

Bell Ringer

1. Briefly describe the Doppler effect in one sentence.
2. What do you want to do someday, like, in life?
3. How do you think science might apply to what you want to do someday?

SCIENCE MATTERS

Asteroids



FLORENCE: LARGEST ASTEROID IN CENTURY TO SAFELY FLY BY EARTH

- Fly by at a distance of 4.4 million miles
- Moon = $\frac{1}{4}$ million miles
- Mars = 225 million miles (at closest)



- ▶ Detect asteroids years in advance
- ▶ Protect against asteroids using missiles, asteroid redirect program, etc.
- ▶ Only for big ones

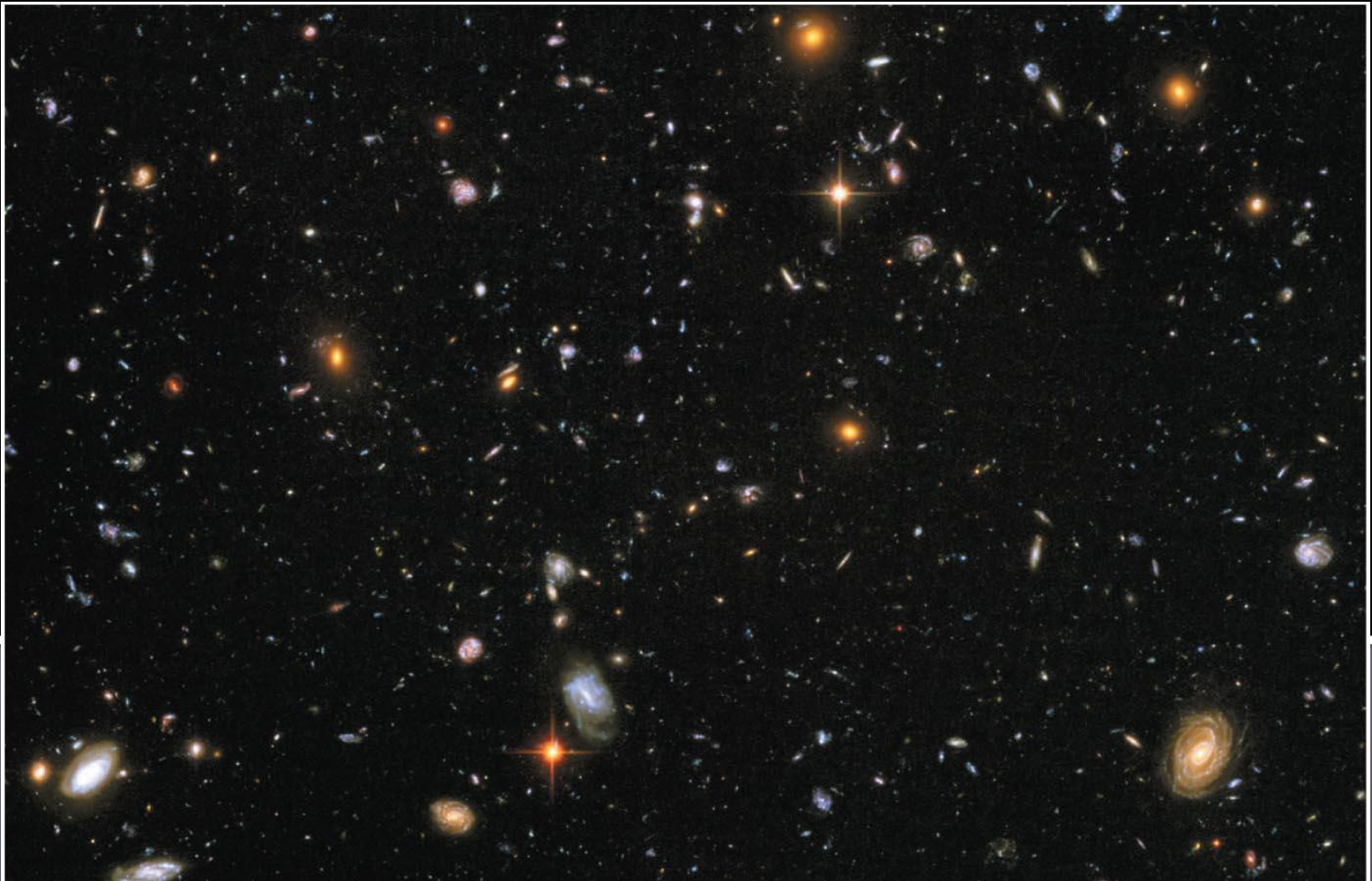


Our place in the Universe

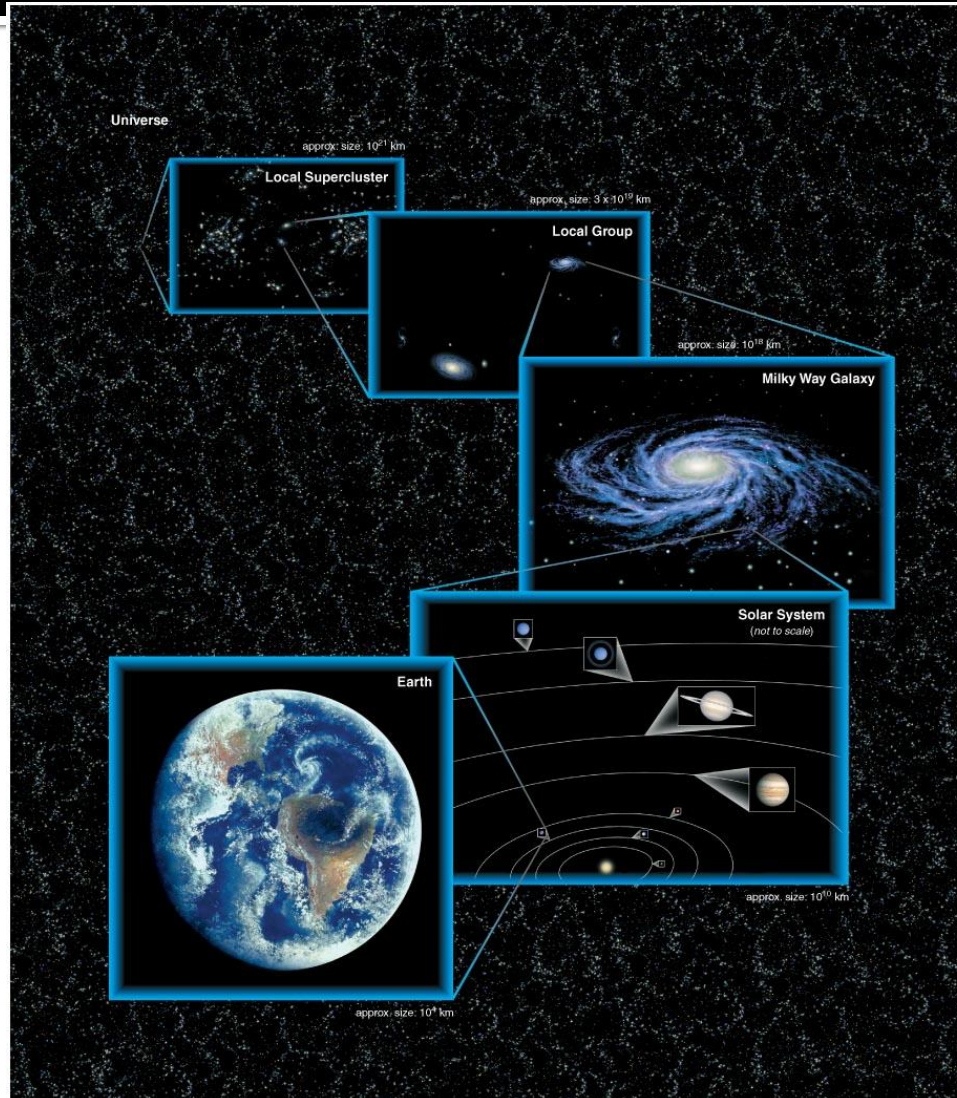
What we will learn:

