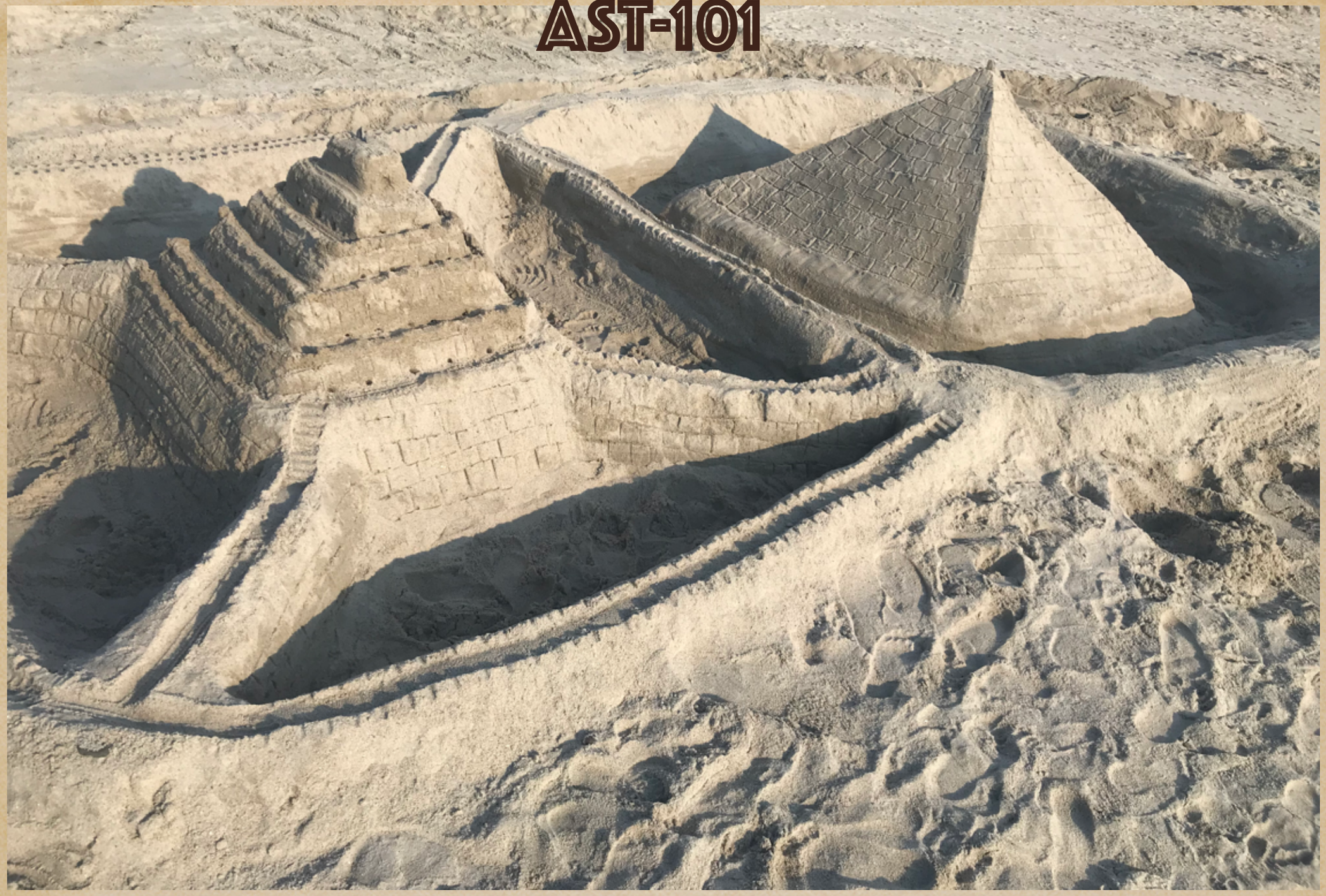
AST-101



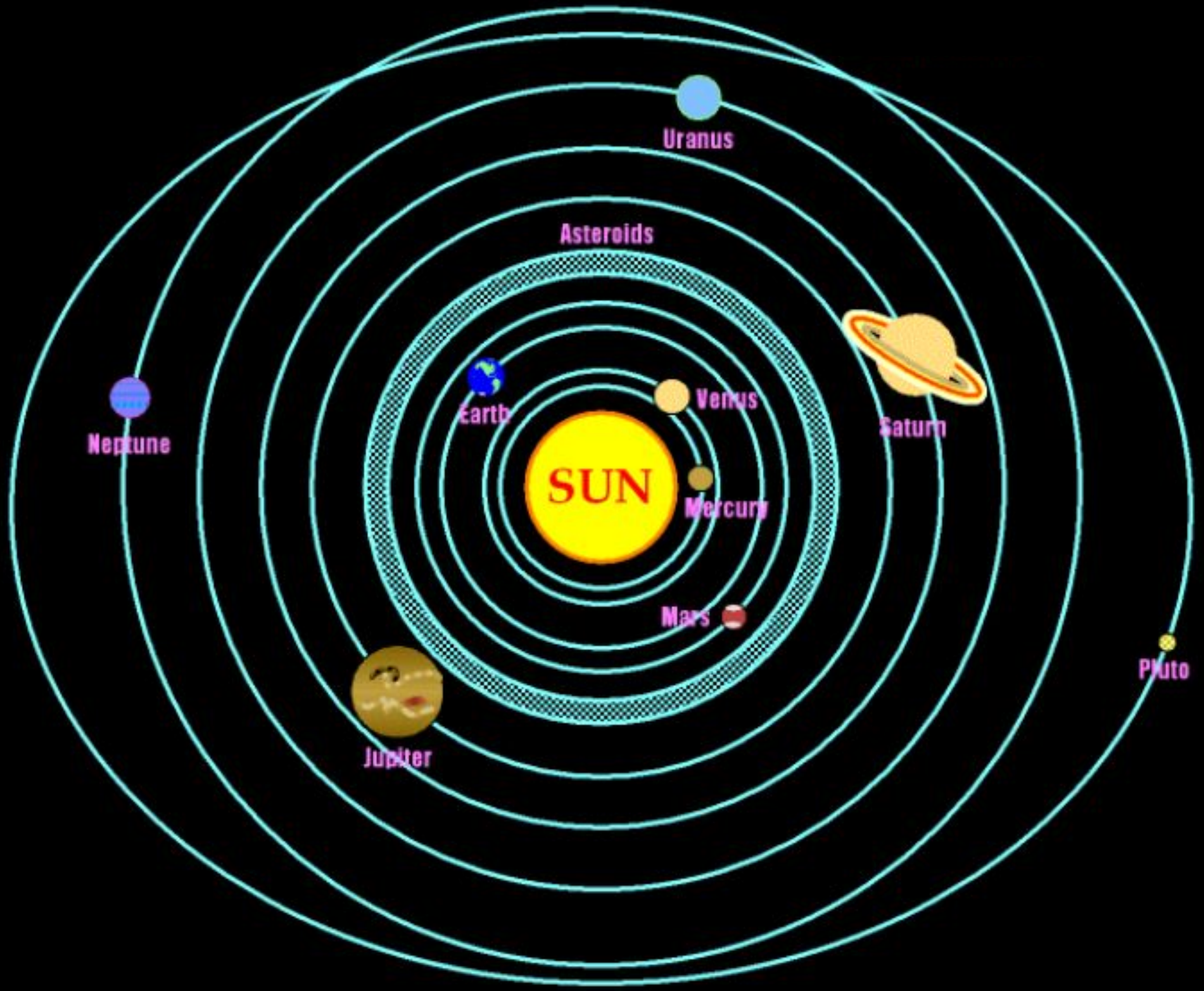
Solar System: planets, moons, and all that ...

Luis Anchordoqui

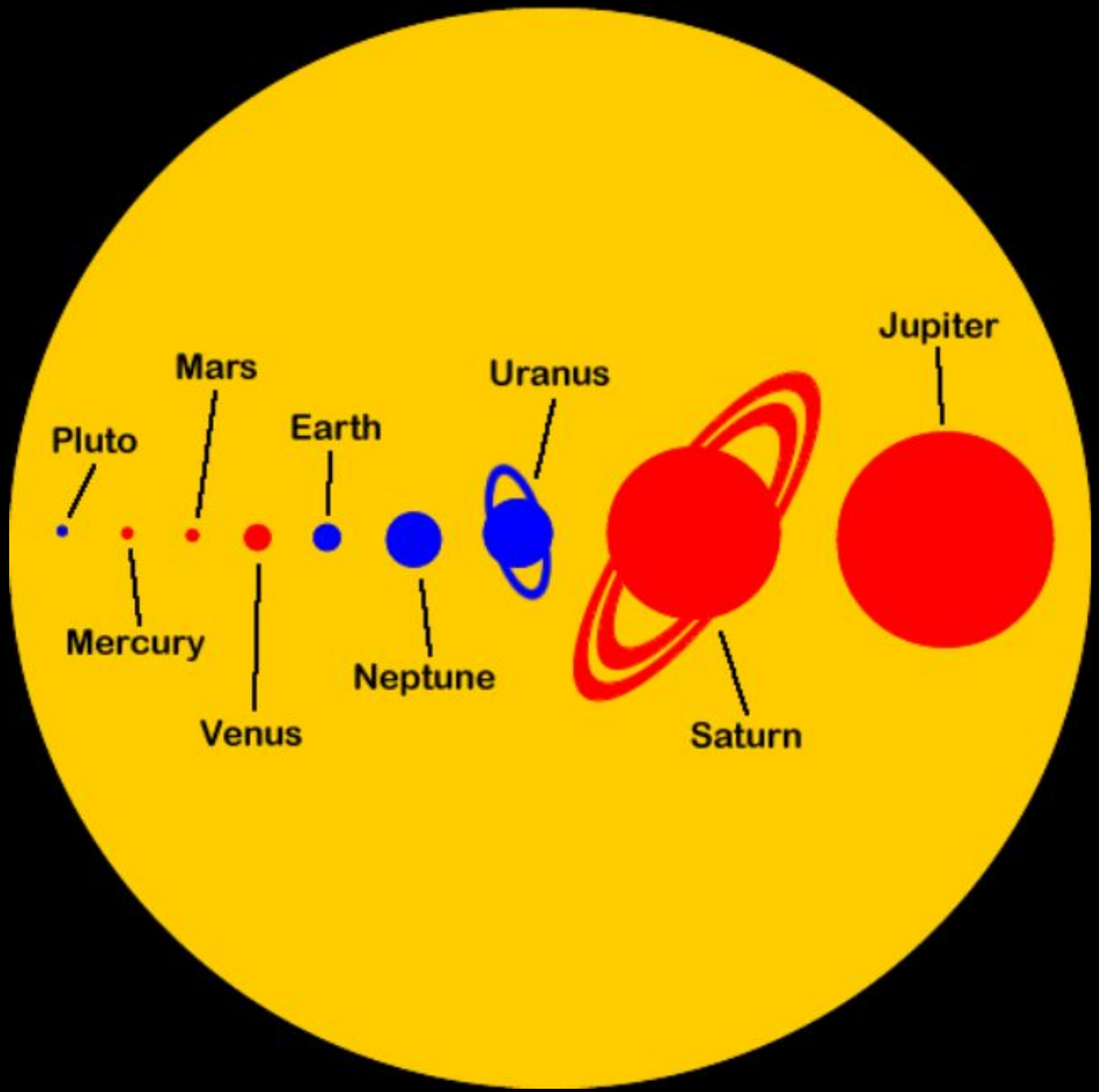
Objects in Our Solar System

Our solar system is made up of the sun, eight planets, their moons or satellites (about 166 in our solar system), dwarf planets, comets, asteroids and meteors ...

