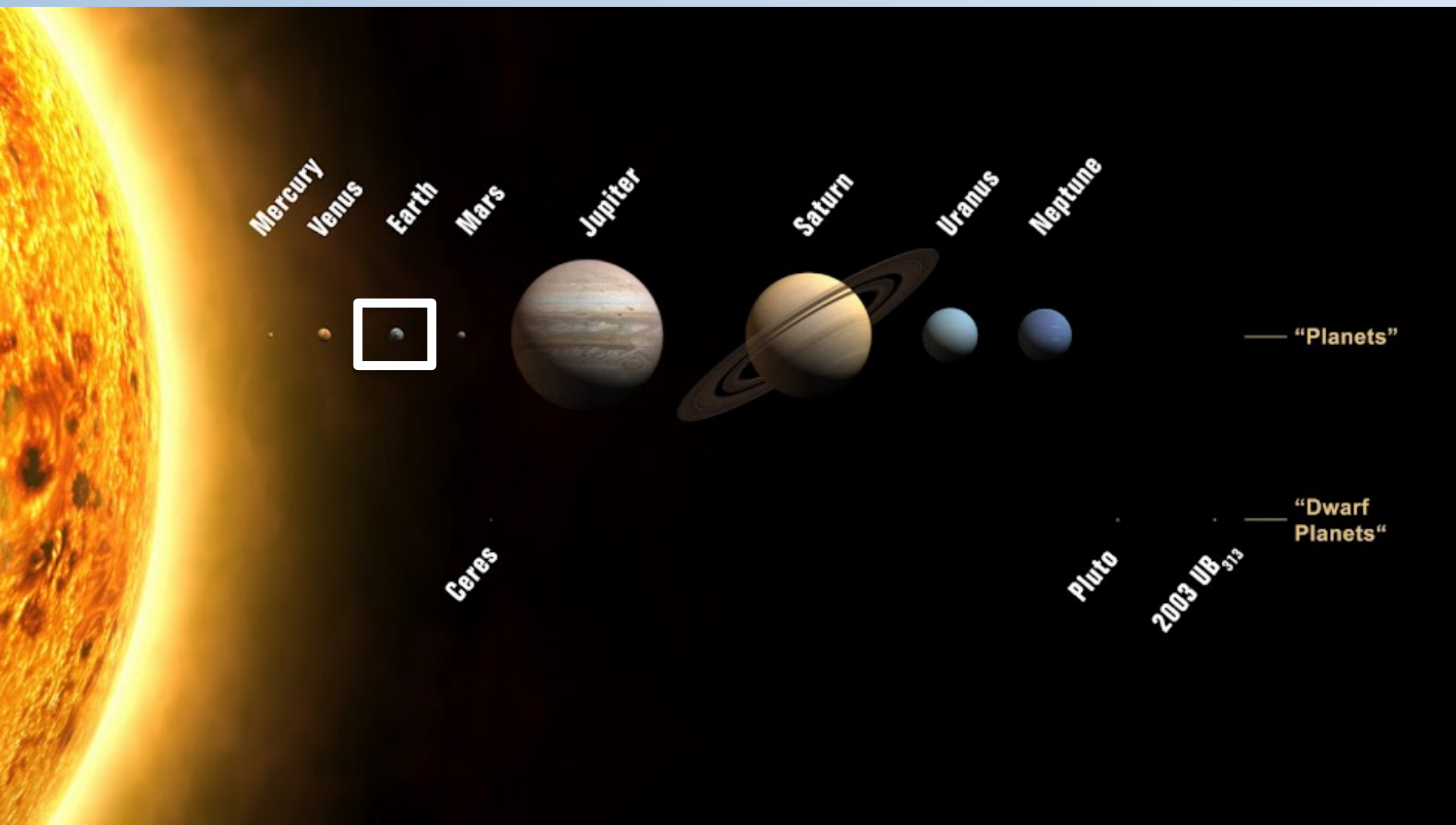


Second closest planet to sun

Earth's sister planet – almost same mass and size

Thick atmosphere causes extreme greenhouse effect

Venus from Pioneer orbiter



Mercury

Venus

Earth

Mars

Jupiter

Saturn

Uranus

Neptune

— "Planets"

Ceres

Pluto

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— "Dwarf Planets"

Earth



Third planet from sun

Earth



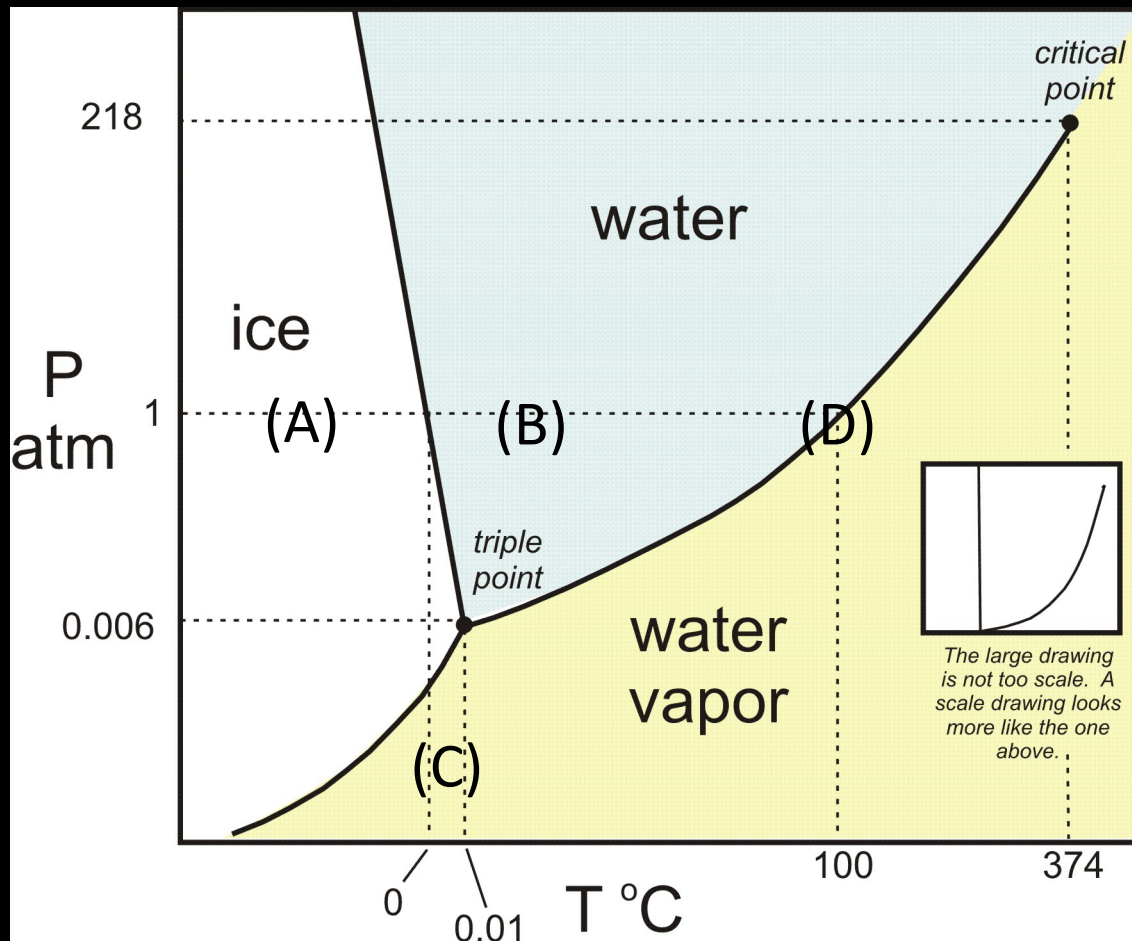
Third planet from sun

Has water!!!

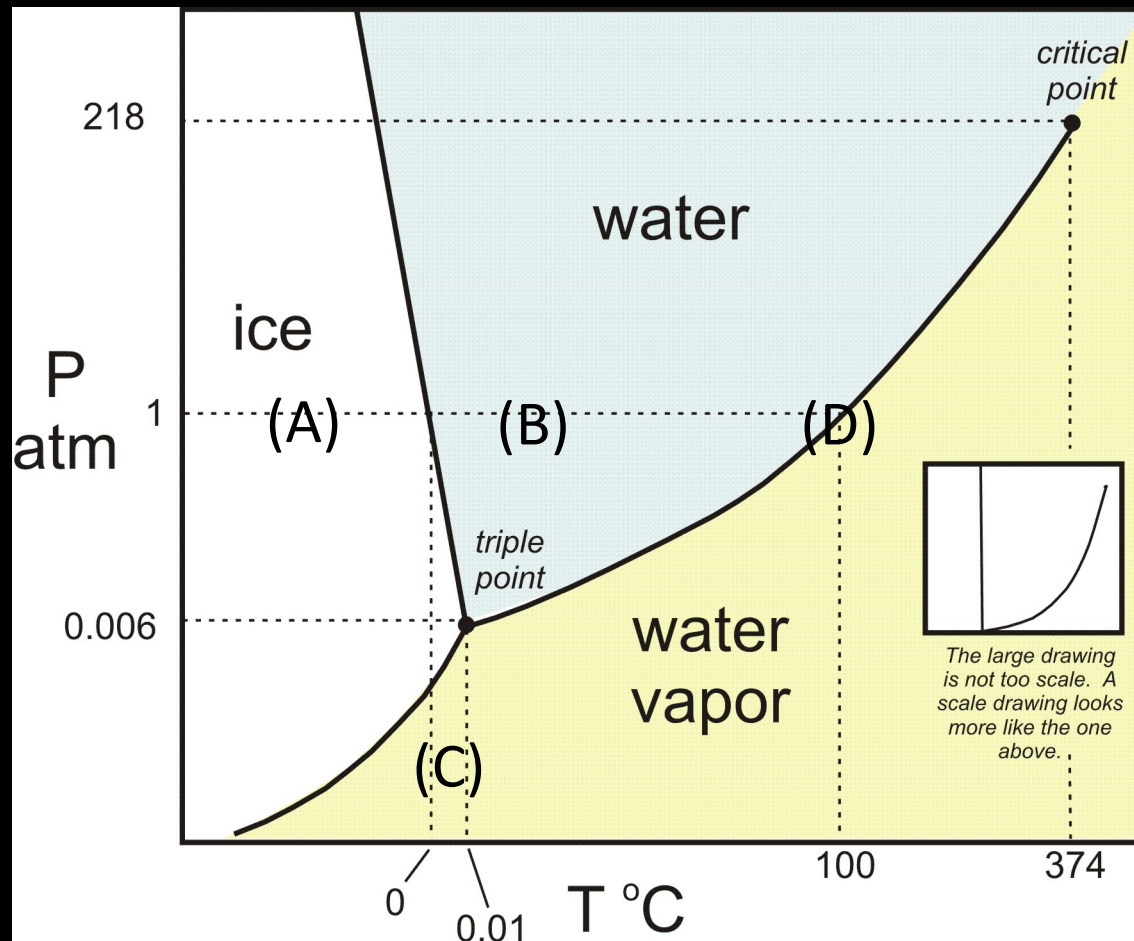
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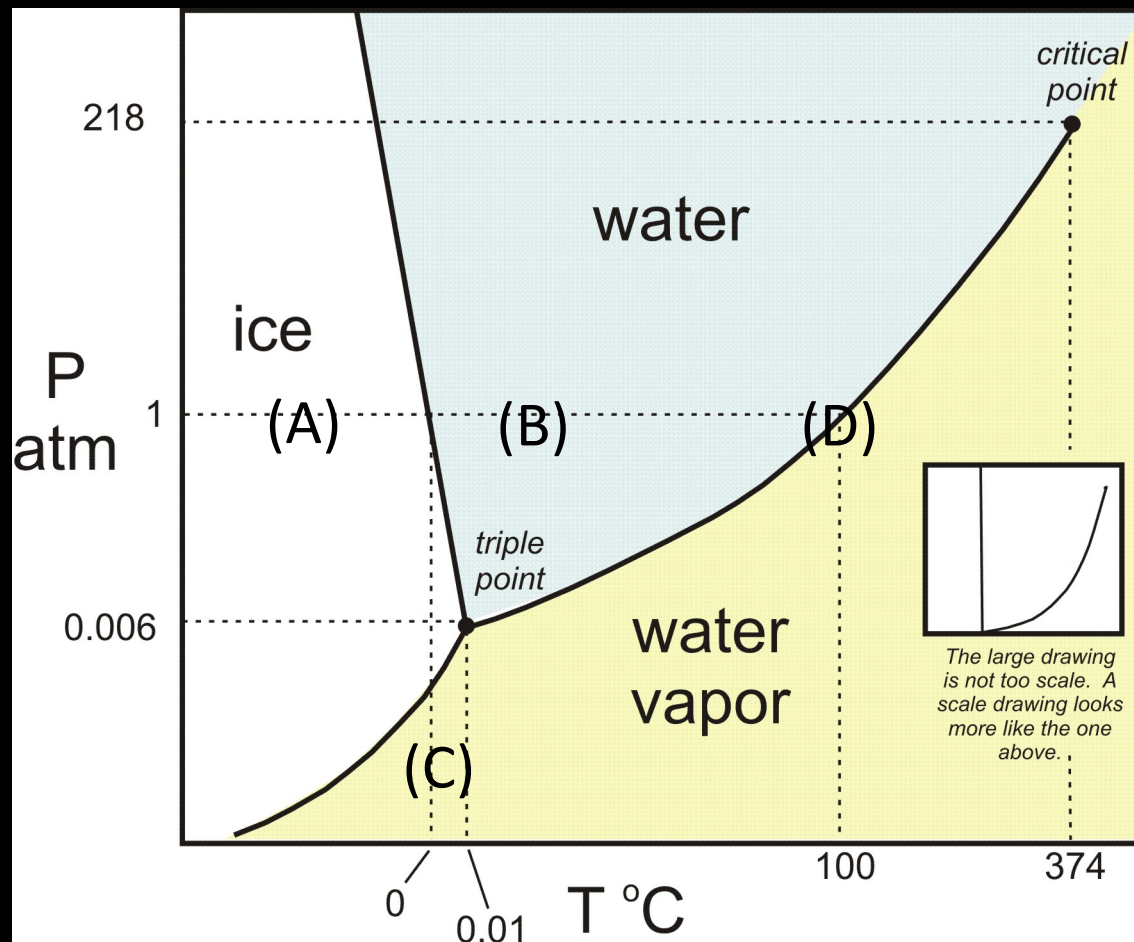
Water phase diagram