- What a planet, moon, asteroid, star, galaxy, and comet is
- The relative sizes of the objects in our solar system
- The relative distances between objects in our universe.
- The relative timeline of events; how young humans are.

Our Place in the Universe



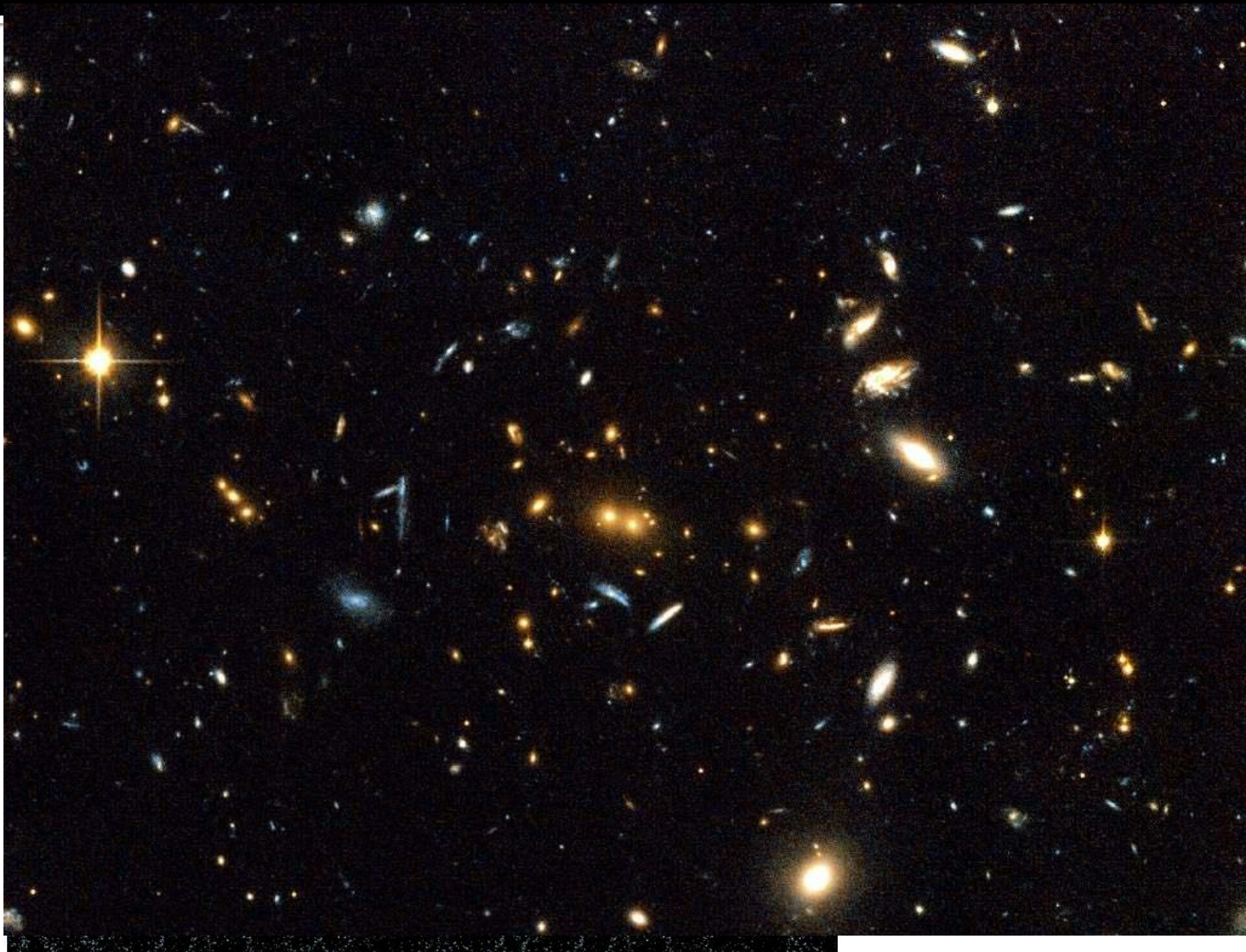
Where do we fit in the Universe?



Where do we fit in the Universe?

The closest galaxy is a dwarf galaxy, only 25,000 light years away!

The Andromeda Galaxy is even further away at over 2.5 million light years!