FACT: All of the planets in our solar system are in orbit around the sun



Size Comparison

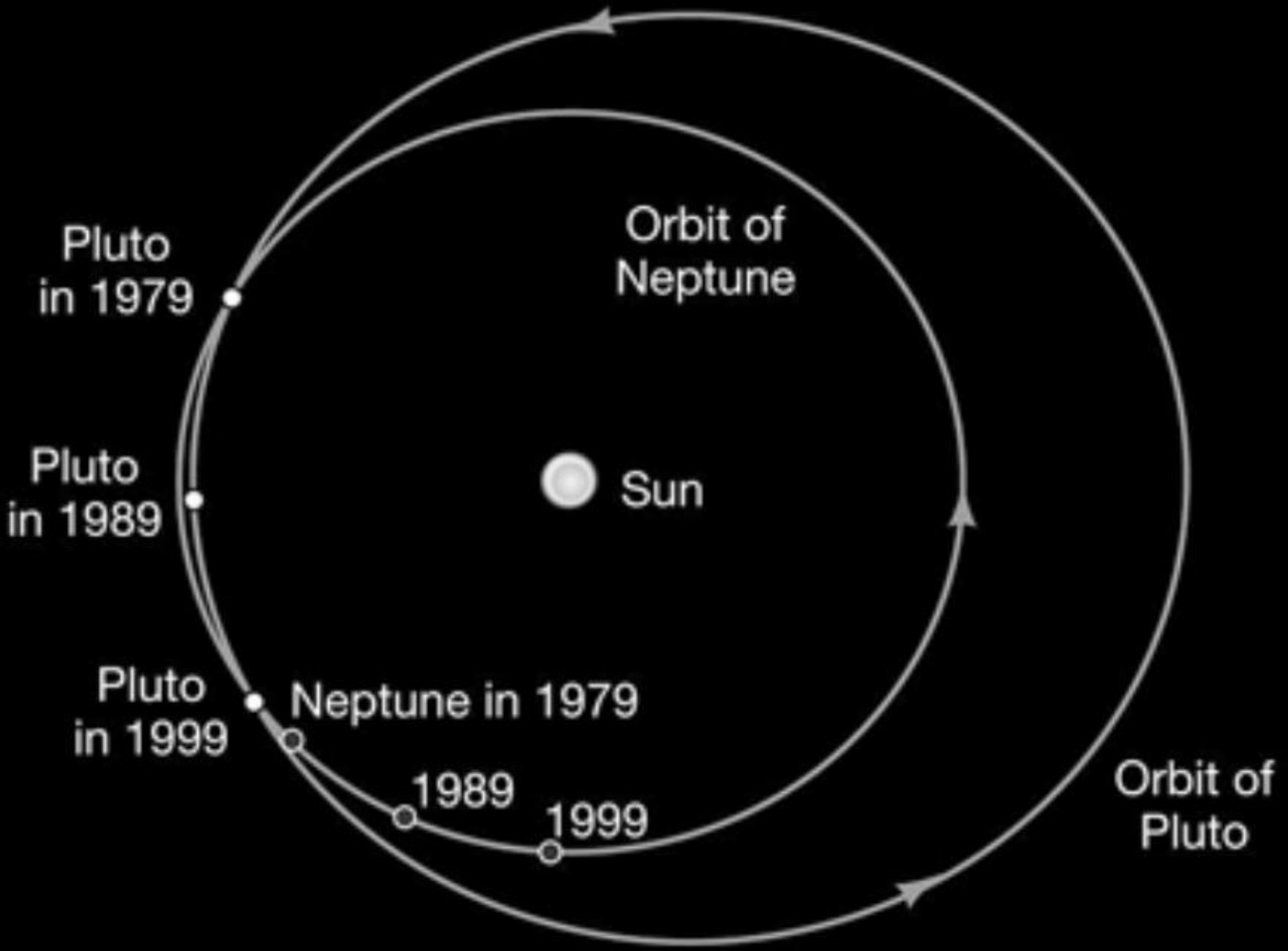


Headline News: Pluto Demoted!!!

➢ Pluto used to be considered a planet until 2006

➢ In 2006, the International Astronomical Union defined a planet as a body that orbits the sun, is spherical, and is large enough to clear its orbit

➢ They reclassified Pluto as a “dwarf planet” because it is not large enough to clear a path around its orbit (to clear its own orbit means a planet has become gravitationally dominant, and there are no other bodies of comparable size other than its own satellites or those otherwise under its gravitational influence)


Pluto
in 1979
Orbit of
Neptune
Pluto
in 1989
Sun
Pluto
in 1999
Neptune in 1979
1989
1999
Orbit of
Pluto

What is a Satellite?

A body that revolves around a planet
This could be “natural” like a planet's moon(s)
o “man-made” like a communications satellite

Moons (natural satellites)

Every planet in our solar system,
except Mercury and Venus,
has at least one natural satellite,
or moon (a body that orbits a planet)

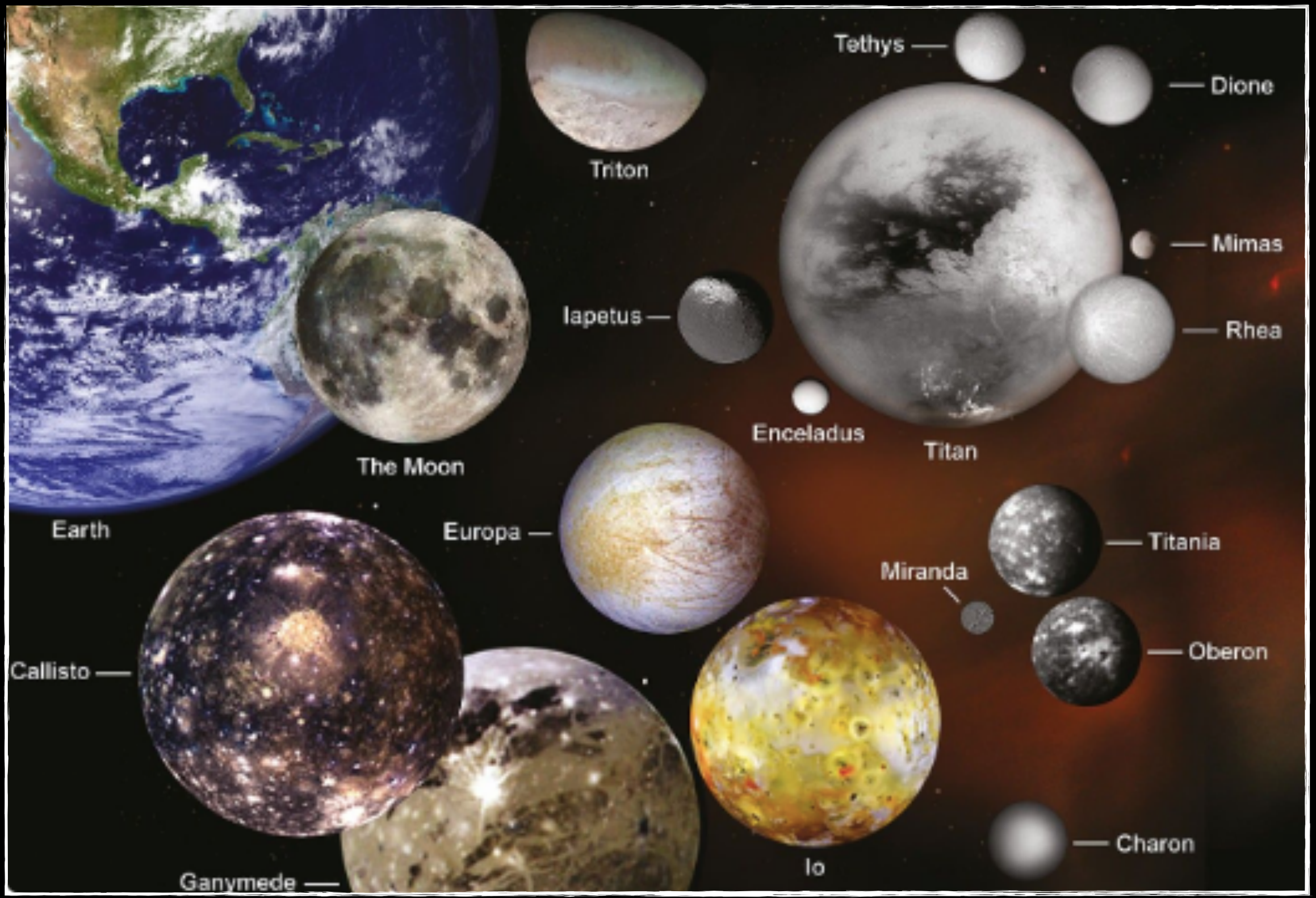
Mercury – 0
Venus – 0
Earth – 1
Mars – 2
Jupiter – 63
Saturn – 60
Uranus – 27
Neptune – 13