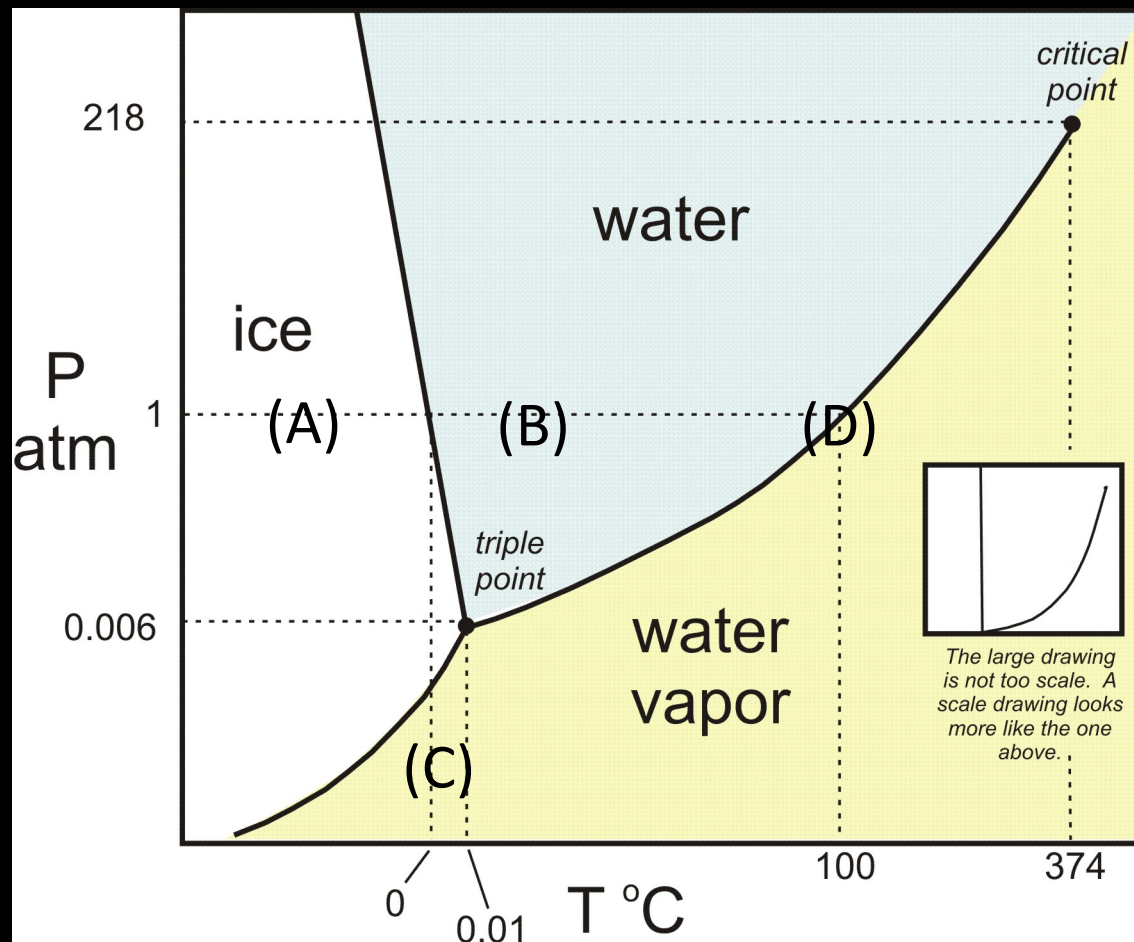
The surface of the Earth has 1 atmosphere of pressure and its average surface temperature is 14 degrees Celsius. Which point on the phase diagram of water may represent Earth's average?



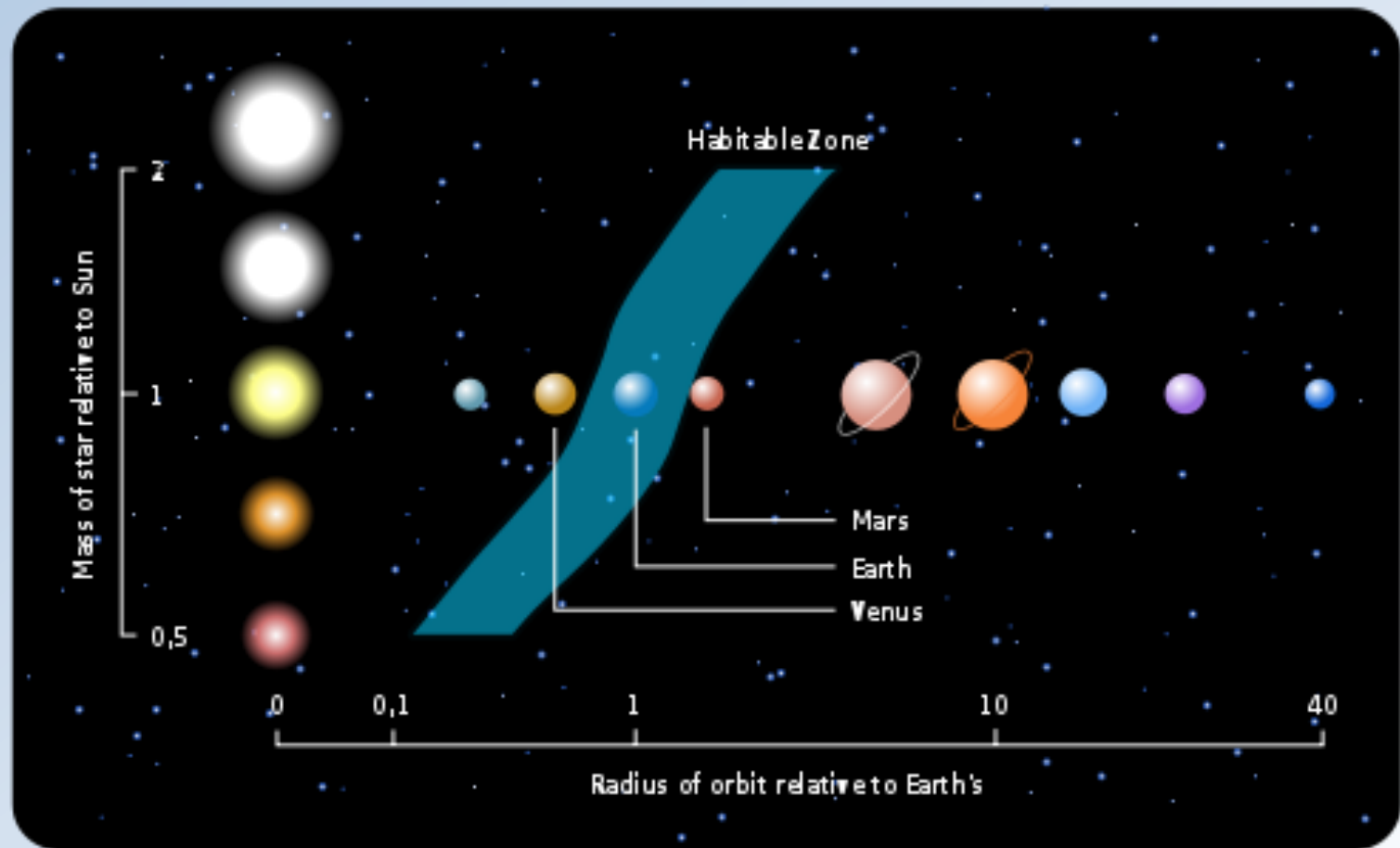
Which point on the phase diagram of water could represent the surface of a planet with the same atmosphere as Earth, but much farther from the sun?

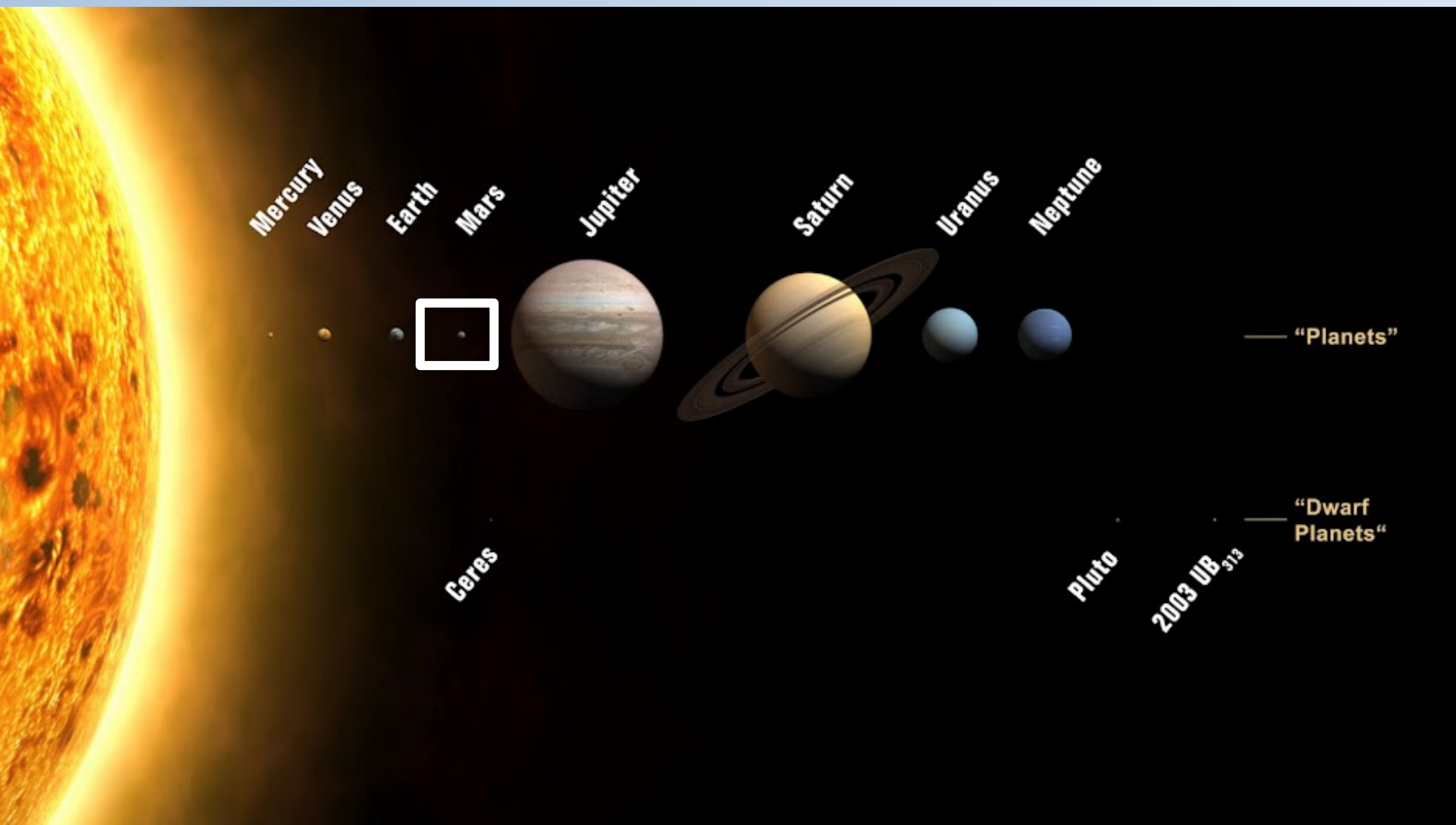


Which point on the phase diagram of water could represent the surface of a planet with the same atmosphere as Earth, but much closer to the sun?