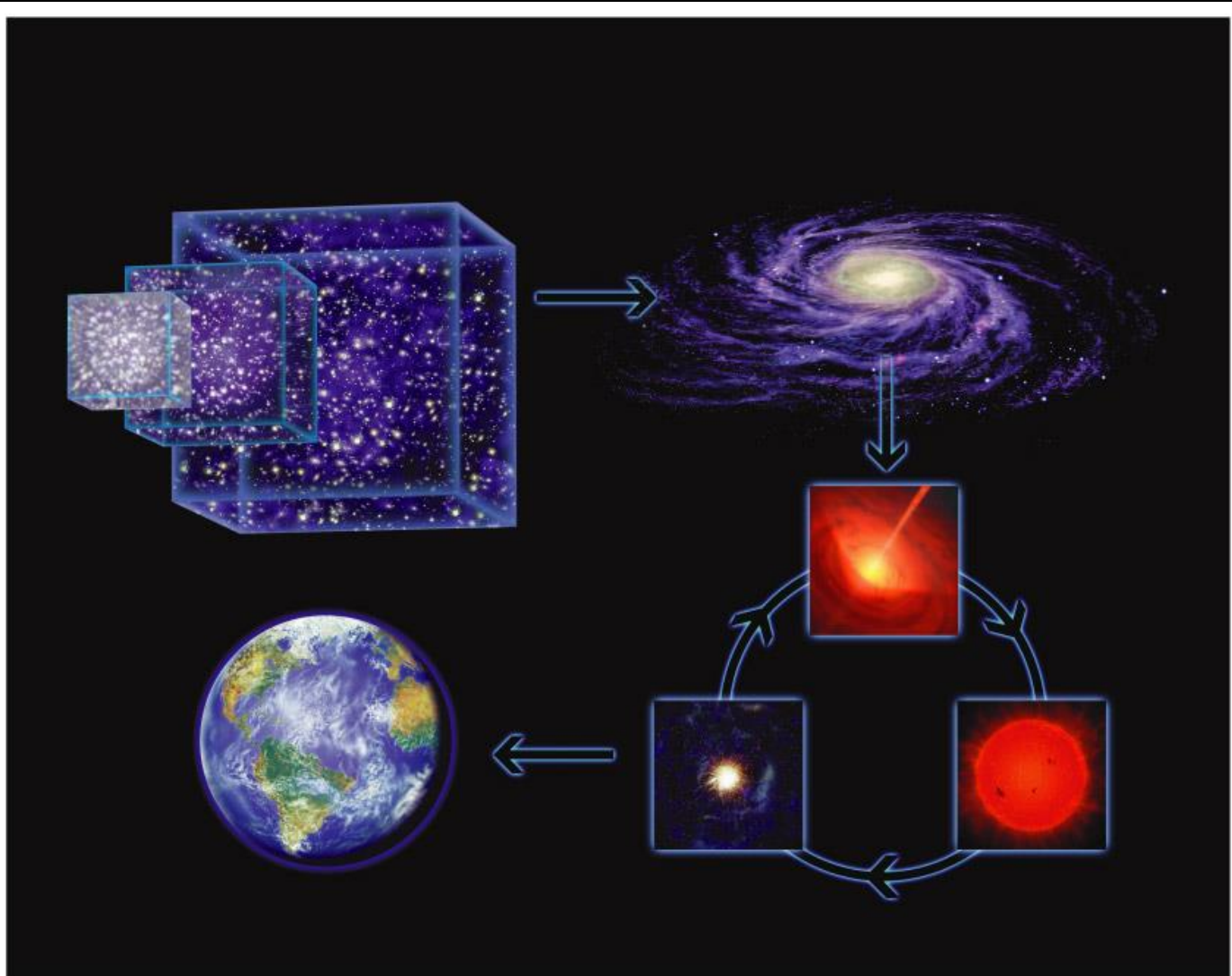


How did we come to be?

Big Bang?

Dust?

The Force?



Gas?

Star stuff?

42?



Moon (or satellite)



An object that orbits a planet.



Moon (or satellite)



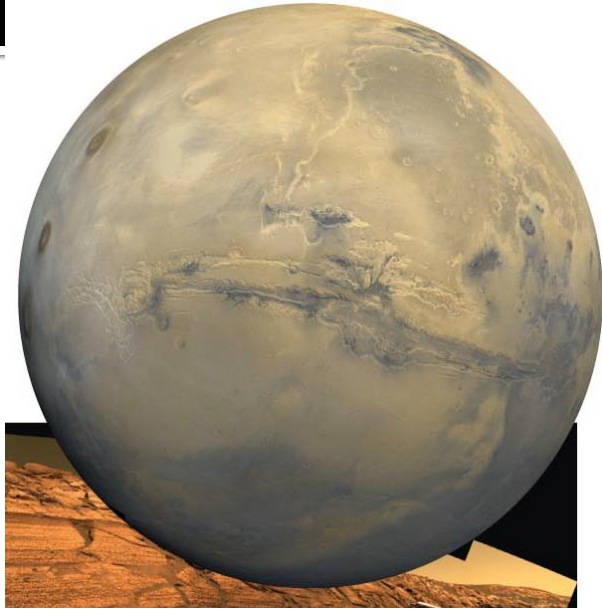
Ganymede (orbits Jupiter)

An object that orbits
a planet.

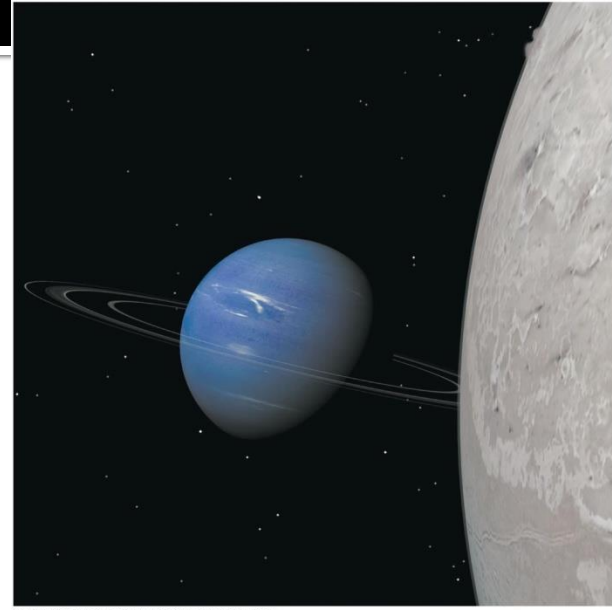


Saturn's moon Titan

Planet



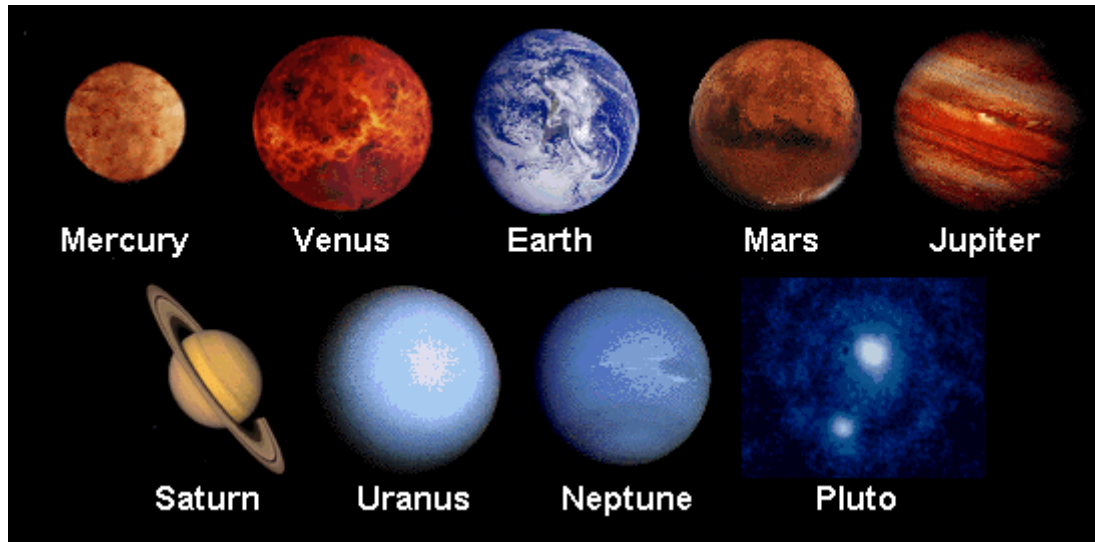
Mars



Neptune

A moderately large object that orbits a star; it shines by reflected light. Planets may be rocky, icy, or gaseous in composition.