Total moons: @ 166

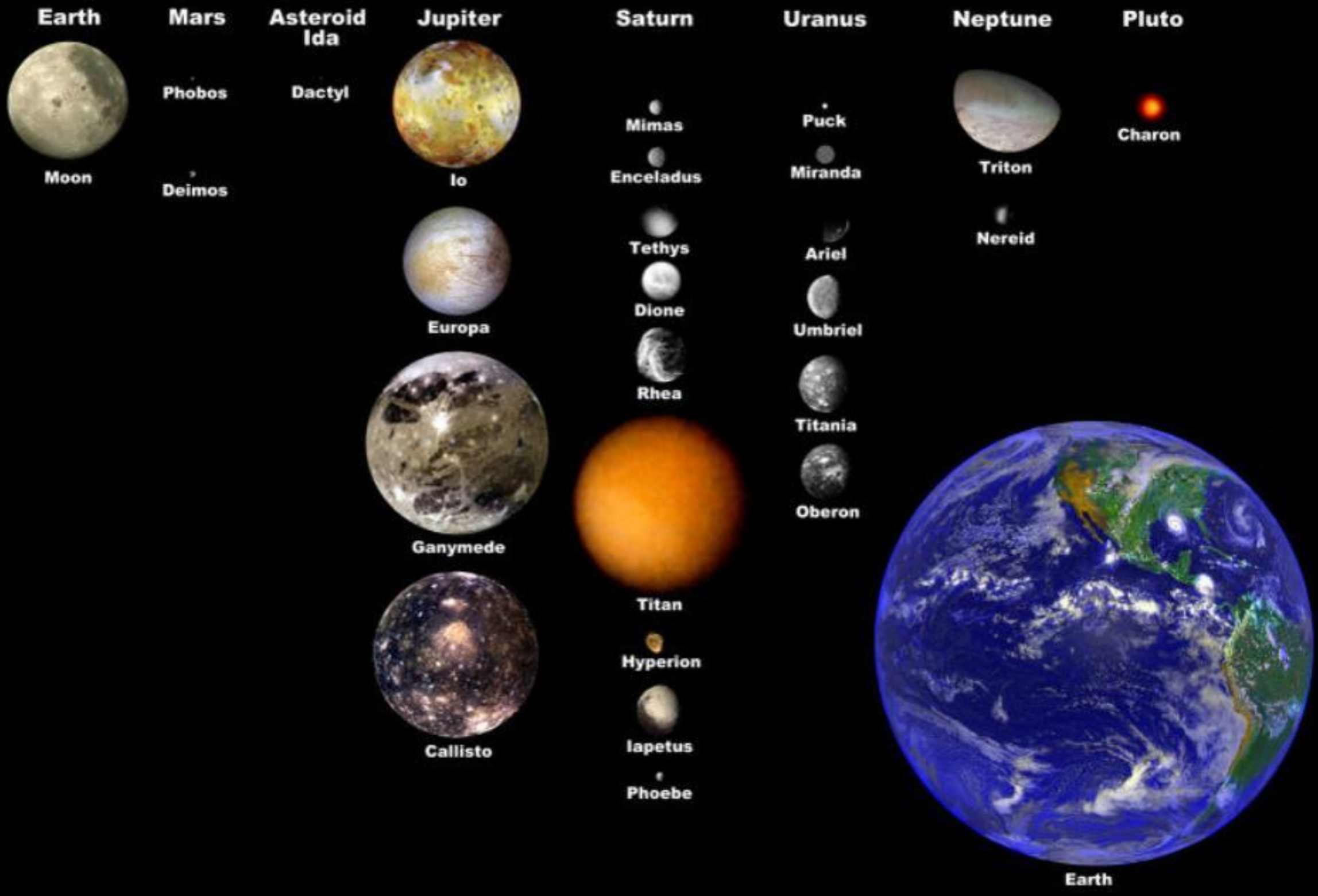
Jupiter

and one of its
60+ moons

Some of the many moons in our solar system



Moons of the Solar System Scaled to Earth's Moon



Planets orbit the Sun in a counterclockwise direction (when viewed from above the Sun North Pole)

6 of the planets including Earth rotate in prograde direction

Venus and Uranus rotate in retrograde direction

Mnemonic phrase to remember the order of the planets,
starting from those closest to the sun:

My Very Eager Mother Just Served Us Nachos

- The planets in our solar system can be divided into two groups, based on their location in relation to our sun and their physical make up

Inner planets

Outer planets

There is also a natural dividing line between the two

The Asteroid Belt

Planets in relation to the Sun

Sun ⟫➡ Inner Planets ⟫➡ Asteroid Belt ⟫➡ Outer Planets

The Inner Planets

- nearest to the Sun -

➢ are small and rocky

- **Mercury** ☛ the closest planet to the sun, with the shortest orbit. It is about half the size of Earth's moon
- **Venus** ☛ about the same size as Earth and the hottest planet
- **Earth** ☛ the only planet that has liquid water and that supports complex life
- **Mars** ☛ sometimes called the "Red Planet" because of its red, iron-oxide soil. It also has 2 moons and the largest volcano in our solar system

The Outer Planets

➢ are the 4 farthest planets from the sun, gas giants (mostly hydrogen and helium), and are more massive than the inner planets

- **Jupiter** ☛ the largest planet in our solar system, has a thin ring and 60+ moons
- **Saturn** ☛ has wide and bright rings and about 60 moons
- **Uranus** ☛ has about 27 moons and a faint ring
- **Neptune** ☛ has about 13 moons, a faint ring and is considered to be the windiest planet in the solar system

Planet Rings

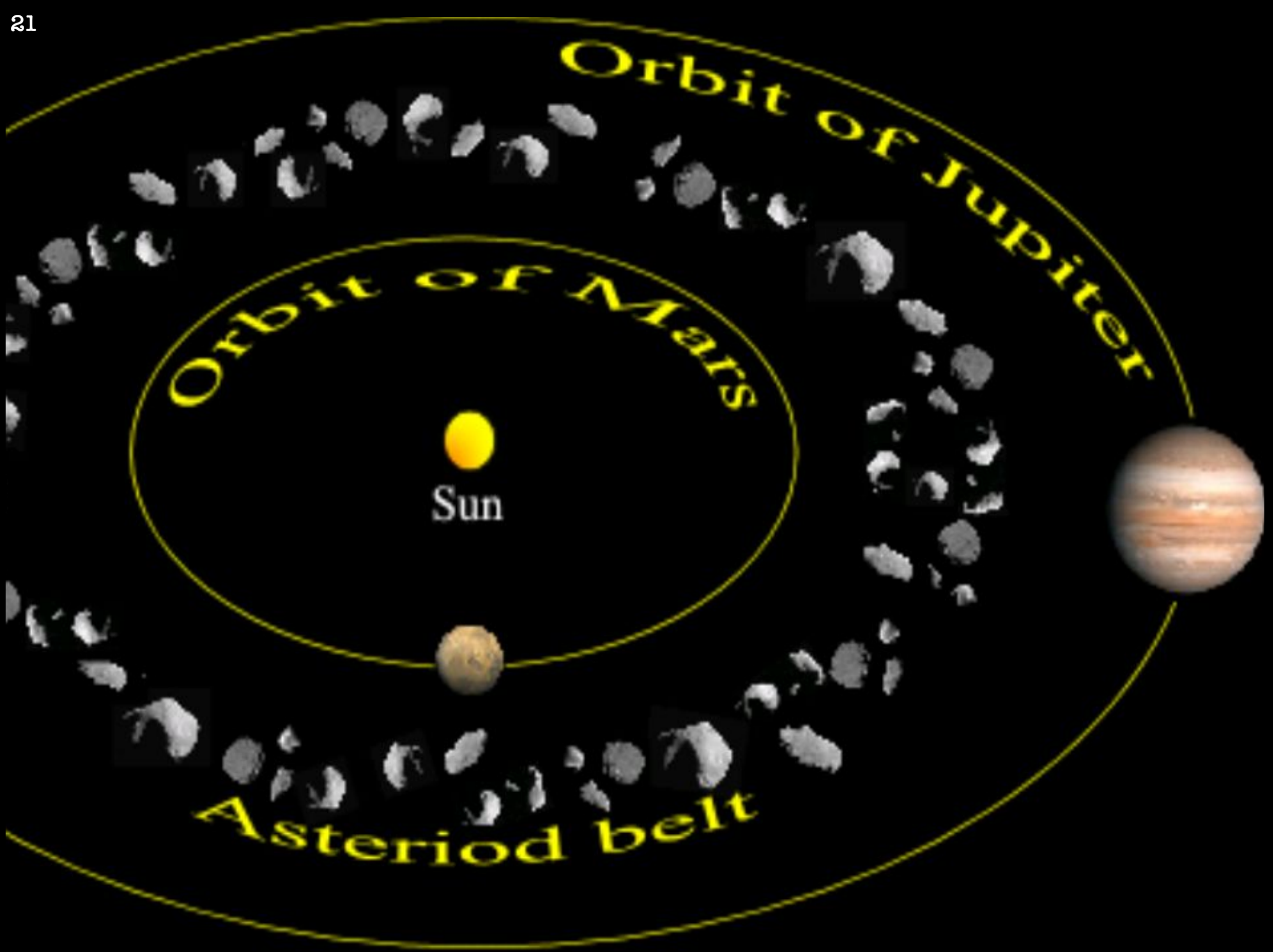
➢ The gas giants all have rings, though some are pretty faint

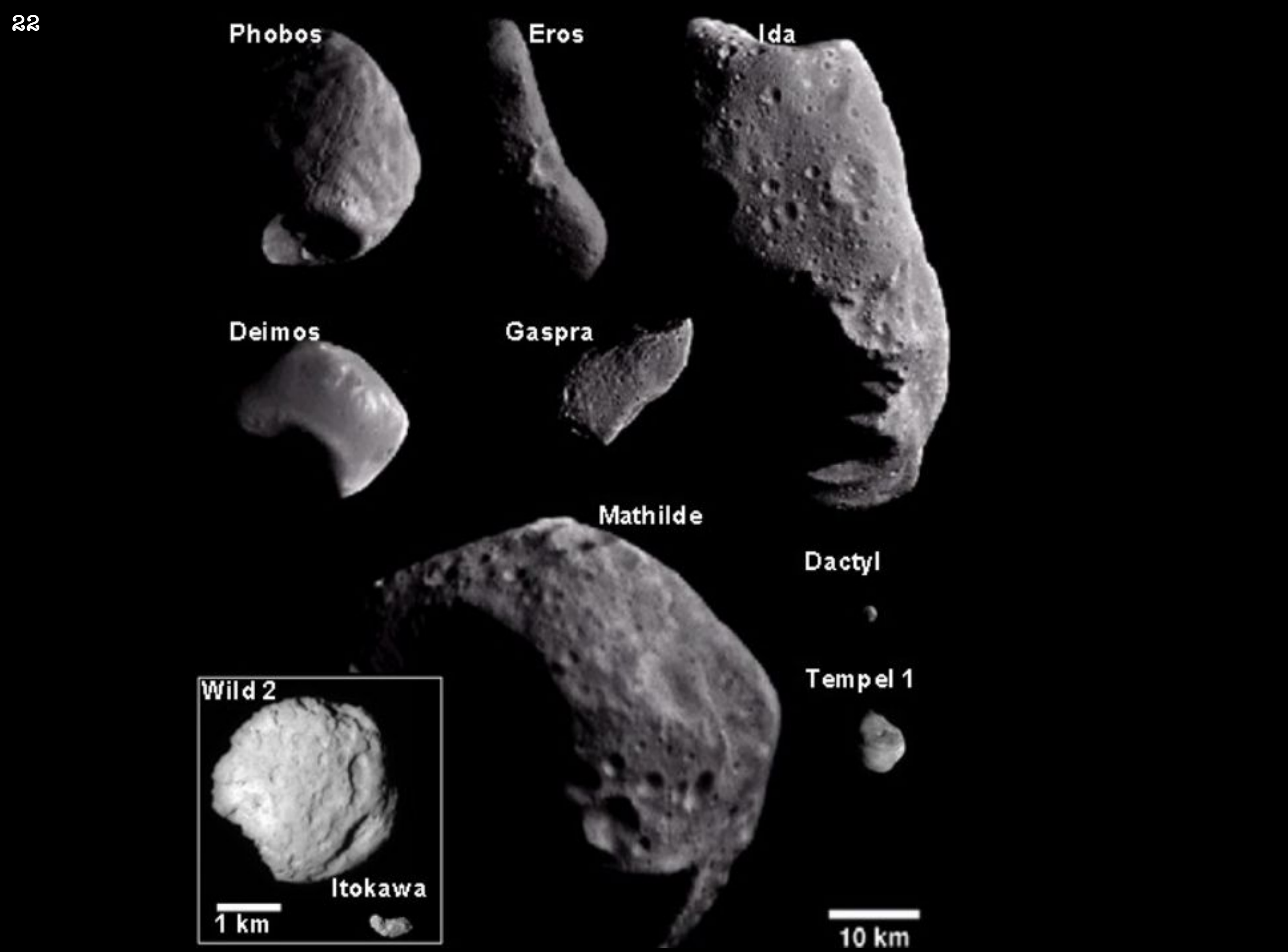
➢ Planet rings are made of tiny bits of dust, ice crystals, and small pieces of rock -RID ☛ Rock, Ice, Dust-