Earth is the “Goldilocks” planets! Not too cold, not too hot, for **LIQUID WATER**. *The Earth is in the “Habitable zone”.*





Mercury

Venus

Earth

Mars

Jupiter

Saturn

Uranus

Neptune



— “Planets”

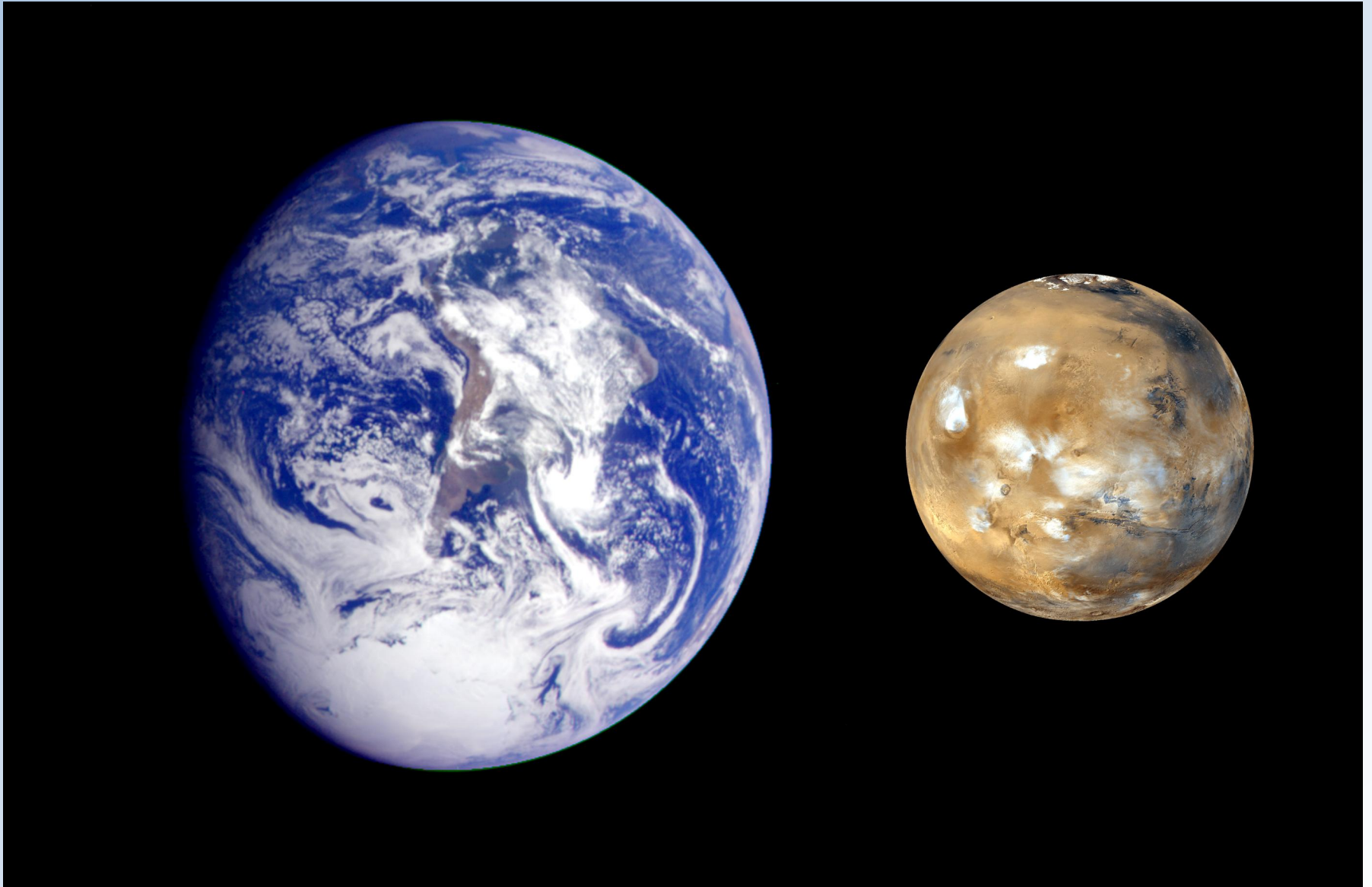
Ceres

Pluto

2003 UB₃₁₃

— “Dwarf Planets”

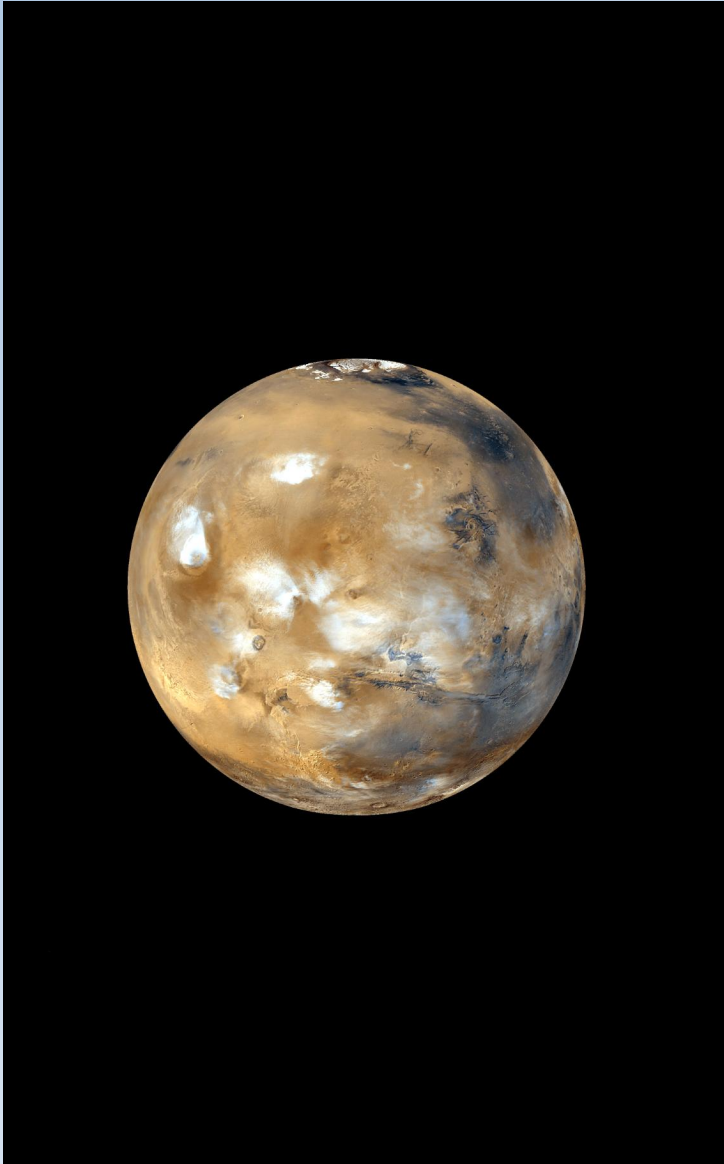
Mars – Earth's little brother



Effective temperature and actual temperature of terrestrial planets

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Mars – Earth's little brother