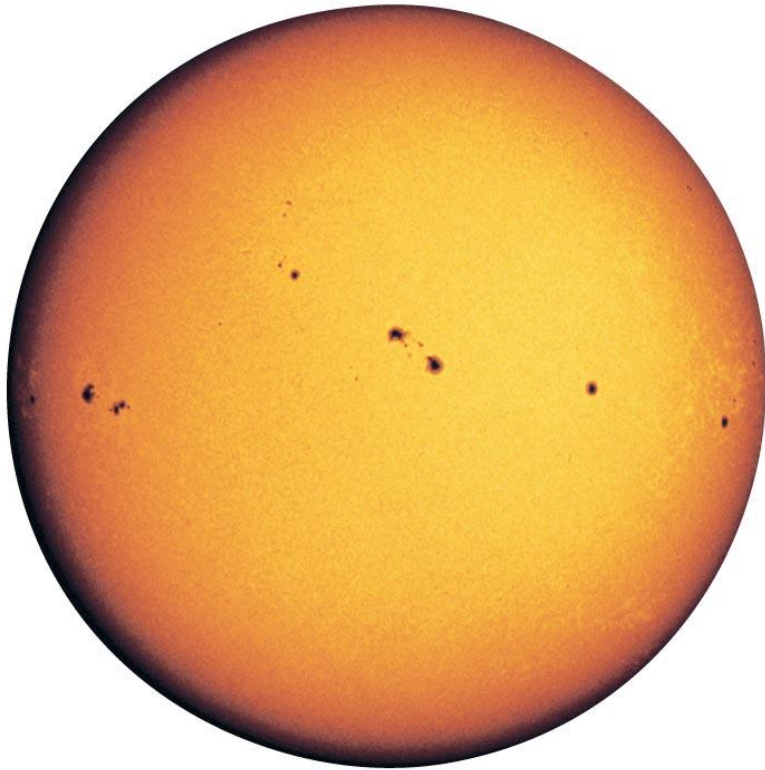
Planets



- First, it must orbit the Sun.
- Second, it must be big enough for gravity to squash it into a round ball.
- Third, it must have cleared other objects out of the way in its orbital neighborhood.

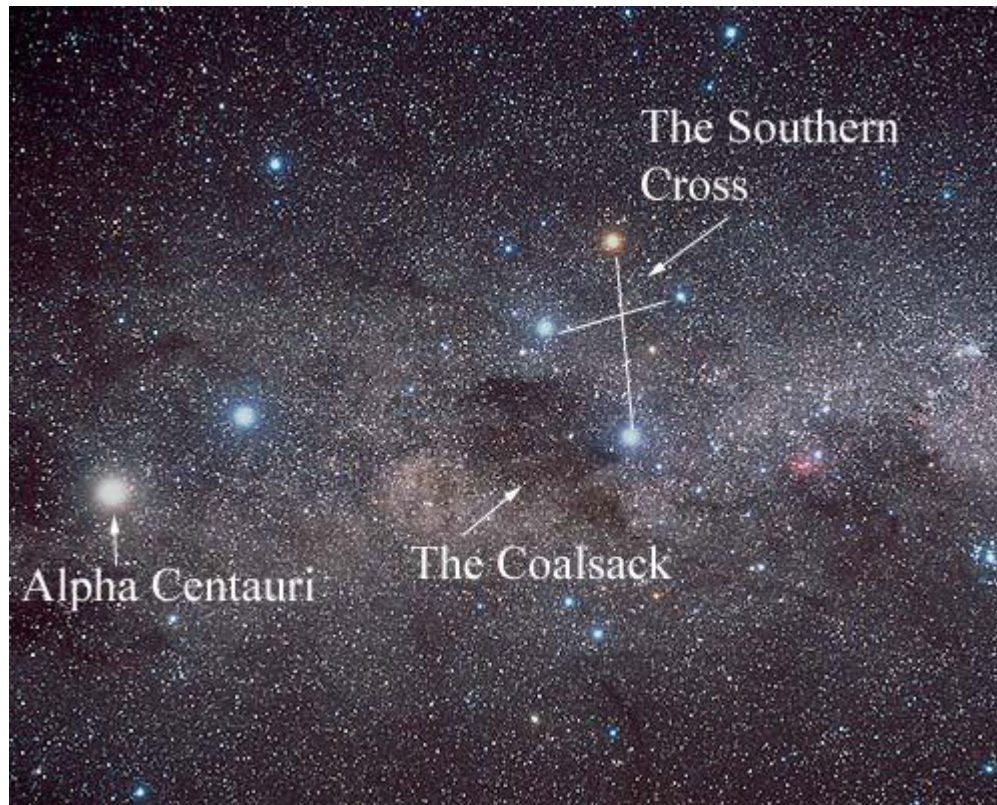
Star

A large, glowing ball of gas that generates heat and light through nuclear fusion