Asteroids & Asteroid Belt

➢ Asteroids are small, rocky objects that move around the Sun

➢ Most of them are scattered in a large area between the orbit paths of Mars and Jupiter called “the asteroid belt”, and rarely move through other parts of the solar system


Orbit of Jupiter
Orbit of Mars
Sun
Asteriod belt


Phobos
Eros
Ida
Deimos
Gaspra
Mathilde
Dactyl
Tempel 1
Wild 2
Itokawa
1 km
10 km

Comets

➢ A Comet is a small mass of dust and ice that orbits the Sun in a long, oval-shaped path

➢ When a comet's orbit takes it close to the sun, some of the ice on the comet's surface changes to water vapor and streams out to form a long, glowing tail.

➢ Halley's Comet, one comet that is visible to Earth, takes 77 years to complete its path

Meteors & Meteorites

➢ Meteors are pieces of rock that travel through space

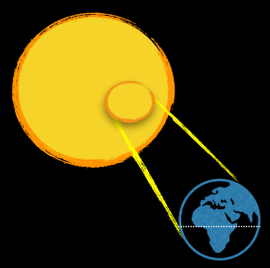
➢ If a meteor reaches a planet's surface, it is called a meteorite

Sun

- Located 93,000,000 miles from Earth
- Closest star to Earth
- At least 4.5 billion years old
- Contains 99.8 % of the mass of our Solar System and yet it has no solid matter
- Consist mostly of hydrogen, with some helium and a few heavier elements
- The tremendous power of the Sun comes from nuclear fusion, the process in which hydrogen atoms fuse togethe to create helium atoms ☛ produces vast amounts of heat
- The temperature at the core is 15,600,000° Celsius

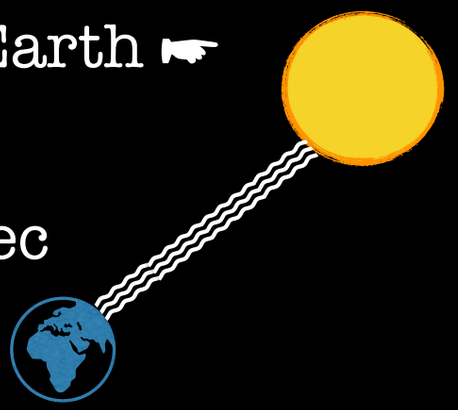
At the surface, the temperature **cools down** to 5500° Celsius

Diameter ☛
109 Earth

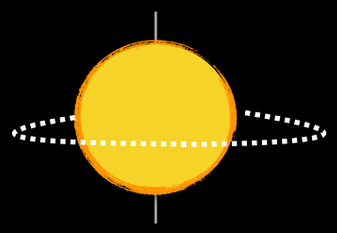


Time it takes for light to reach Earth ☛

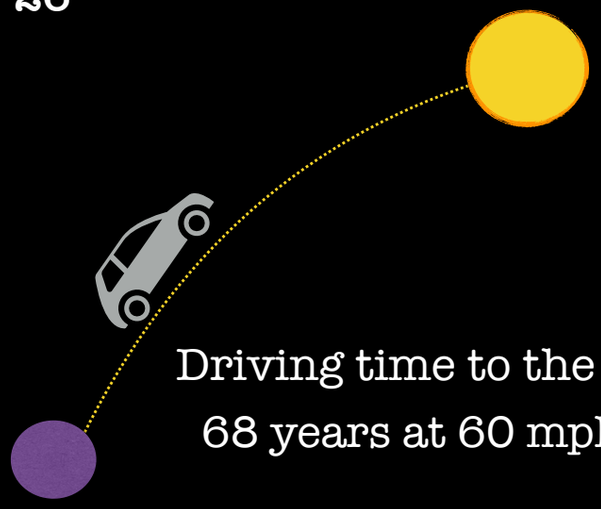
8 min 19 sec



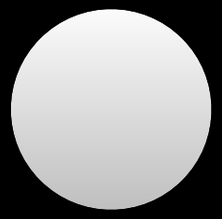
Length of day ☛ 25 Earth days
(at the equator)