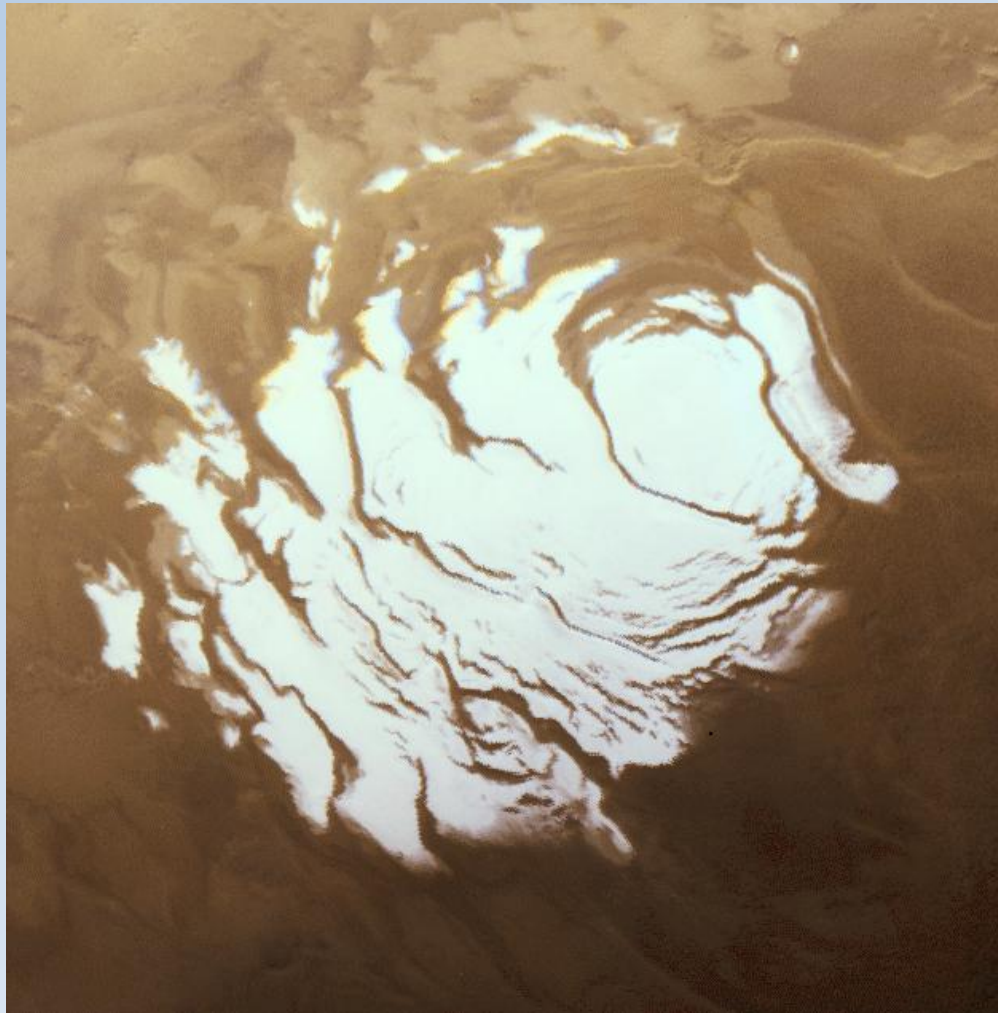


Two moons

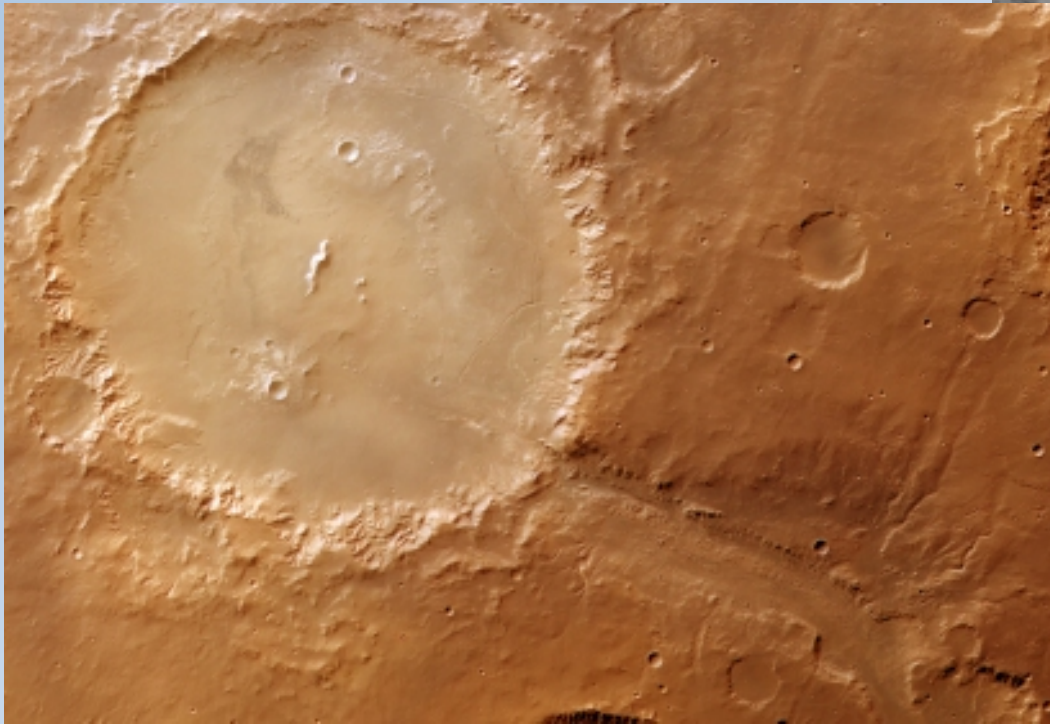
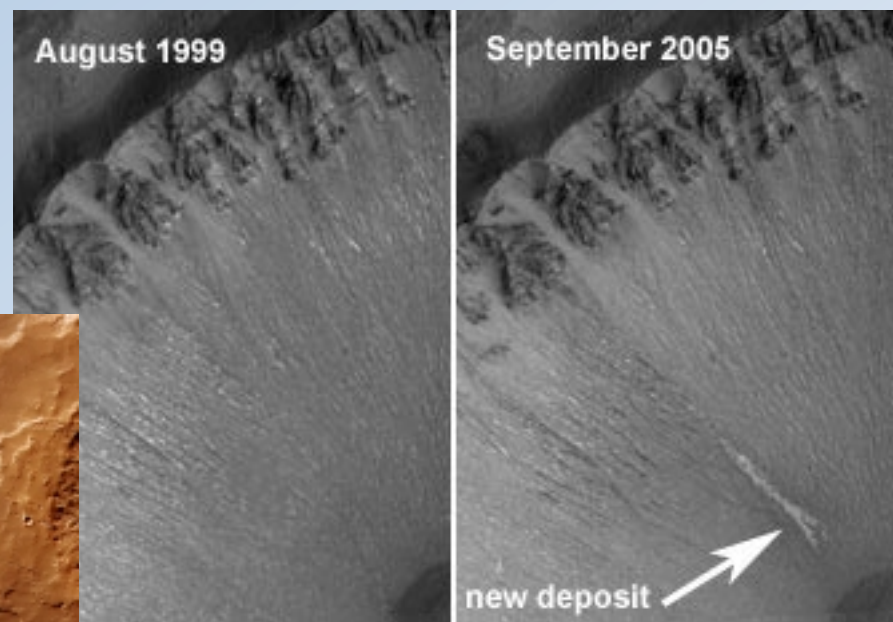
Smaller than Earth

Most Earth-like climate, but thin atmosphere

Is there water on Mars? Mars's south pole



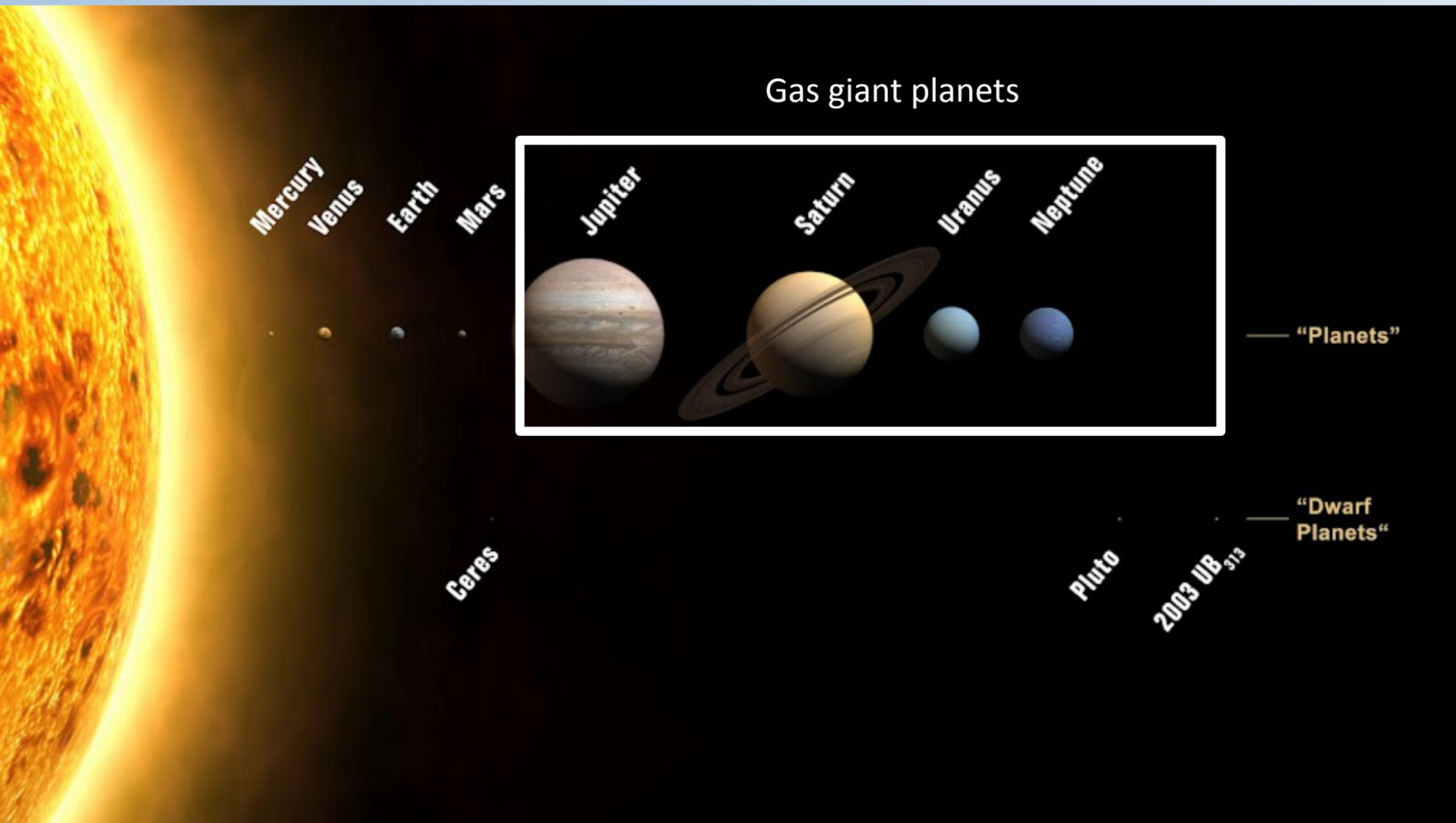
Evidence for current and past **liquid** water on Mars



Could Mars have supported life?
Could Mars **still** support life?

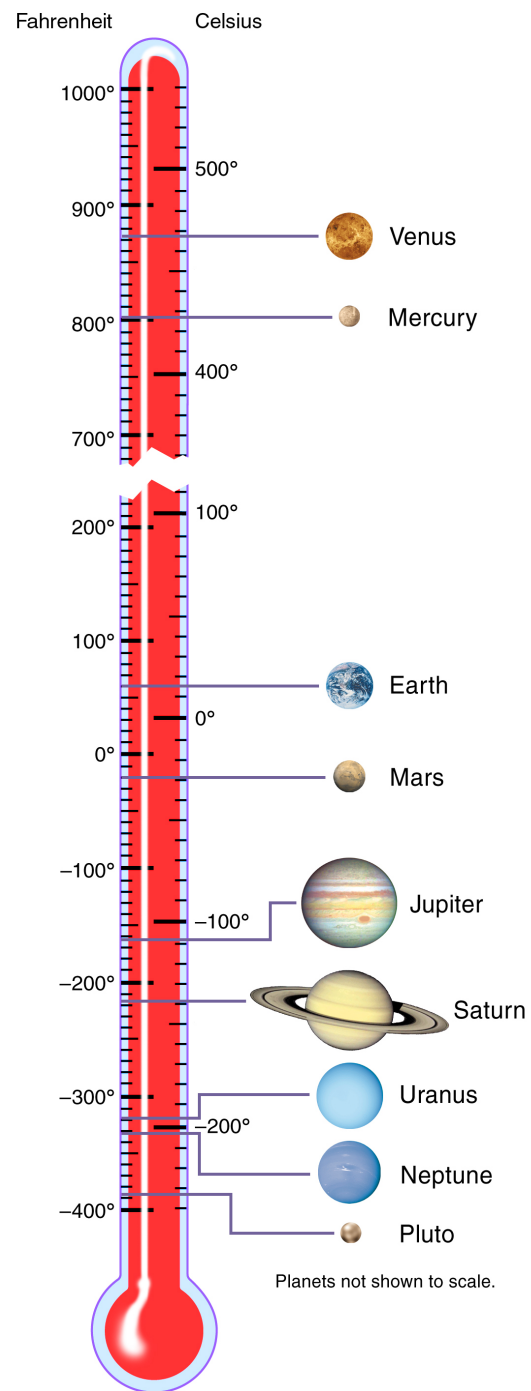


What are the characteristics of the gas giant planets?