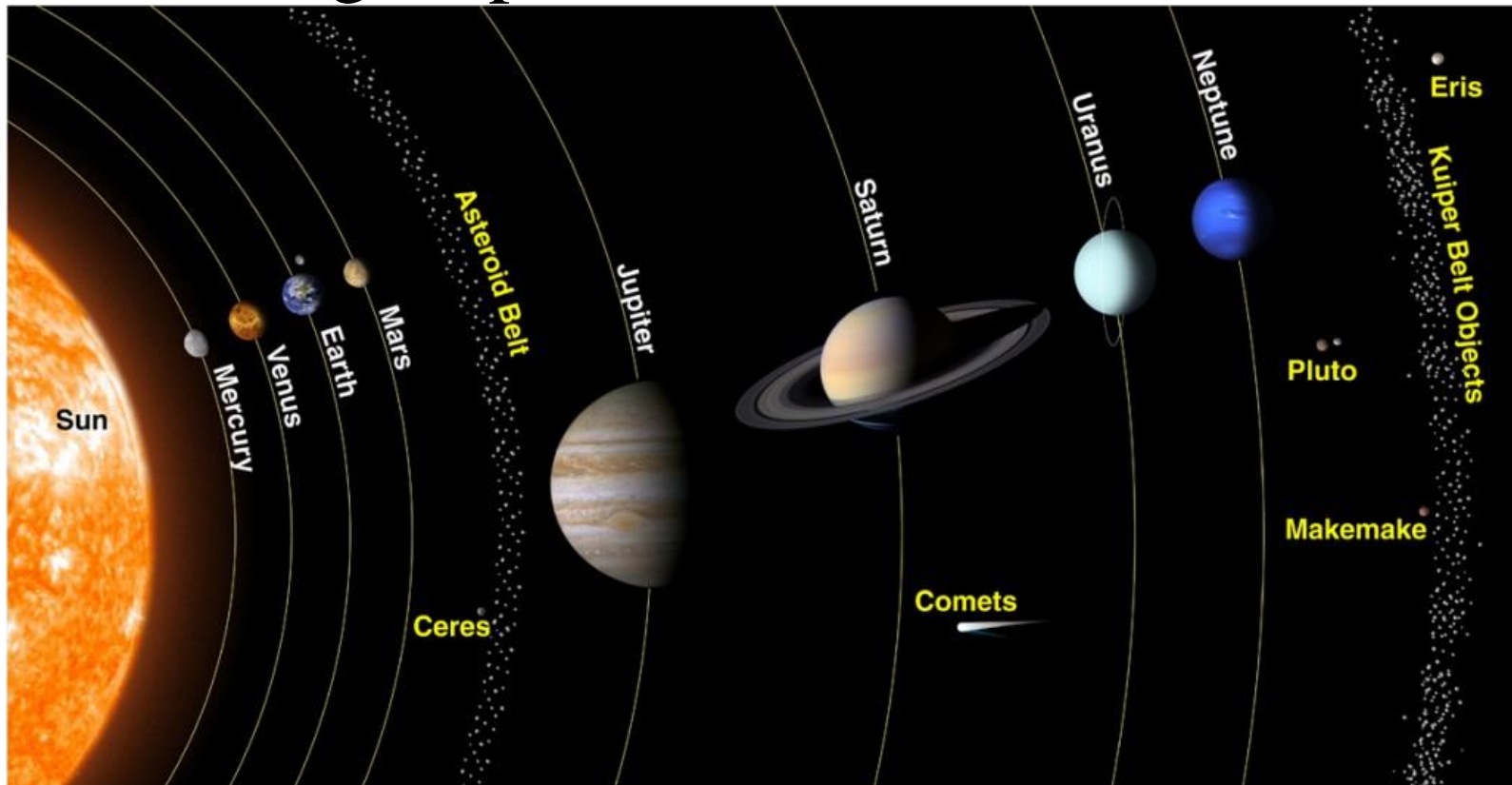
Star

Alpha Centauri



Solar (Star) System

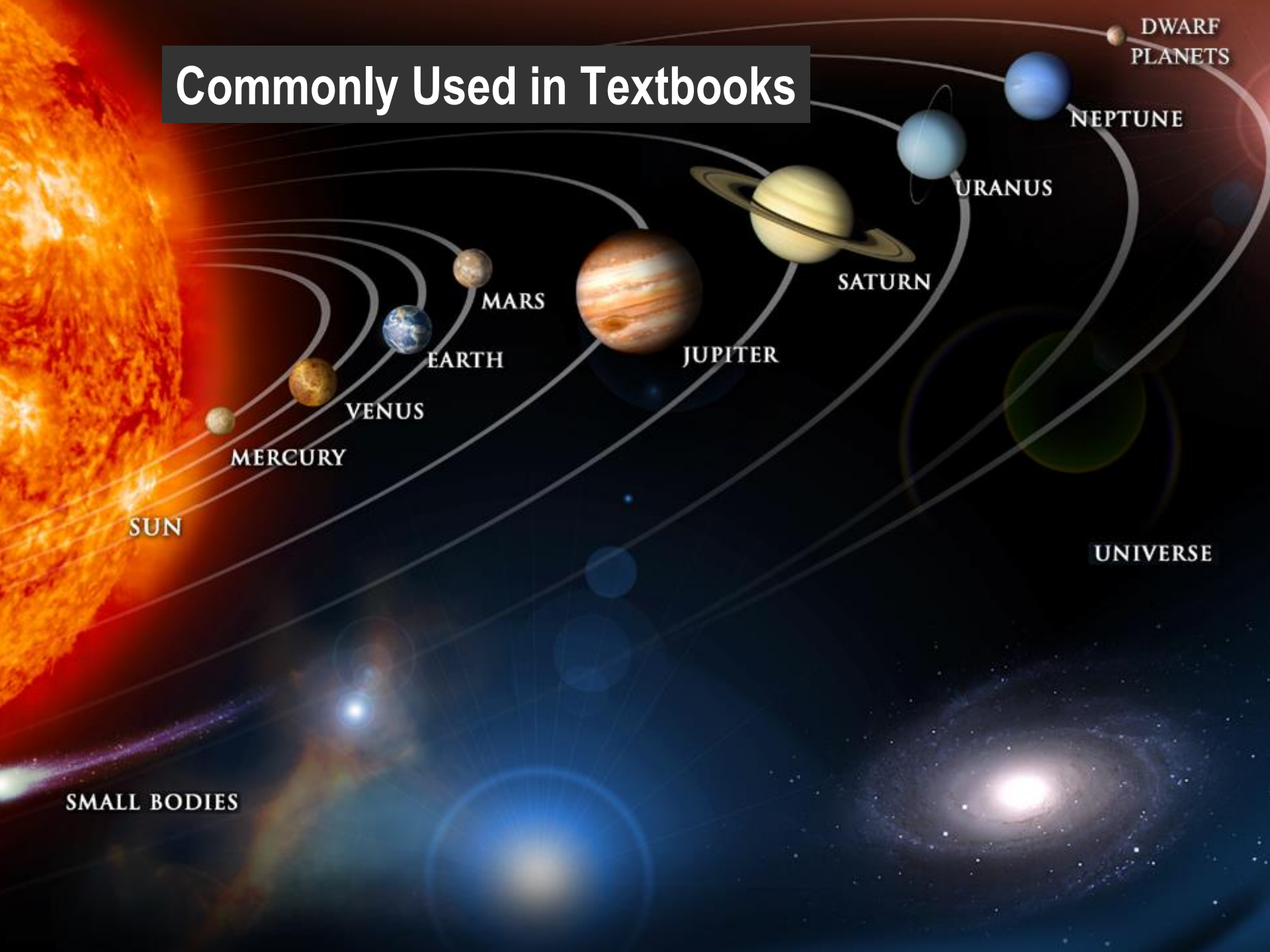
A star and all the material that orbits it, including its planets and moons



What are your observations?