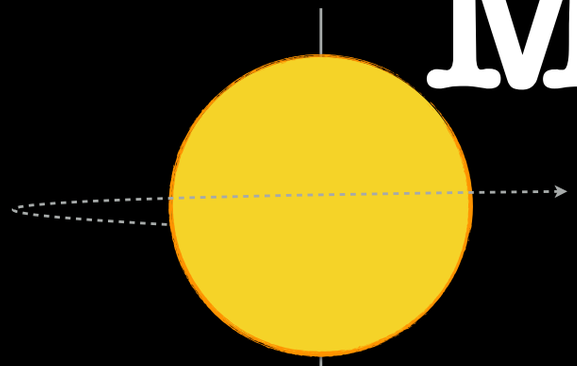
Mercury



Driving time to the Sun
68 years at 60 mph

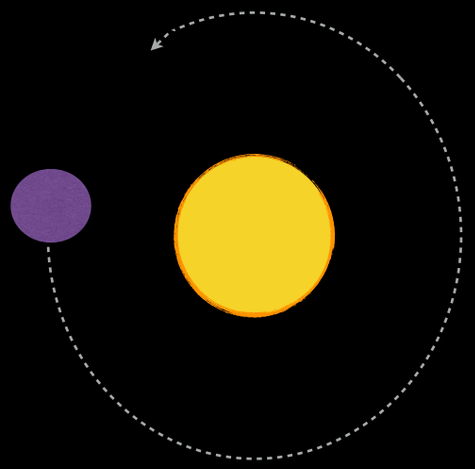


Number of moons
0

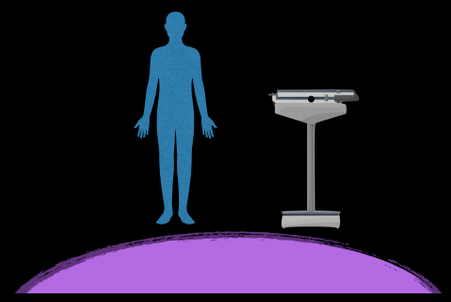


Length of day
59 Earth days

Mass in Earths
.06 Earth

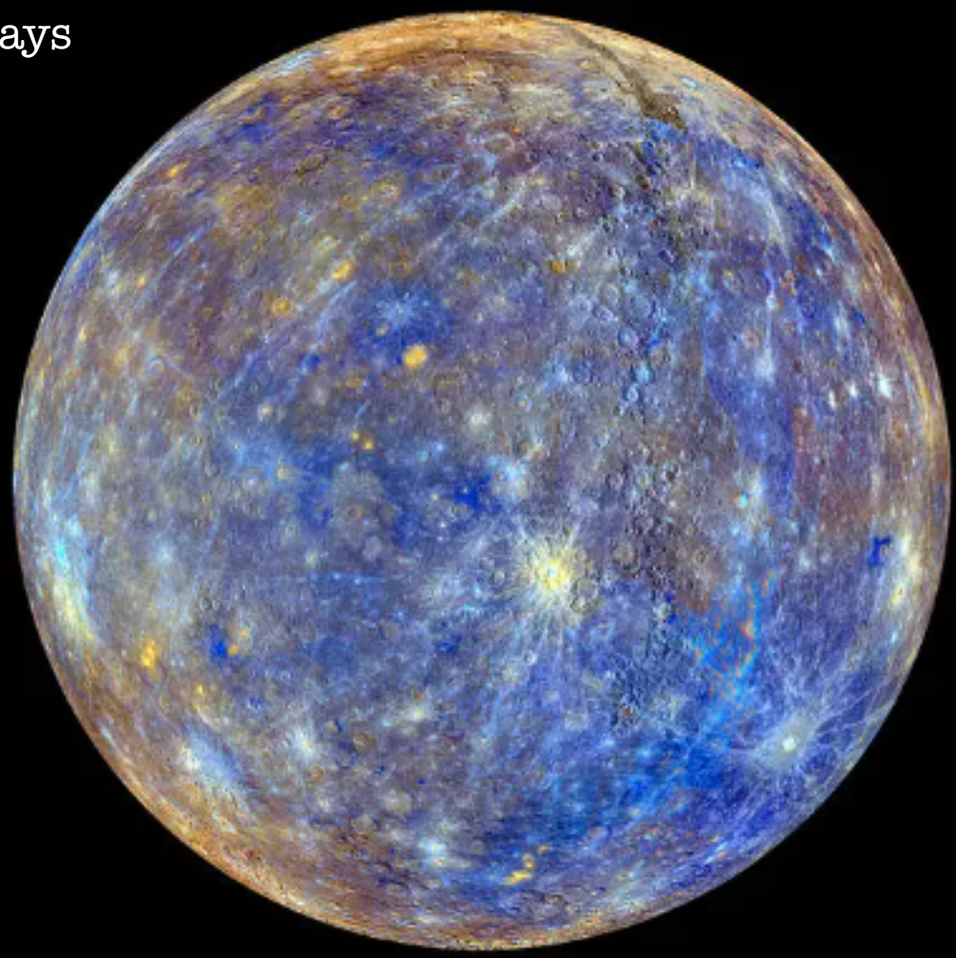


Length of year
88 Earth days



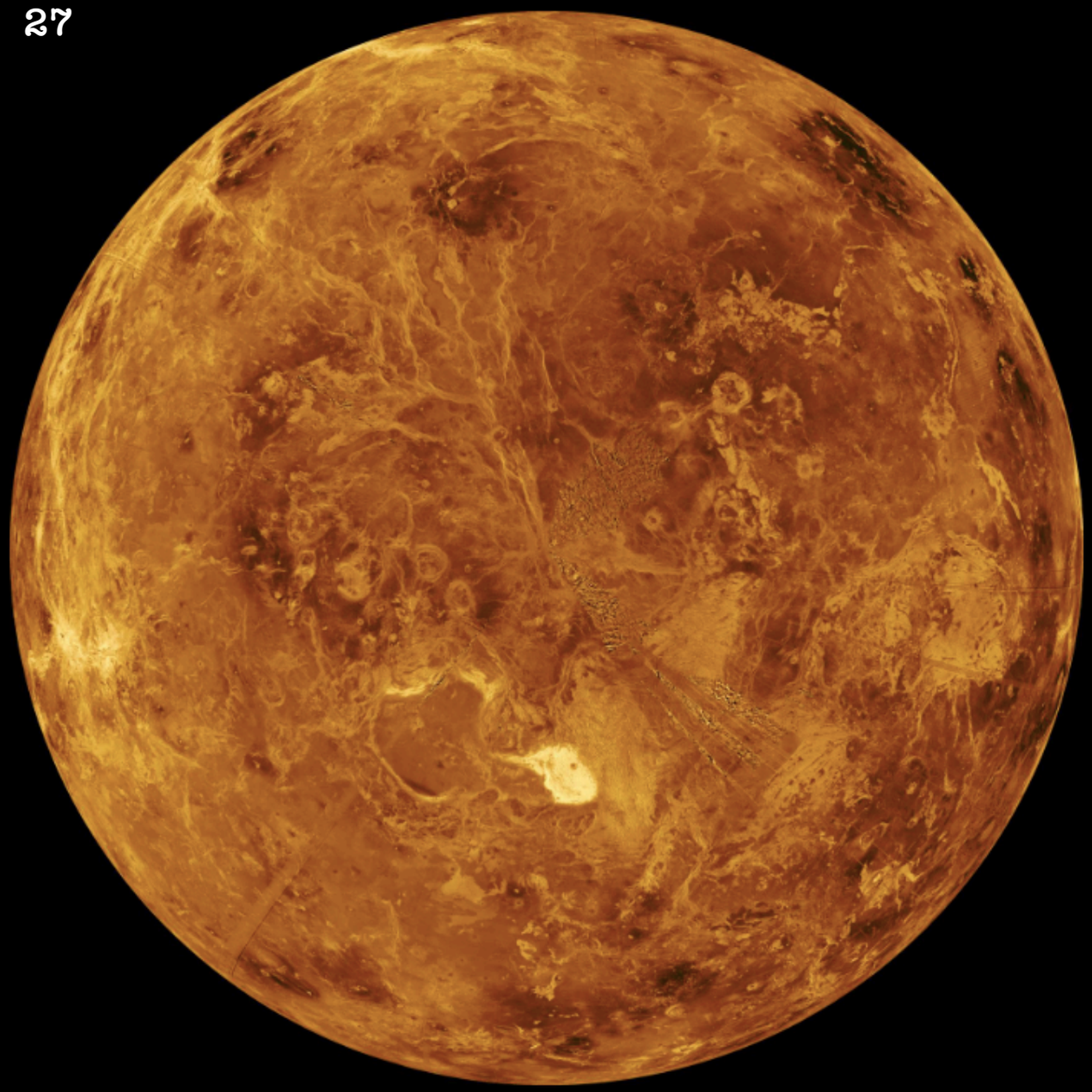
Weight of 200 lb person

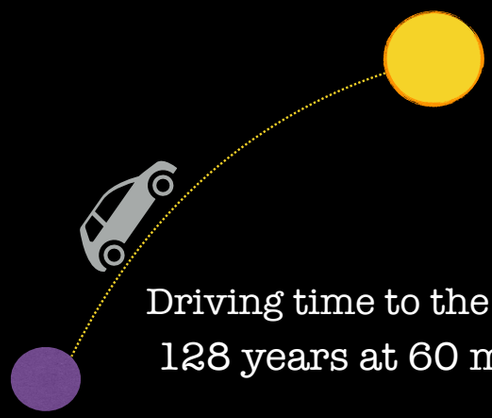
76 lbs



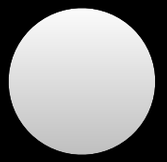
- Closest to the Sun
- Smallest planet
- One day on Mercury lasts 176 Earth days
- Very dry, hot and almost airless

Venus

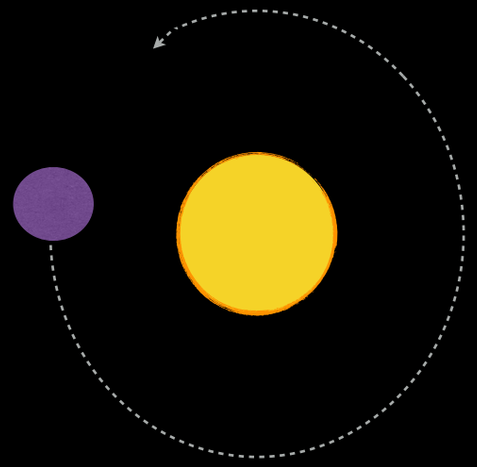




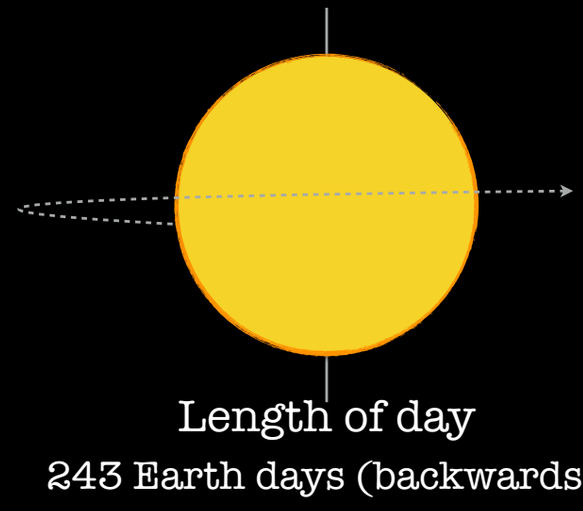
Driving time to the Sun
128 years at 60 mph



Number of moons
0

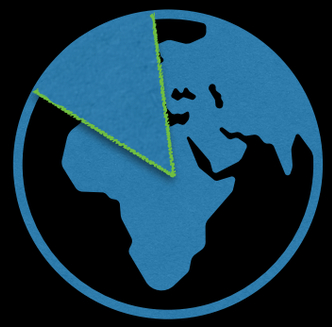


Length of year
225 Earth days

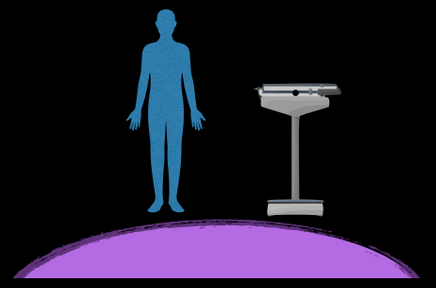


Length of day
243 Earth days (backwards)

- Second closest planet to the Sun
- Brightest celestial body resides the moon and Sun
- Cannot be seen in the middle of the night
- Can be observed in the east at sunrise
  and the west at sunset



Mass in Earths
.82 Earths

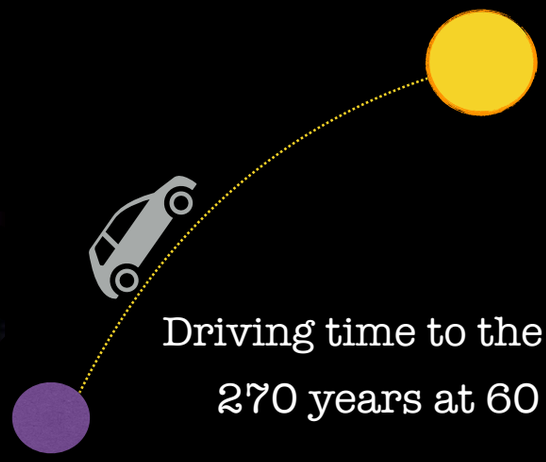


Weight of 200 lb person
181 lbs

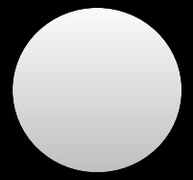
Earth

- 3rd from the Sun
- 5th largest planet in the solar system
- More than 4.5 billion years old
- Has one natural satellite we call the moon
- Is the only planet in our Solar System that we know has liquid water
- Two-thirds of the planet surface is covered with water
- Water, in the form of ice, can be found all around the solar system -on the surface of Mars, in the rings of Saturn, in comets- but liquid water is rare
- Life as we known it original evolved in liquid water ☛ searching for water on other planets may be the key to finding Life outside the Earth

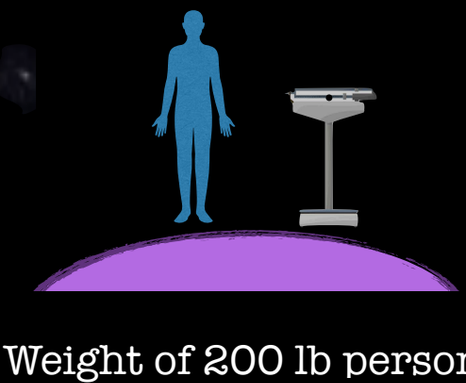
Mars



Driving time to the Sun
270 years at 60 mph

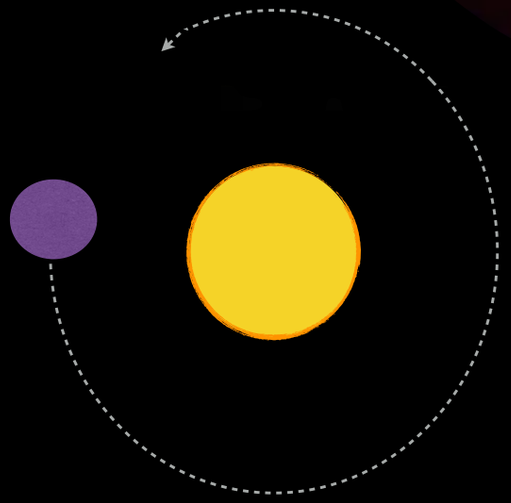


Number of moons
2

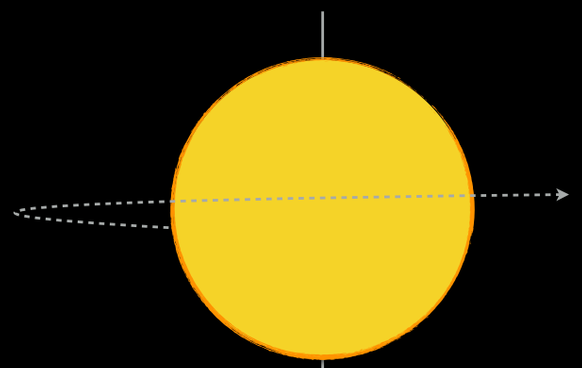


Weight of 200 lb person
75 lbs

Mass in Earths
+11 Earth



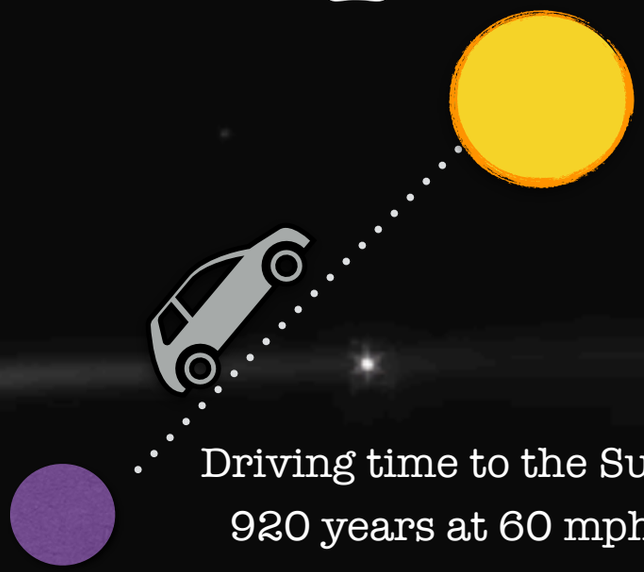
Length of year
1.9 Earth days



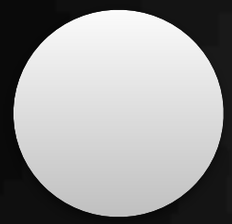
Length of day
24.6 Earth hours

- Fourth from the Sun
- Only planet whose surface can be seen in detail from the Earth
- Reddish in color, the atmosphere of Mars is made of carbon dioxide