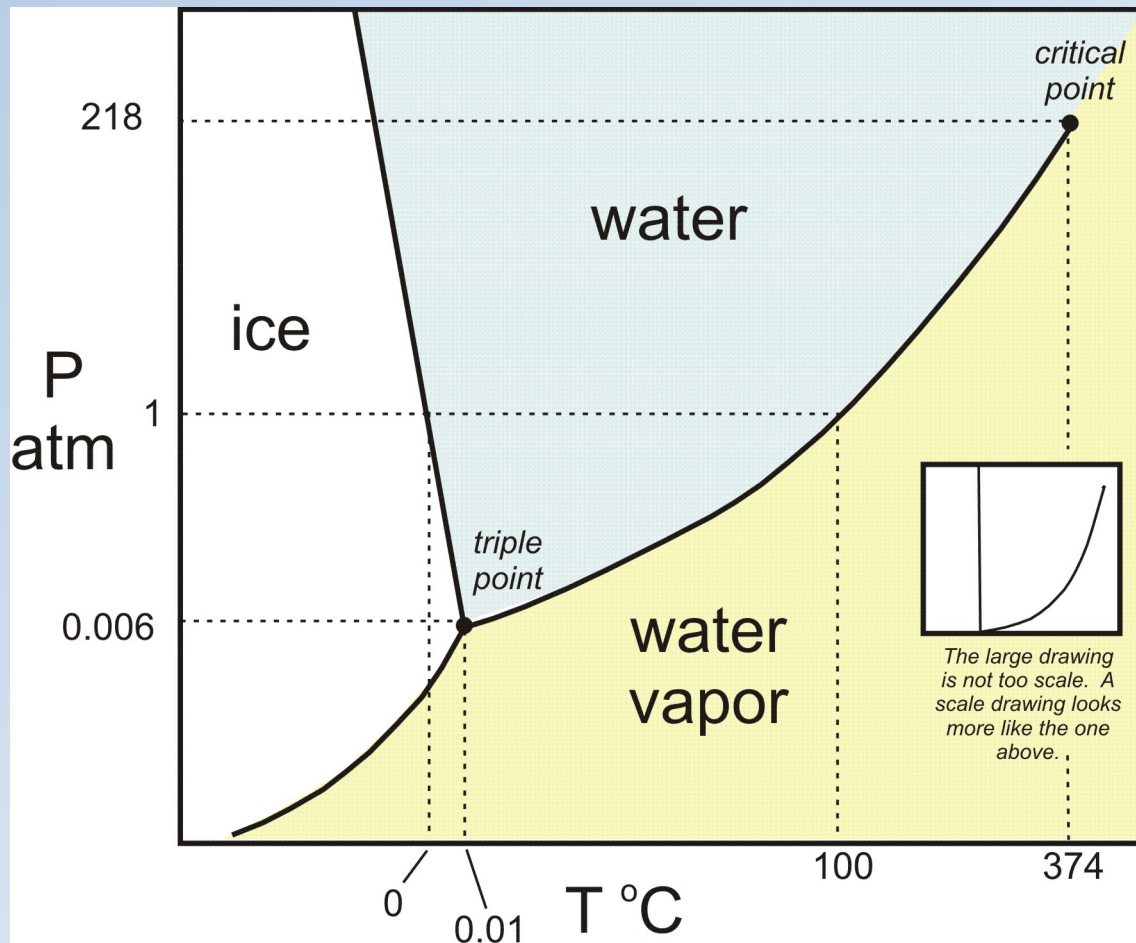


Surface temperatures of gas giant planets

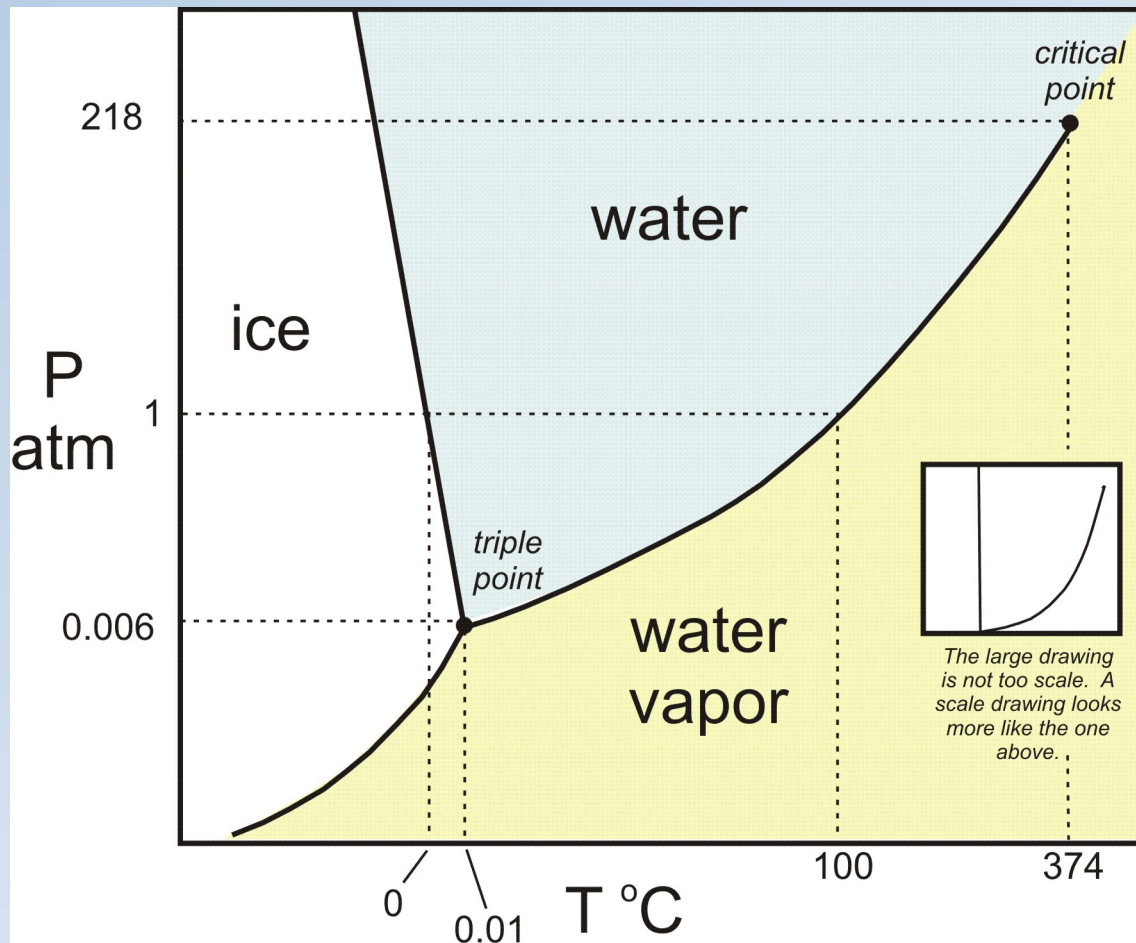
Planet	“Surface” (cloud top) Temperature
Jupiter	-243° F
Saturn	-301° F
Uranus	-353° F
Neptune	-373° F



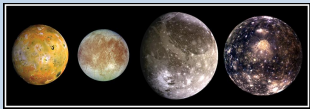
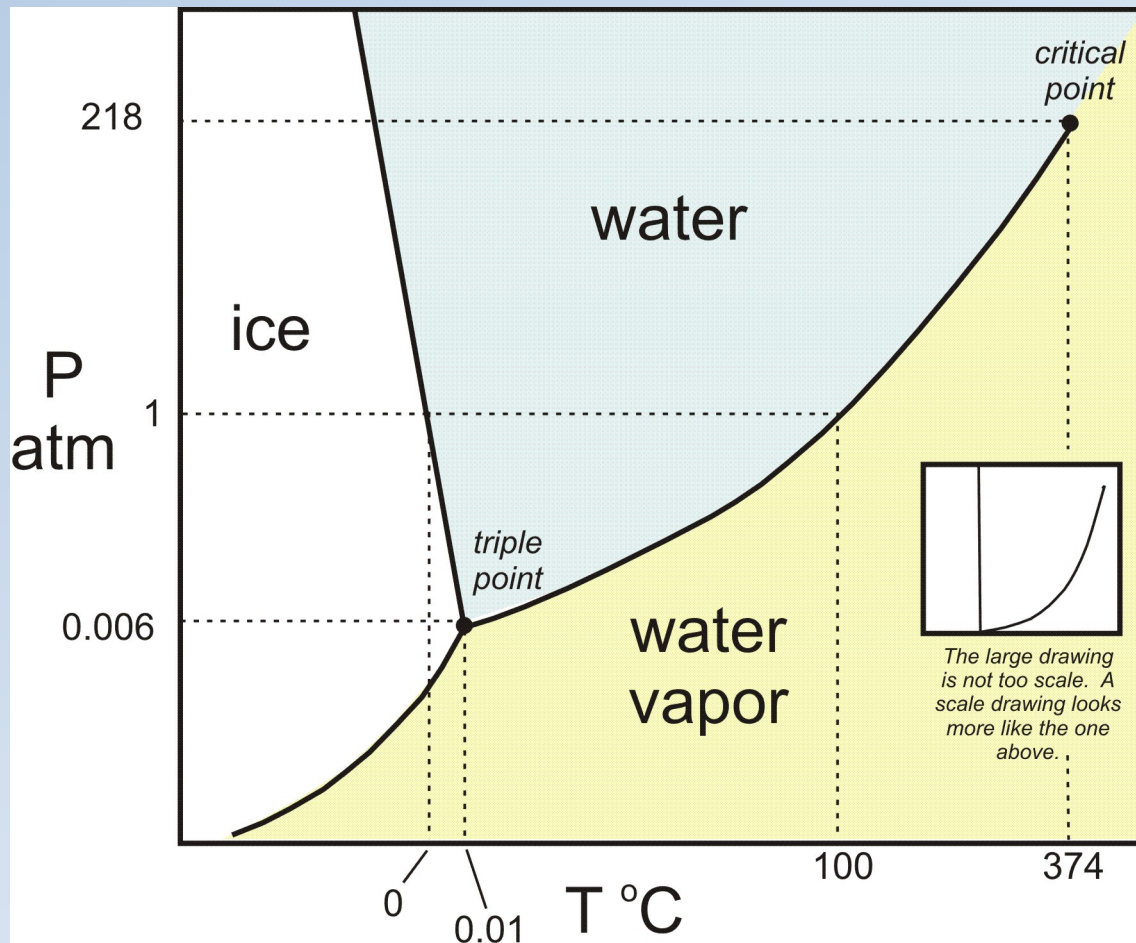
Where are the surfaces of gas giant planets located on this phase diagram?



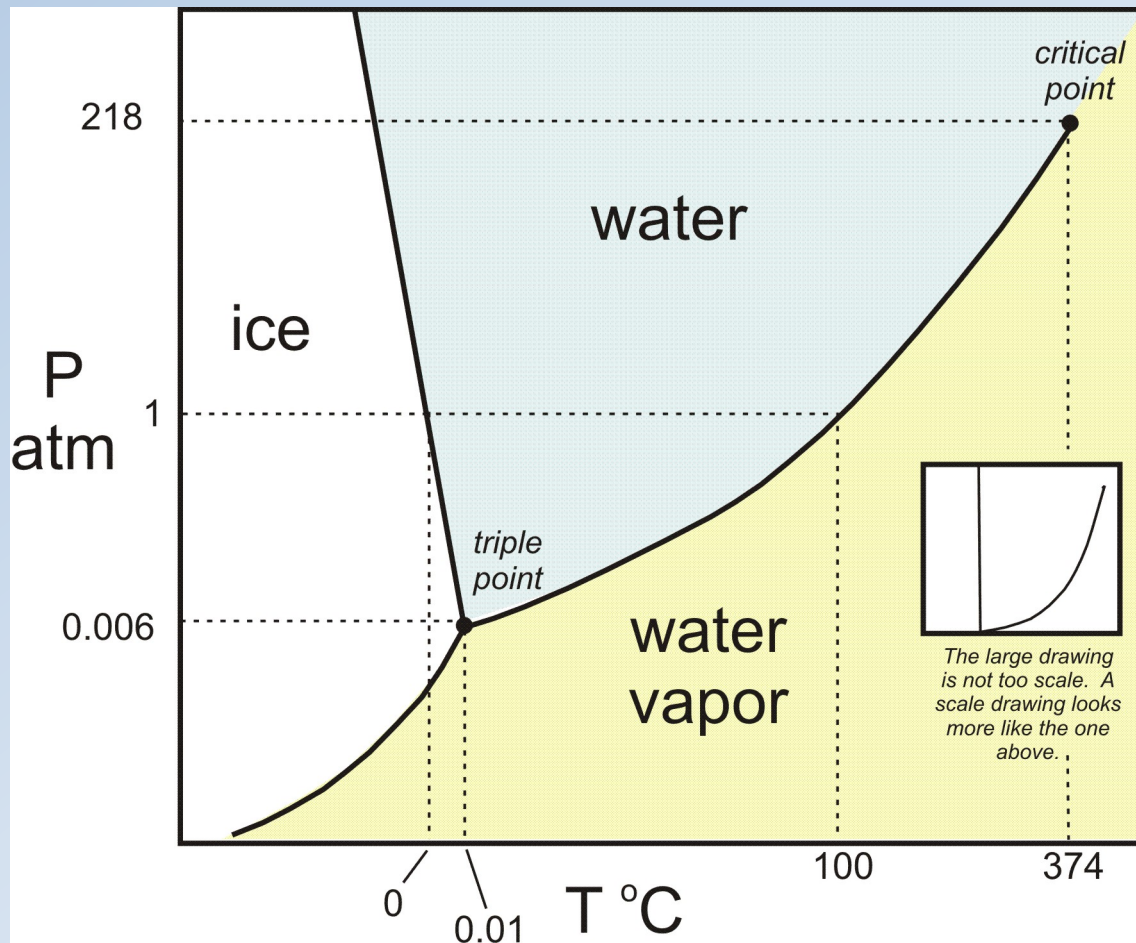
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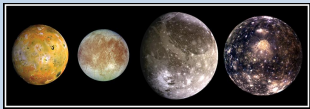
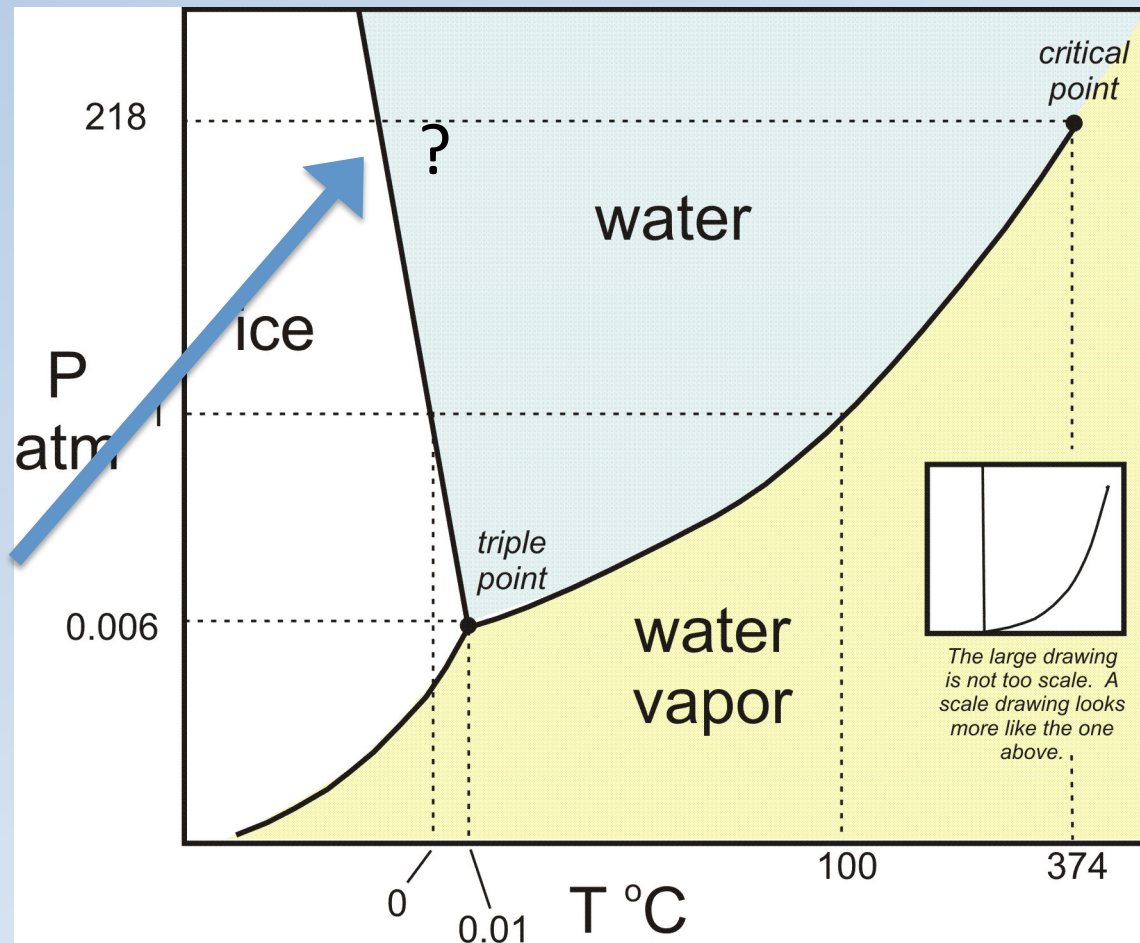
Where are the surfaces of the *moons* of the gas giant planets located on this plot?