Commonly Used in Textbooks



DWARF
PLANETS

NEPTUNE

URANUS

SATURN

JUPITER

MARS

EARTH

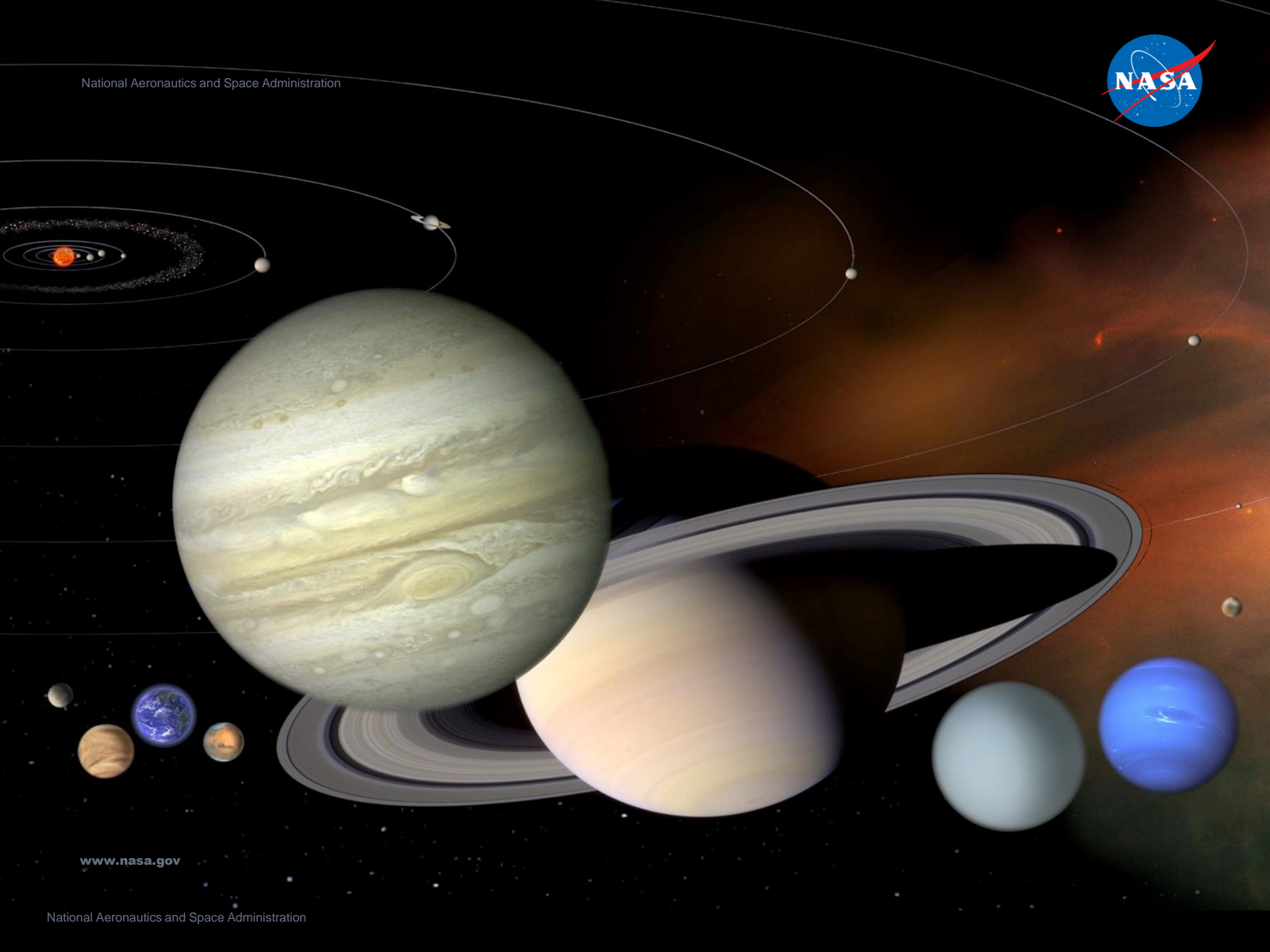
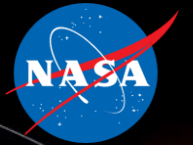
VENUS

MERCURY

SUN

UNIVERSE

SMALL BODIES



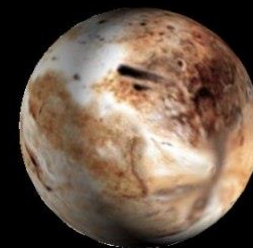
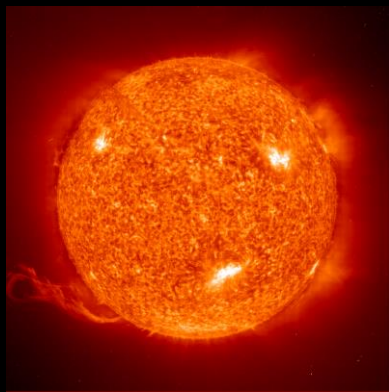
Pocket Solar system

First, order of the planets:



Pocket Solar System

STEP 1: Label one end the Sun and the opposite end Pluto/Kuiper Belt.



Sun

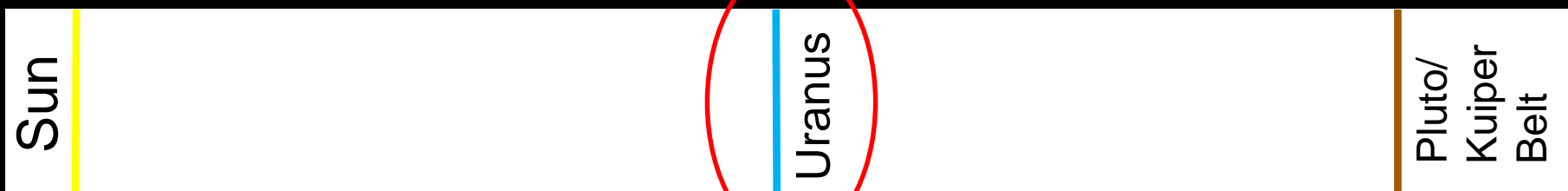
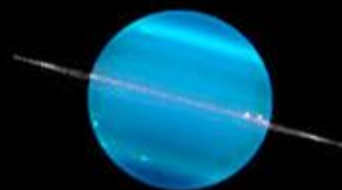
Pluto/
Kuiper
Belt



Pocket Solar System

STEP 2: Fold in half. "Sun meets Pluto/Kuiper Belt"

- Label Uranus

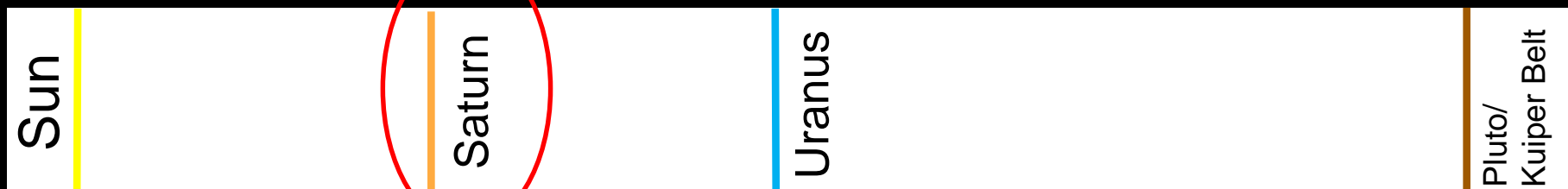
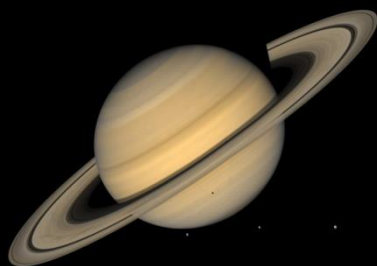




Pocket Solar System

STEP 3: Fold the Sun to Uranus. Unfold.