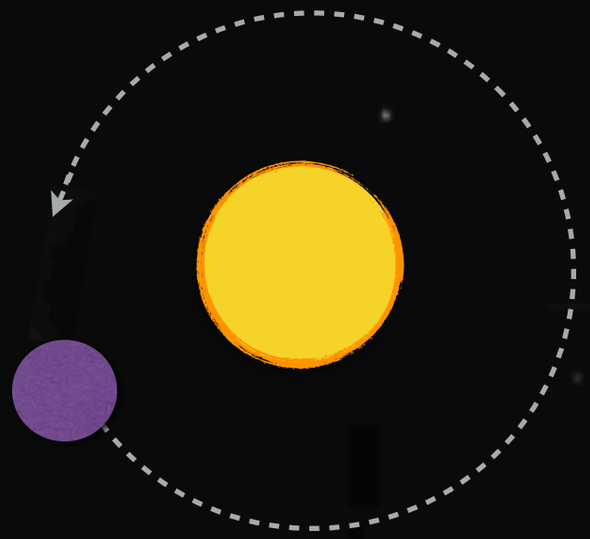
Jupiter



Driving time to the Sun
920 years at 60 mph



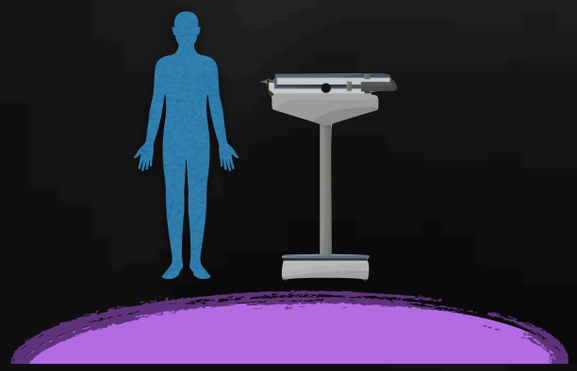
Number of moons
At least 62



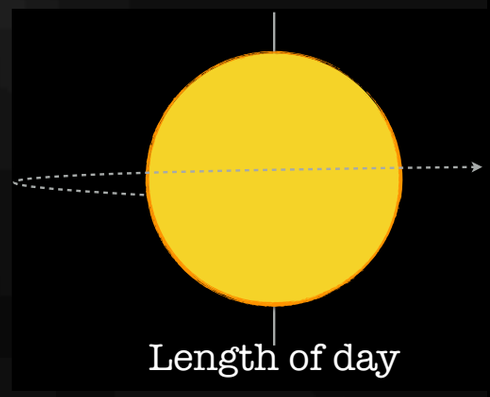
Length of year
11.8 Earth years

Mass in Earths
318 Earths

- The Fifth planet from the Sun
- Largest planet in the solar system

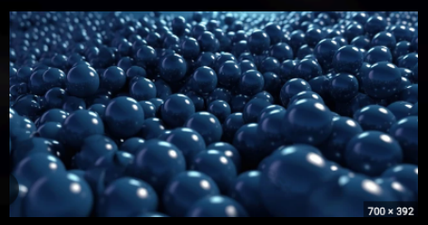


Weight of 200 lb person
473 lbs

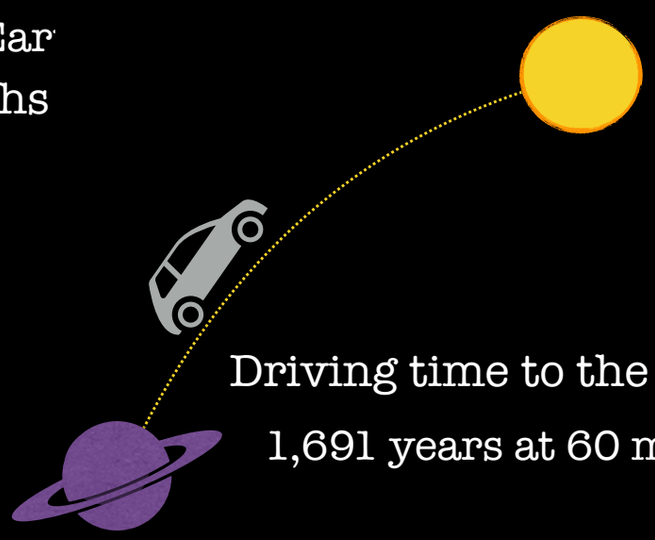


Length of day
9.9 Earth hours

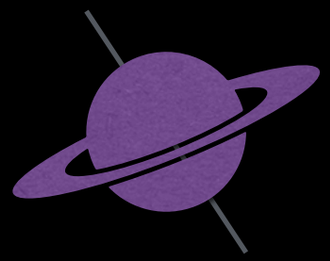
Saturn



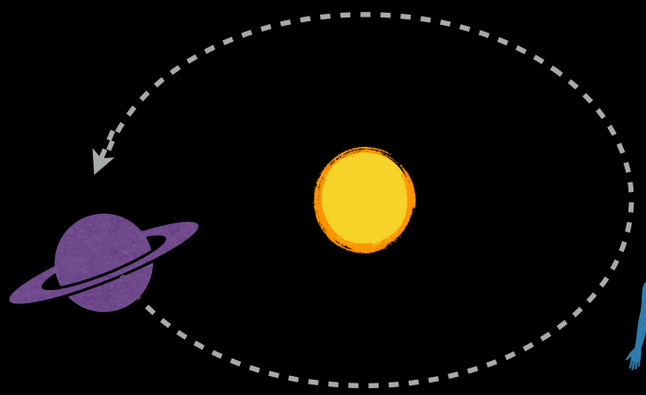
Mass in Ear
95 Earths



Driving time to the Sun
1,691 years at 60 mph

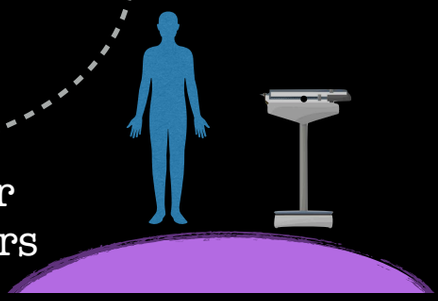


Length of day
10.7 Earth hours



Length of year
29.5 Earth years

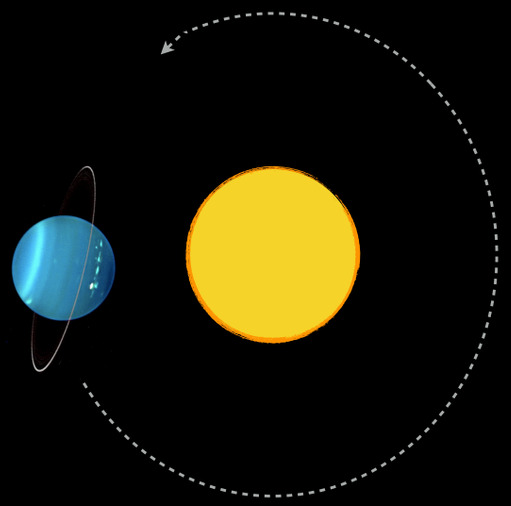
Number of moons
62



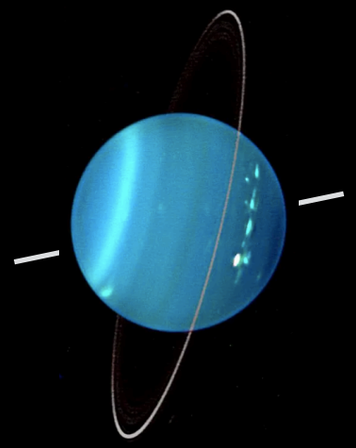
Weight of 200 lb person
214 lbs

- Sixth planet from the Sun
- The surface consists of liquid and gas

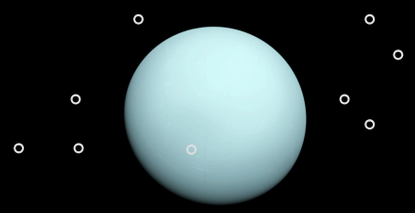