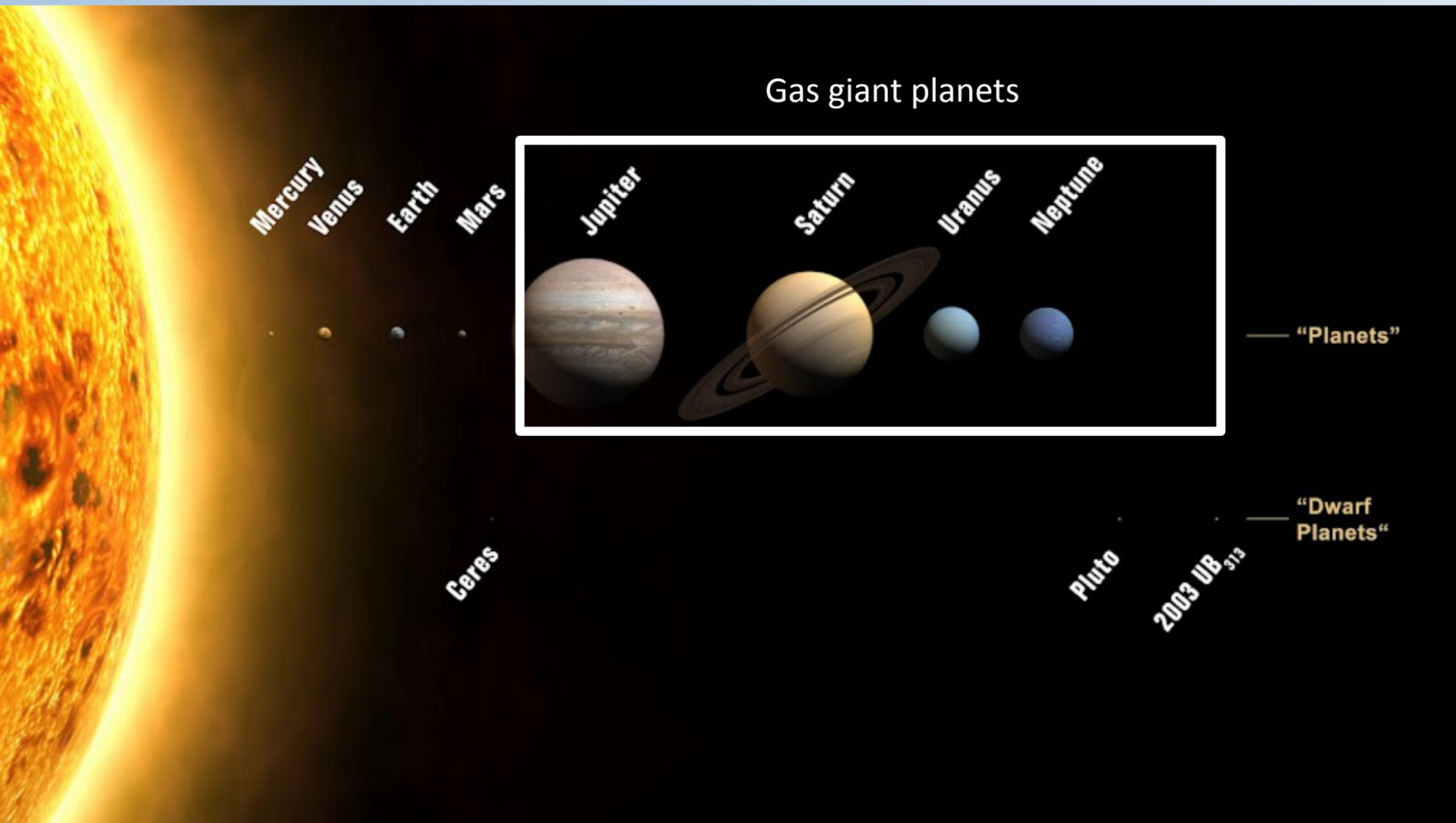
What happens as you move to the interior of the planets or moons?



What happens as you move to the interior of the planets or moons?



What are the characteristics of the gas giant planets?



Jupiter



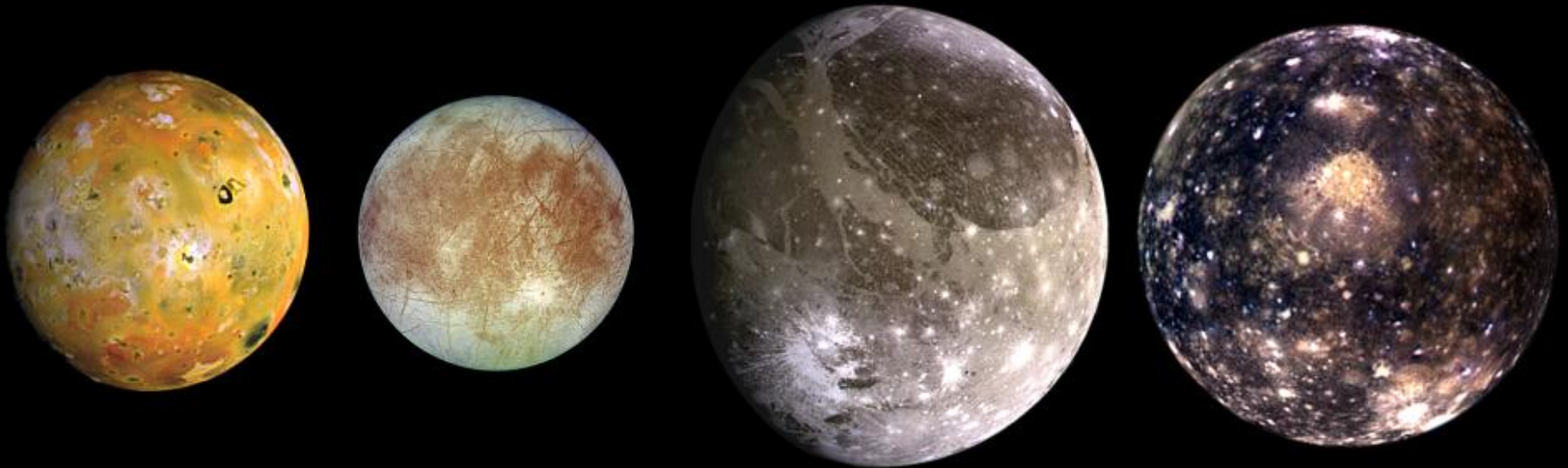
The largest planet in the solar system.

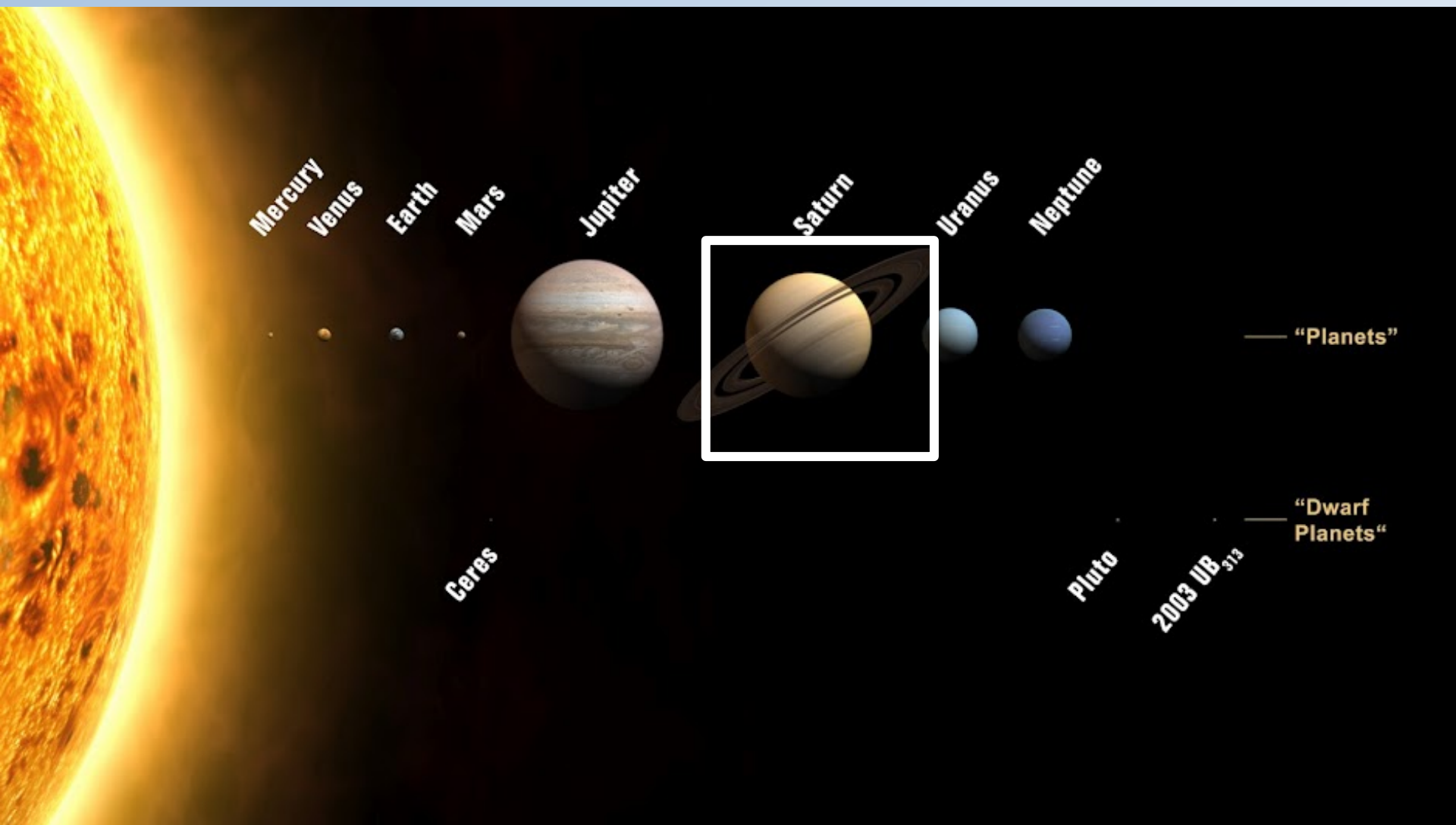
A gas giant – made mostly of Hydrogen and Helium. You can't stand on it!