- Label Saturn



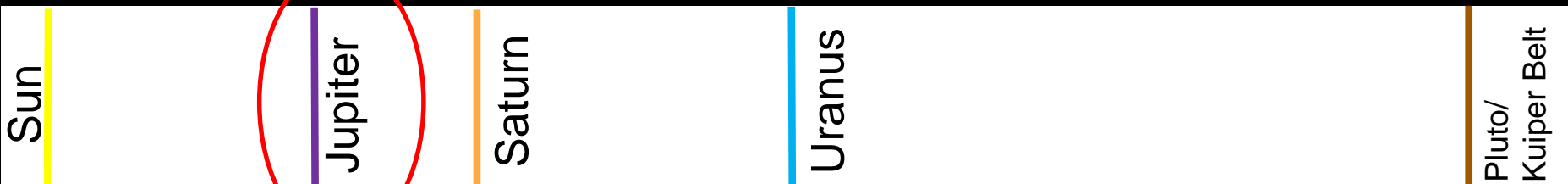


Pocket Solar System

STEP 4: Fold the Sun to Saturn. Unfold.



- Label Jupiter

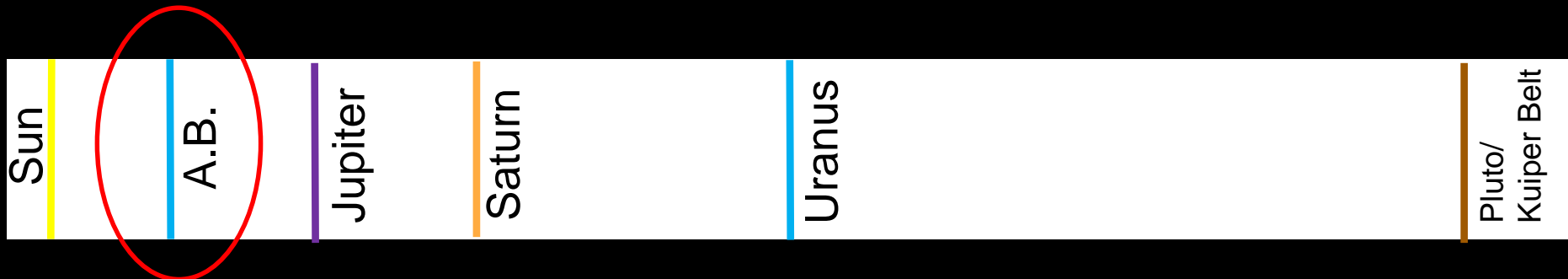




Pocket Solar System

STEP 5: Fold the Sun to Jupiter. Unfold.

- Label Asteroid Belt

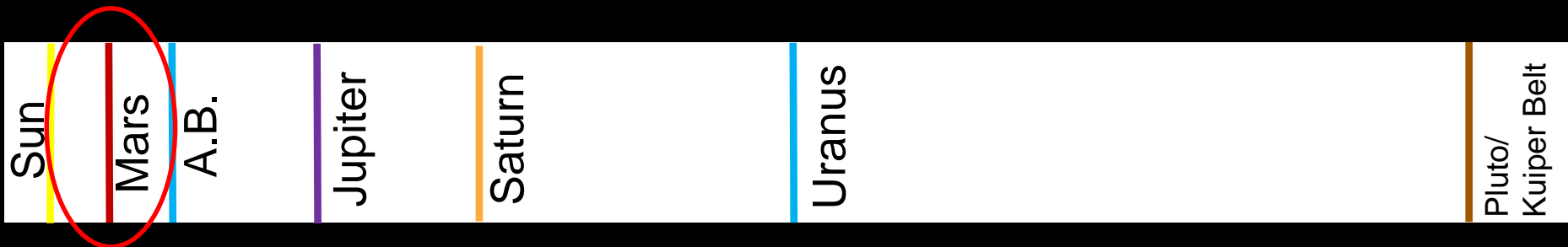




Pocket Solar System

STEP 6: Fold the Sun to the Asteroid Belt. Unfold.

- Label Mars



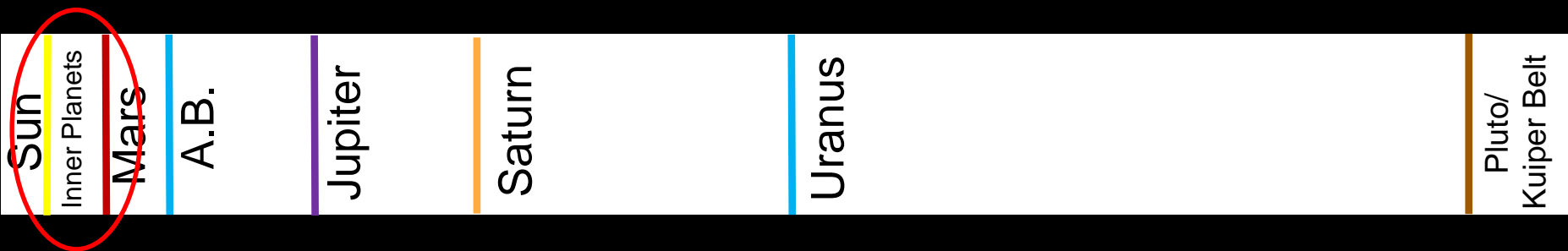


Pocket Solar System

STEP 7: Fold the Sun to Mars. Leave folded. Fold in half again. Unfold.



- Label the remaining planets in their proper order in the space between the Sun and Mars.

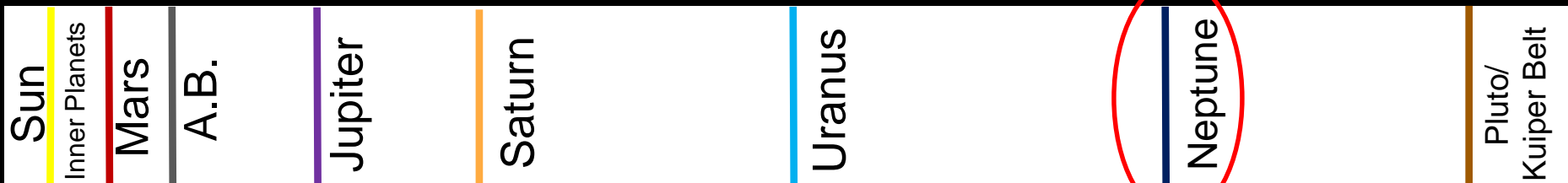
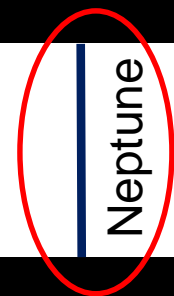




Pocket Solar System

STEP 8: Which Planet is missing? Where do you think it should be?