Uranus



Length of year
84 Earth years

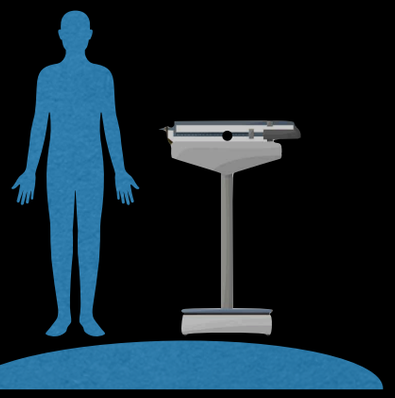


Length of day
17.3 Earth hours

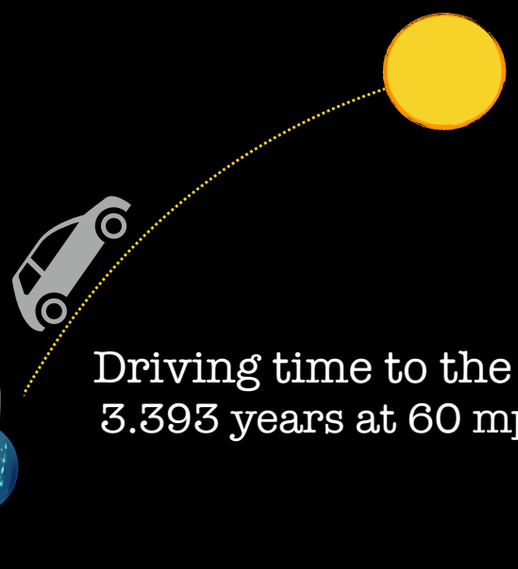


Number of moons
At least 27

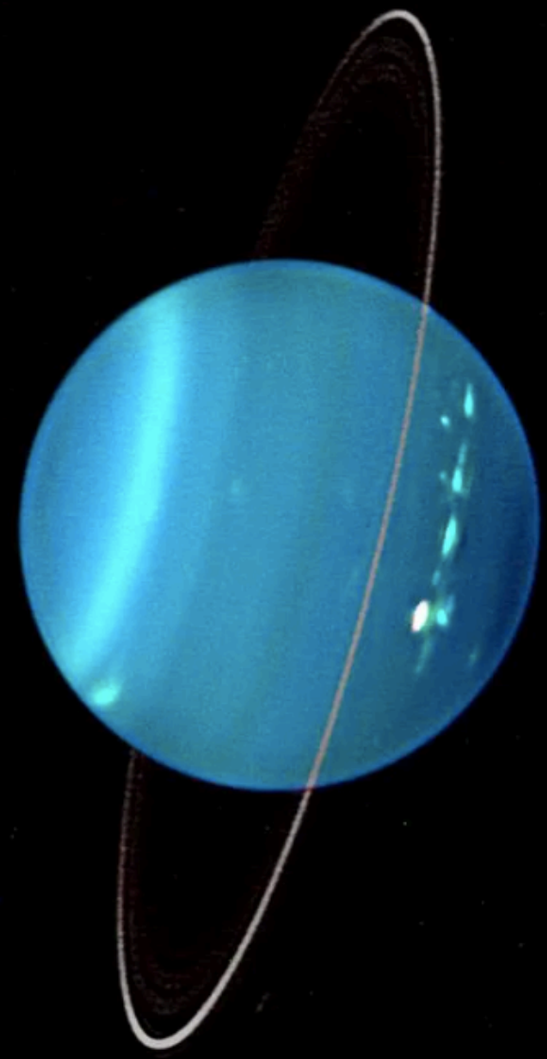
Mass in Earths
15 Earths



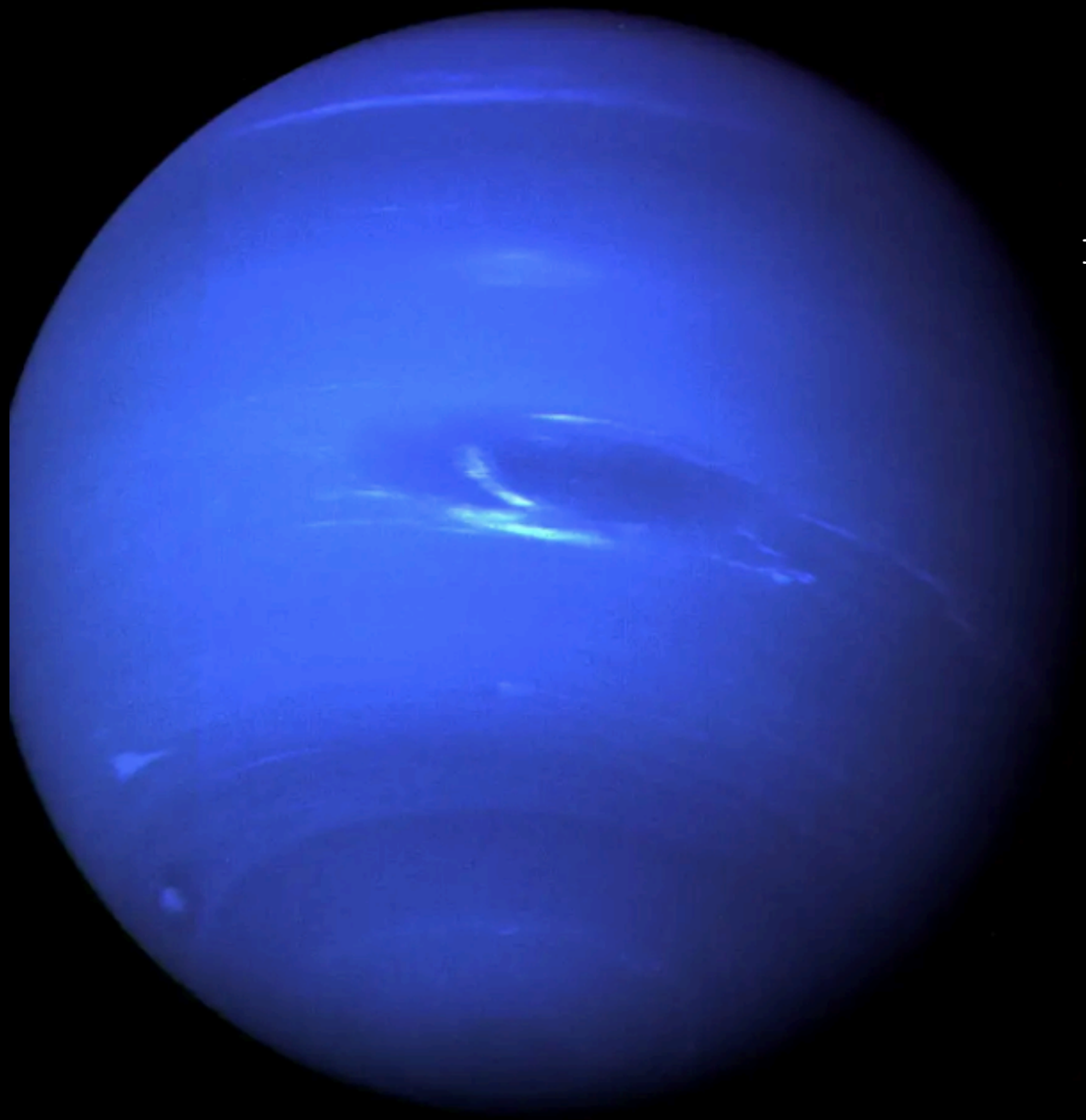
Weight of 200 lb person
178 lbs



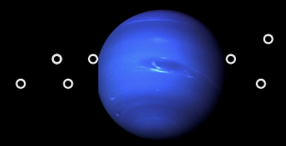
Driving time to the Sun
3.393 years at 60 mph



- Seventh planet from the Sun
- 1st planet discovered with a telescope
- Atmosphere is a mixture of hydrogen, helium and methane
- Does not have a solid surface

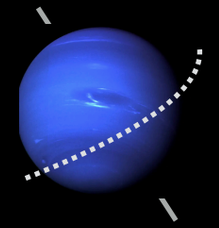


Neptune



Number of moons

At least 13

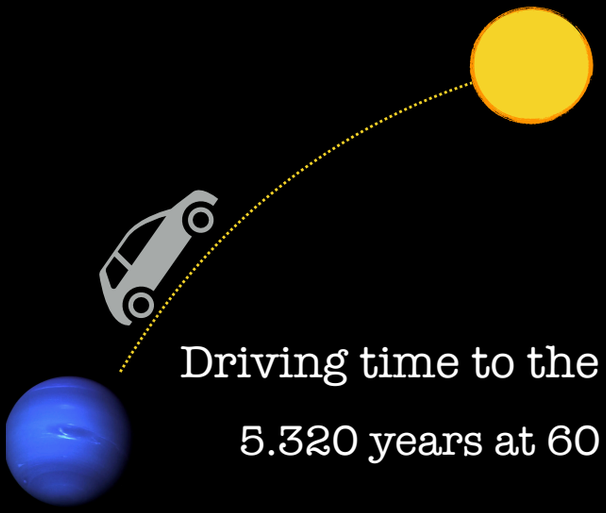


Length of day

16 Earth hours

Mass in Earths

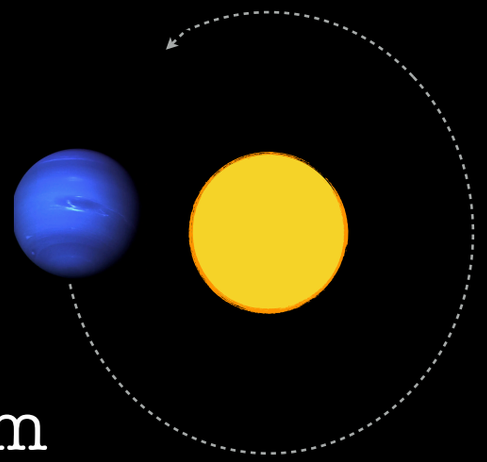
17 Earths



Driving time to the Sun

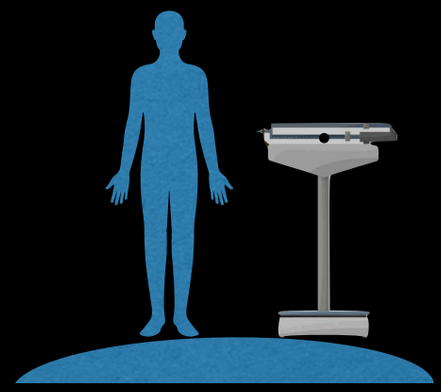
5.320 years at 60 mph

- 8th and farthest planet from the Sun
- Atmosphere is mostly hydrogen and helium