The great red spot
(the size of the Earth)



Jupiter's moons





Mercury

Venus

Earth

Mars

Jupiter

Saturn

Uranus

Neptune

Ceres

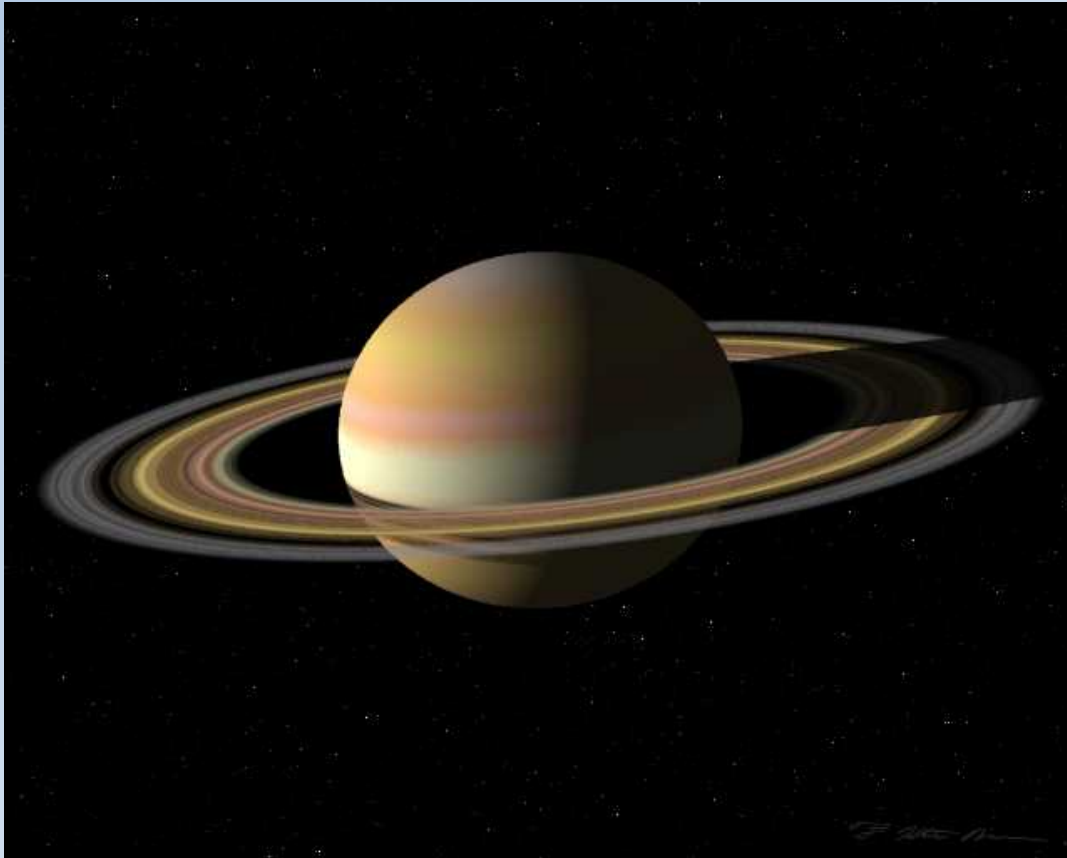
Pluto

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— "Planets"

— "Dwarf Planets"

Saturn



The second largest planet in the solar system.

A gas giant – made mostly of Hydrogen and Helium.

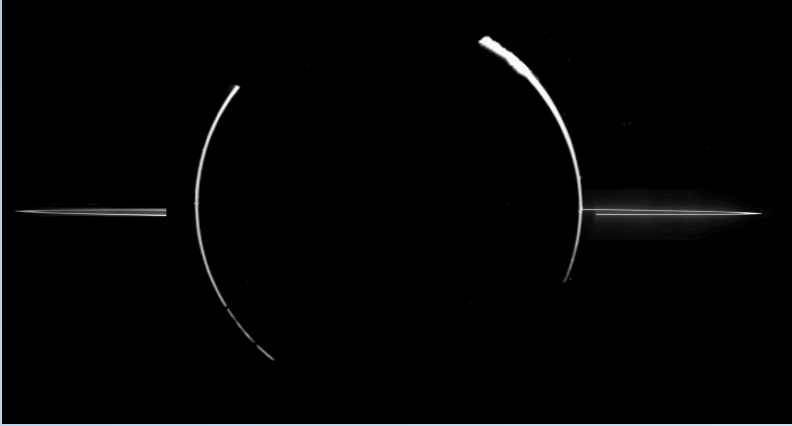
Largest ring system.

The Cassini spacecraft looks back at the Earth

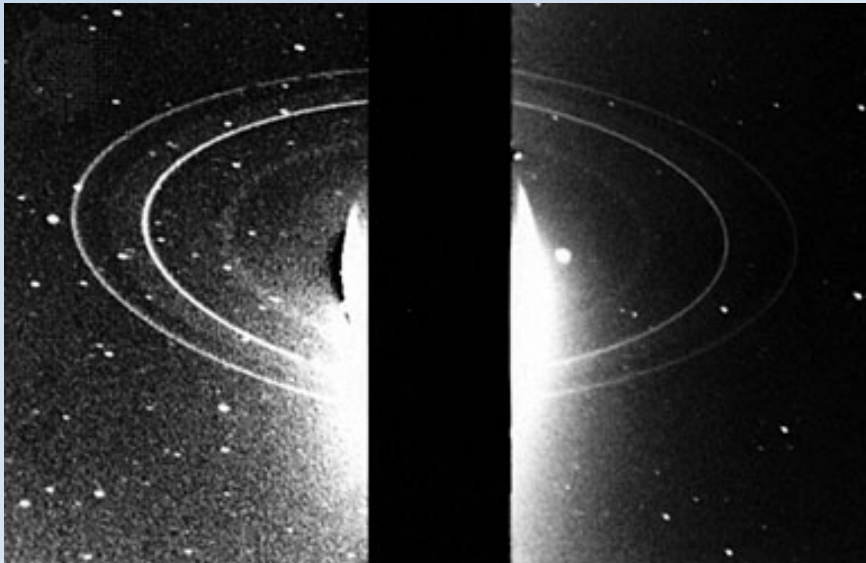
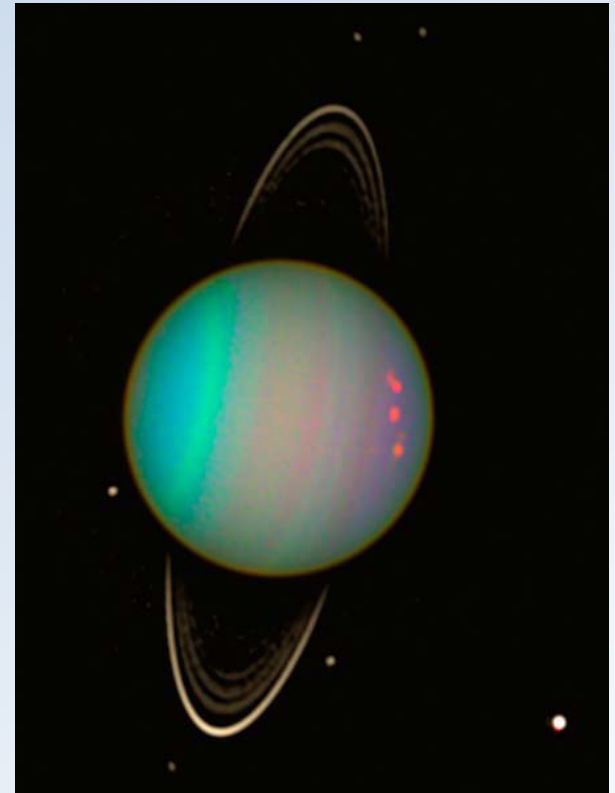