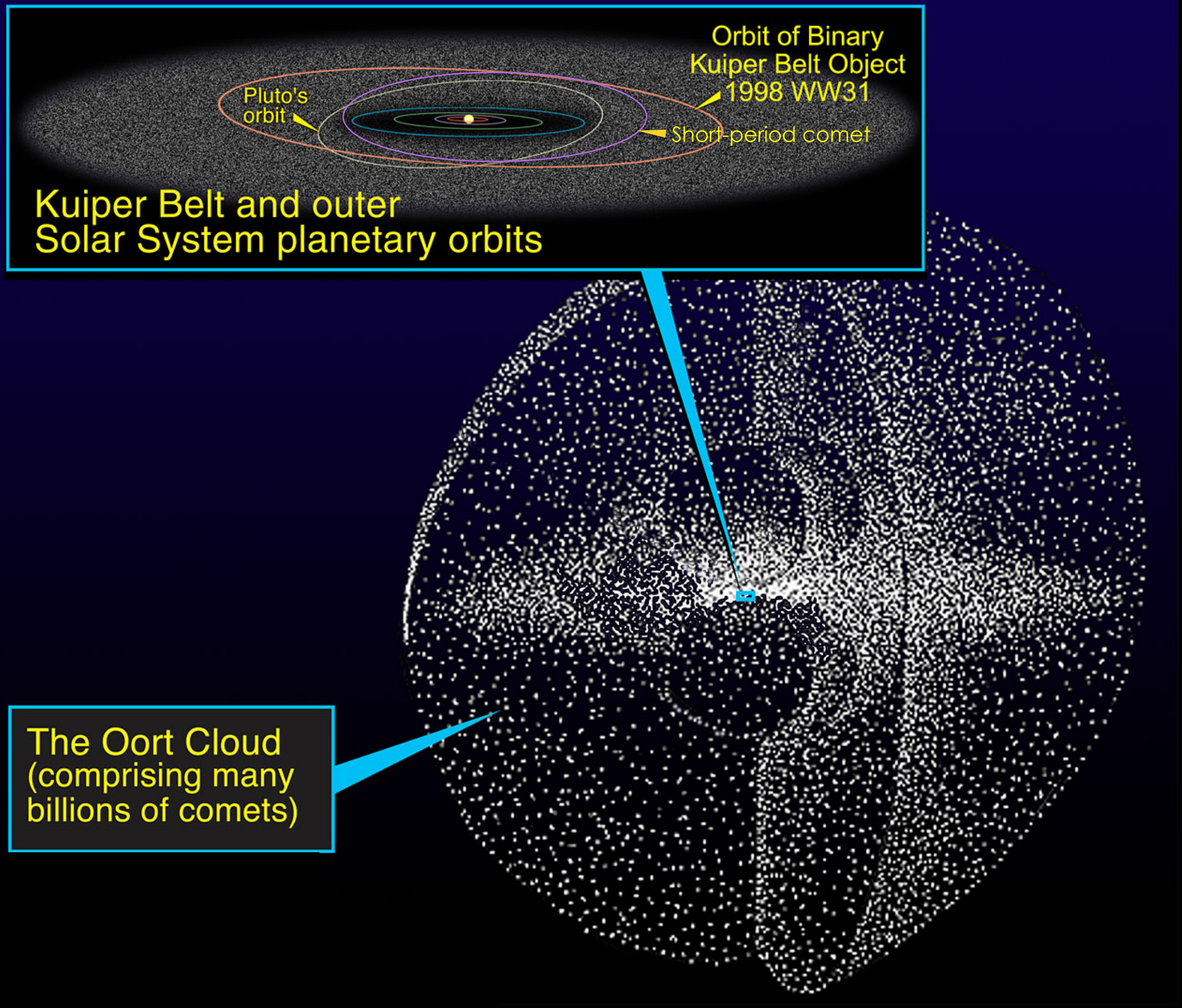
Length of year

165 Earth years



Weight of 200 lb person

225 lbs


Orbit of Binary
Kuiper Belt Object
1998 WW31
Pluto's
orbit
Short-period comet
Kuiper Belt and outer
Solar System planetary orbits
The Oort Cloud
(comprising many
billions of comets)

PRESENTLY, what is the farthest planet from the sun?

A. Mercury

B. Neptune

C. Uranus

D. Non of the above

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A. Mercury

B. Neptune

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D. Non of the above

Is Pluto a planet?

The debate isn't over

Is Pluto a planet?

The debate isn't over

We are in 2024 ☛ we should let Pluto be what Pluto wants to be

The solitary moon of Pluto is named after the boatman of Greek mythology who ferries the dead across the River Styx. Its name is:

A. Erebus

B. Charon

C. Nox

D. Persephone

The solitary moon of Pluto is named after the boatman of Greek mythology who ferries the dead across the River Styx. Its name is:

A. Erebus

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D. Persephone

The sun is primarily composed of which gas?

A. Hydrogen

B. Helium

C. Nitrogen

D. Argon

The sun is primarily composed of which gas?

A. Hydrogen

B. Helium

C. Nitrogen

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What is the hottest terrestrial planet?

A. Mercury

B. Venus

C. Earth

What is the hottest terrestrial planet?

A. Mercury

B. Venus

C. Earth

Which of these classifications are used to identify a dwarf planet?

1. Is in orbit around the Sun
2. Is not a satellite
3. Has not cleared the neighbourhood around its orbit
4. Has hydrostatic equilibrium (near spherical/consistent shape)

Which of these classifications are used to identify a dwarf planet?

1. Is in orbit around the Sun
2. Is not a satellite
3. Has not cleared the neighbourhood around its orbit
4. Has hydrostatic equilibrium (near spherical/consistent shape)

The asteroid belt is between..?

A. Mercury and Venus

B. Mars and Jupiter

C. Jupiter and Saturn

The asteroid belt is between..?

A. Mercury and Venus

B. Mars and Jupiter

C. Jupiter and Saturn

Long term comets are thought to originate in what area of the solar system?

A. Asteroid Belt

B. Kuiper Belt

C. Oort Cloud

Long term comets are thought to originate in what area of the solar system?

A. Asteroid Belt

B. Kuiper Belt

C. Oort Cloud

Short term comets are thought to originate in what area of the solar system?

A. Asteroid Belt

B. Kuiper Belt

C. Oort Cloud

Short term comets are thought to originate in what area of the solar system?

A. Asteroid Belt

B. Kuiper Belt

C. Oort Cloud

Which of these planets spins clockwise?

A. Venus

B. Mars

C. Earth

D. Uranus

E. Neptune

Which of these planets spins clockwise?

A. Venus

B. Mars

C. Earth

D. Uranus

E. Neptune

The Earth is approximately how many miles from the sun?

A. 53 million

B. 73 million

C. 93 million

D. 113 million

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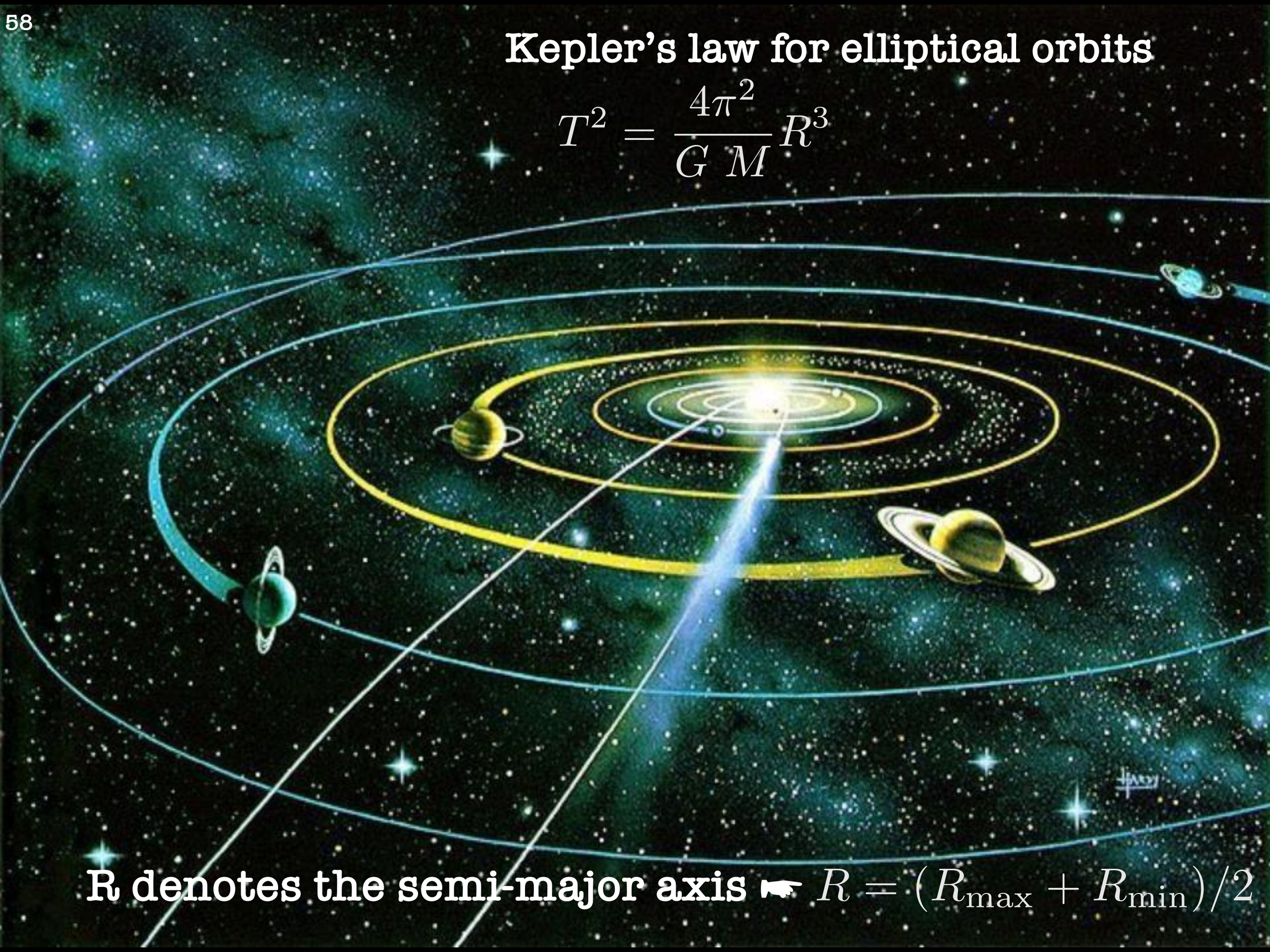
QUERY 8

Haley's Comet approaches the sun to within 0.570 A.U., and its orbital period is 75.6 years
(A.U. is the abbreviation for astronomical units, where 1 A.U. =1 .5 x 10^{11} m is the mean Earth-Sun distance)
How far from the sun will Haley's comet travel before it starts its return journey?

Kepler's law for elliptical orbits

$$T^2 = \frac{4\pi^2}{G\ M} R^3$$



R denotes the semi-major axis ☛ $R = (R_{\max} + R_{\min})/2$

QUERY 8

Haley's Comet approaches the sun to within 0.570 A.U., and its orbital period is 75.6 years

(A.U. is the abbreviation for astronomical units, where 1 A.U. =1 .5 x 10^{11} m is the mean Earth-Sun distance)

How far from the sun will Haley's comet travel before it starts its return journey?

$$R^3 = \frac{GM}{4\pi^2}T^2$$

$$R^3 = (6.67 \times 10^{-11}\ Nm^2/kg^2)(1.991 \times 10^{30} kg)(75.6 \times 365 \times 24 \times 3600 s)^2/4\pi^2 = 1.91 \times 10^{37} m^3$$

$$R = 2.67 \times 10^{12}\ m = (R_{\max} + R_{\min})/2$$

$$R_{\max} = 5.35 \times 10^{12}\ m - 0.570 \times 1.5 \times 10^{11}\ m = 5.26 \times 10^{12} m$$

$R_{\max}$ ☛ is the maximum distance of comet from the Sun

If the inner edge of the doughnut-shapped Kuiper Belt begins at the orbit of Neptune at a distance of 30 AU from the sun and it ends at about 50 AU from the sun, how would you classify the Haley comet?

A. Short term comet

B. Long term comet

If the inner edge of the doughnut-shapped Kuiper Belt begins at the orbit of Neptune at a distance of 30 AU from the sun and it ends at about 50 AU from the sun, how would you classify the Haley comet?

A. Short term comet

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