Actually, all of the giant planets have rings

Jupiter

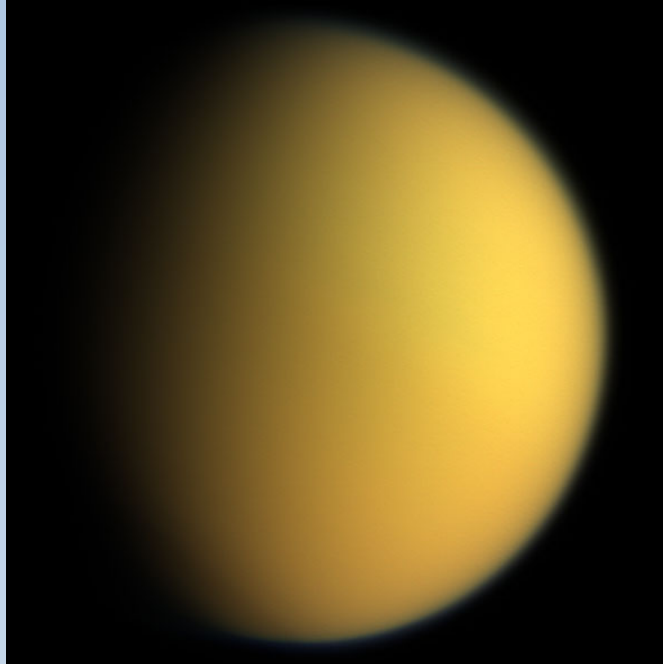


Uranus

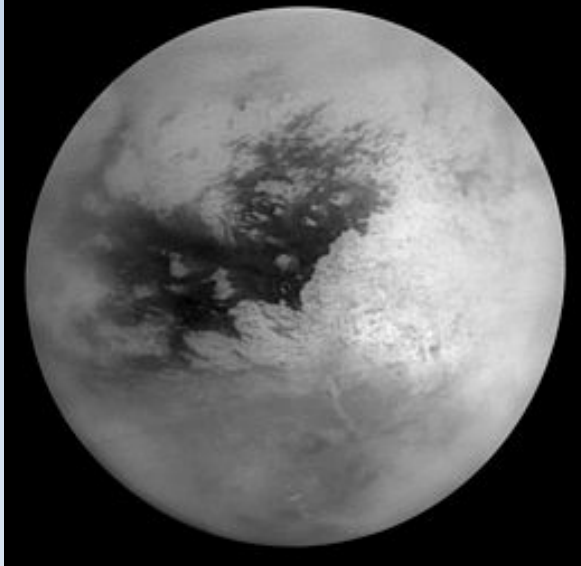


Neptune

Saturn's largest moon Titan

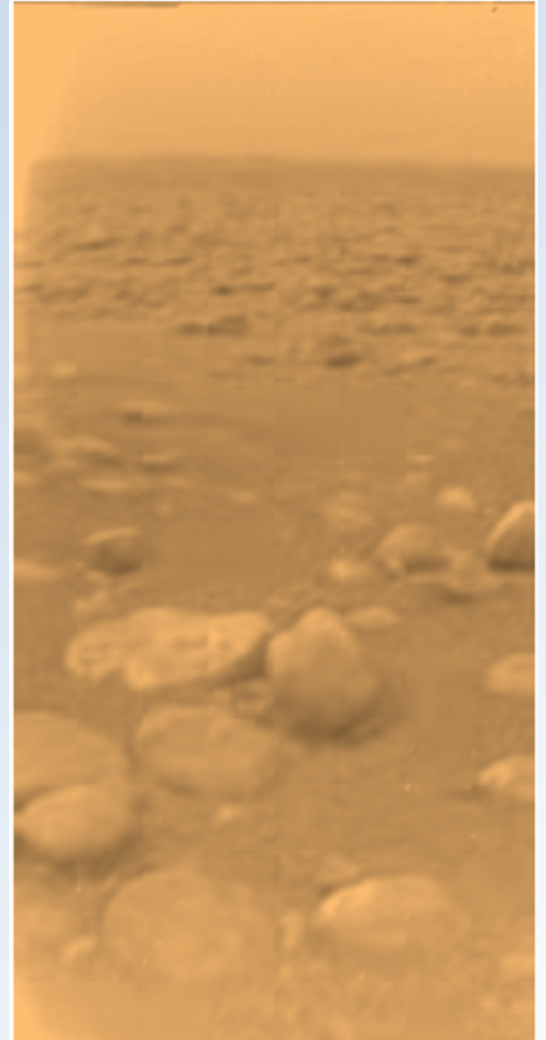


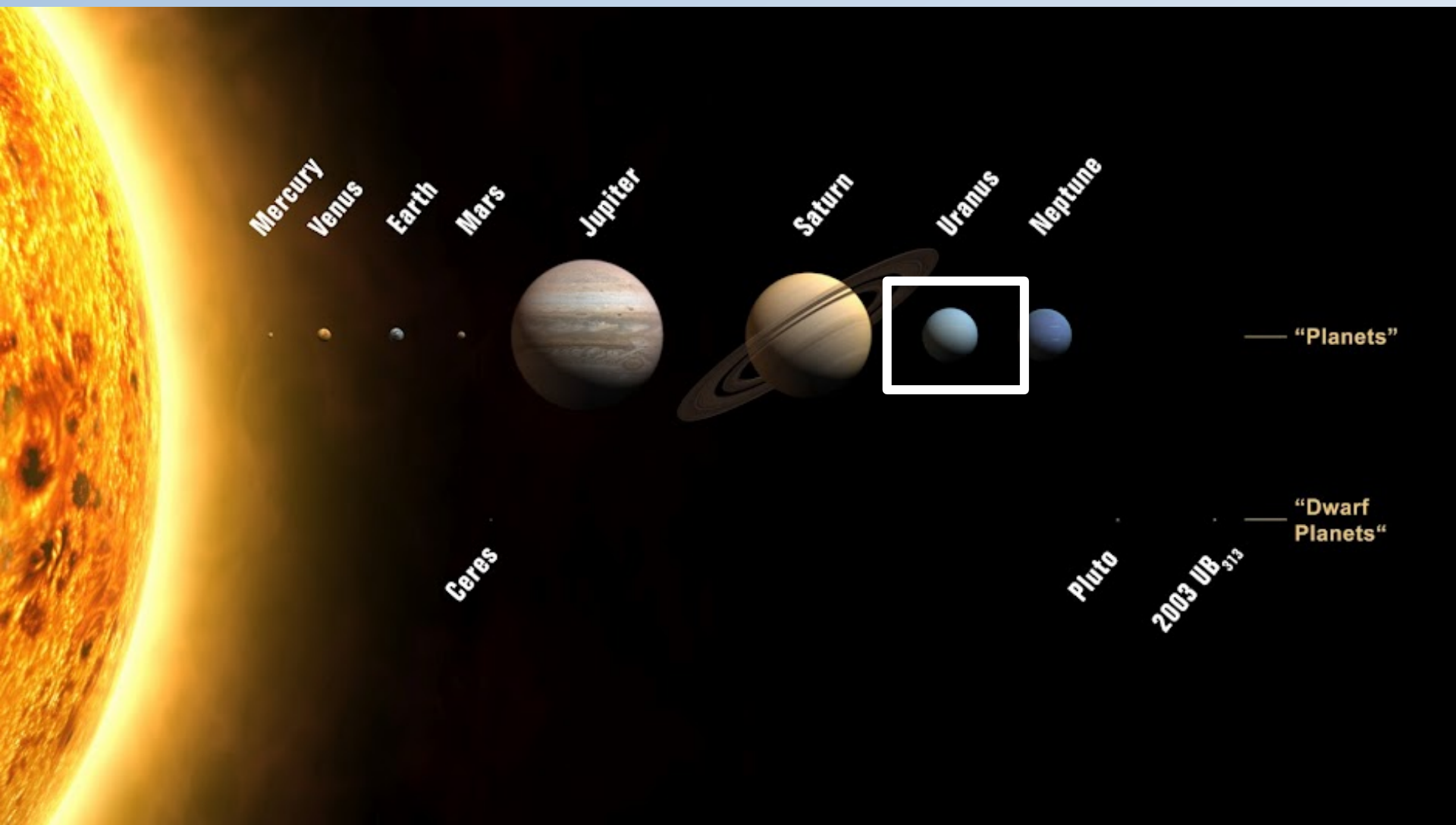
atmosphere



surface

View of surface from Huygens probe





Mercury

Venus

Earth

Mars

Jupiter

Saturn

Uranus

Neptune

Ceres

Pluto

2003 UB₃₁₃

— “Planets”

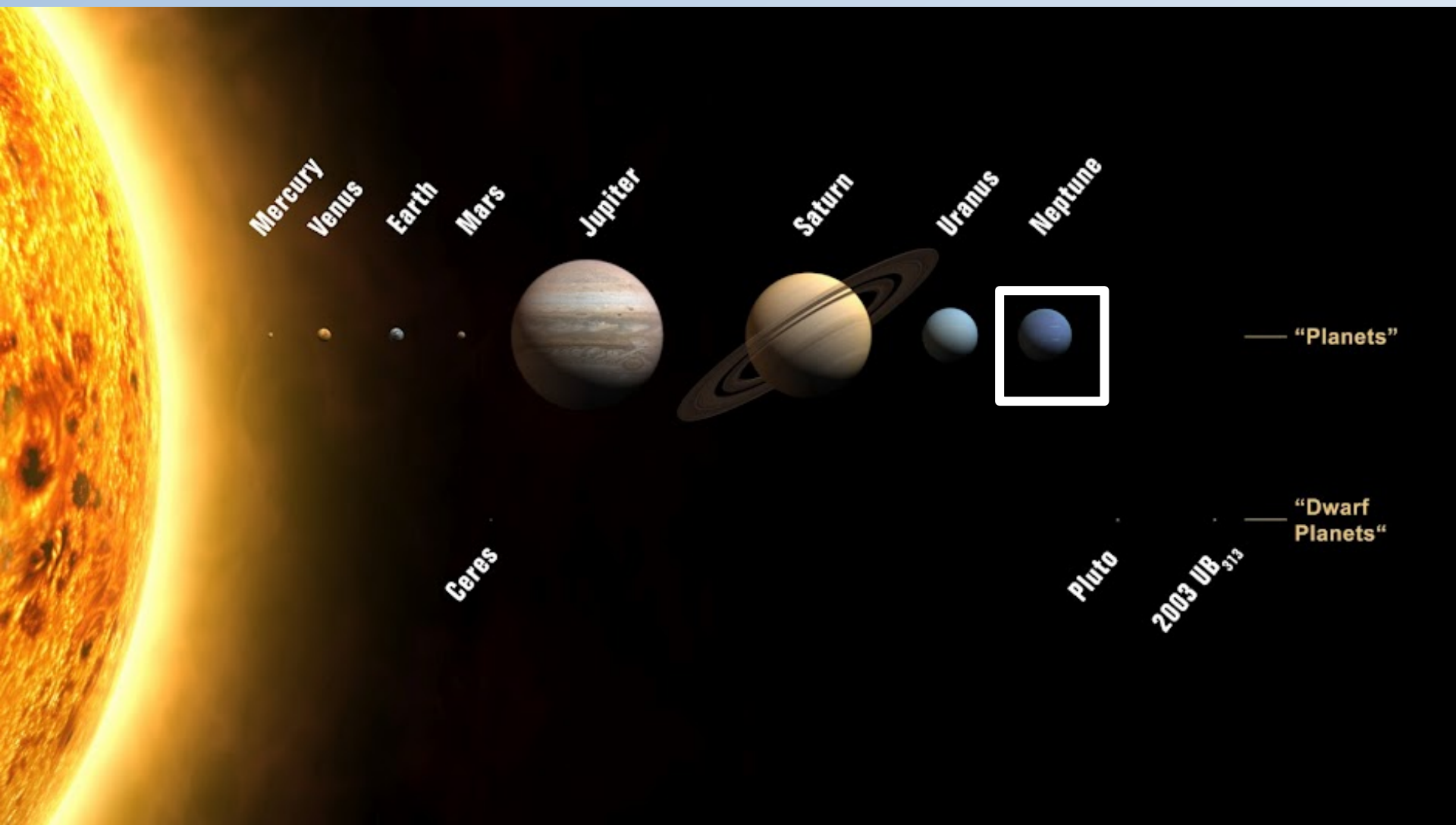
— “Dwarf Planets”

Uranus



Gas giant

Flipped on its side



Mercury

Venus

Earth

Mars

Jupiter

Saturn

Uranus

Neptune

Ceres

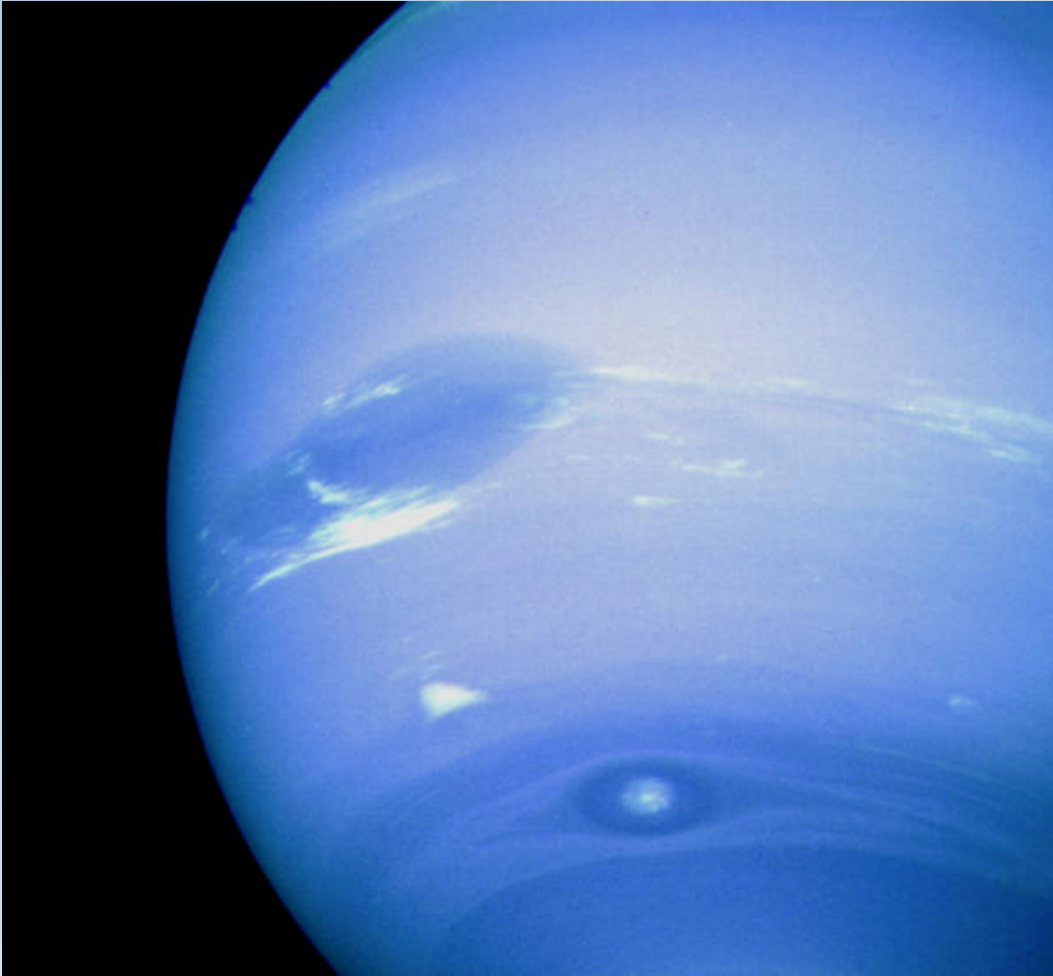
Pluto

2003 UB₃₁₃

— "Planets"

— "Dwarf Planets"

Neptune

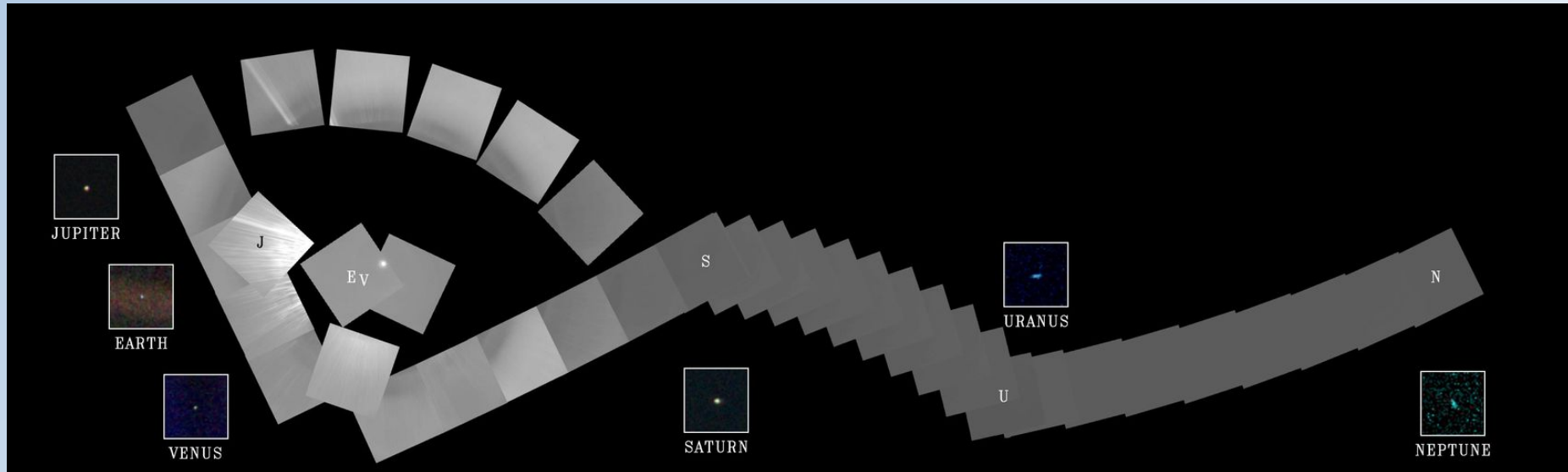


Gas giant

Farthest planet
from sun

Also has giant
storms

Voyager 2 looks back at the solar system



Given the scale model we did on Monday (the play-doh lab), which of the following would best represent the distance between the Earth and the sun?

- (A) The length of this classroom
- (B) The length of a dinner table
- (C) The length of a football field
- (D) The distance from Sells to Tucson