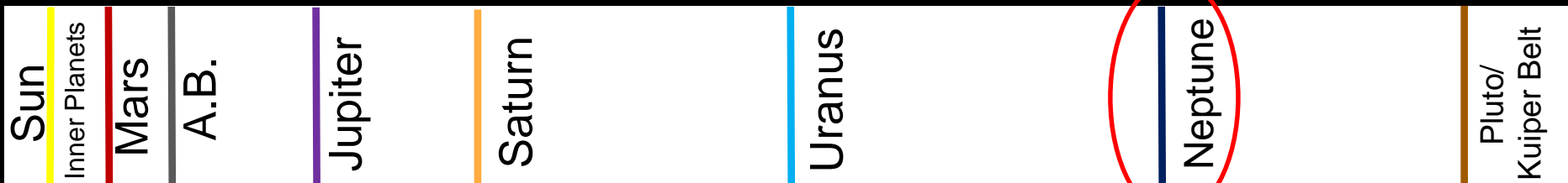
- Label Neptune





Pocket Solar System

Neptune was discovered mathematically!



Sun

Inner Planets

Mars

A.B.

Jupiter

Saturn

Uranus

Neptune

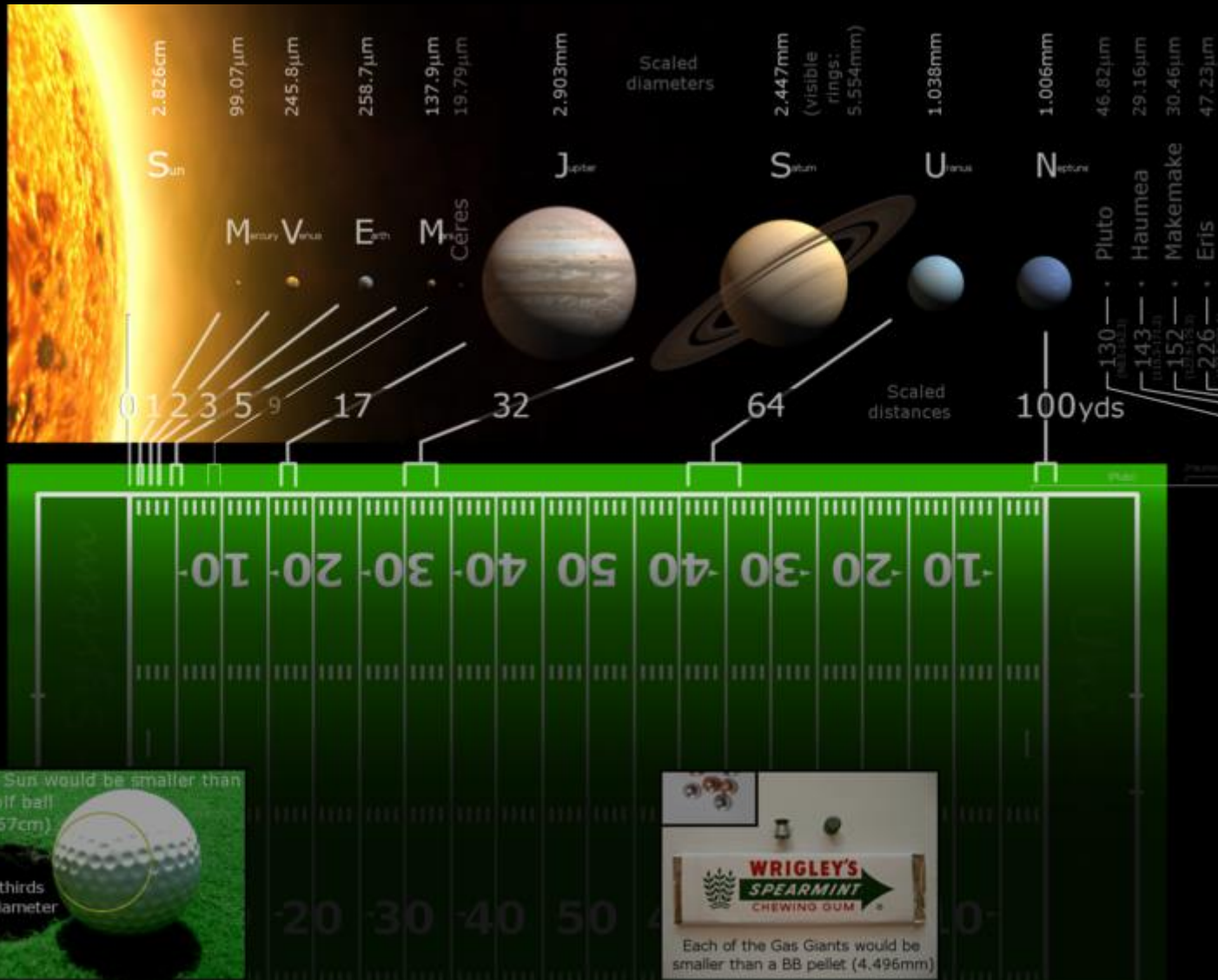
Pluto/
Kuiper Belt

Solar (Star) System

GAME TIME



Solar (Star) System



How big is Earth compared to our solar system?

Let's reduce the size of the solar system by a factor of 10 billion; the Sun is now the size of a large grapefruit (14 cm diameter).

How big is Earth on this scale?

- A. an atom
- B. a ball point
- C. a marble
- D. a golf ball



Let's reduce the size of the solar system by a factor of 10 billion; the Sun is now the size of a large grapefruit (14 cm diameter).

How big is Earth on this scale?

- A. an atom
- B. a ball point**
- C. a marble
- D. a golf ball



Let's go see what this looks like in the hall

How far away are the stars?

On our 1-to-10 billion scale, it's just a few minutes walk to Pluto.

How far would you have to walk to reach Alpha Centauri (nearest star to our solar system)?

- A. 1 mile
- B. 10 miles
- C. 100 miles
- D. the distance across the U.S. (2500 miles)

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How far is a light-year?

$$\begin{aligned} 1 \text{ light - year} &= (\text{speed of light}) \times (1 \text{ year}) \\ &= \left(300,000 \frac{\text{km}}{\cancel{s}} \right) \times \left(\frac{365 \cancel{\text{ days}}}{1 \cancel{\text{ yr}}} \times \frac{24 \cancel{\text{ hr}}}{1 \cancel{\text{ day}}} \times \frac{60 \cancel{\text{ min}}}{1 \cancel{\text{ hr}}} \times \frac{60 \cancel{\text{ s}}}{1 \cancel{\text{ min}}} \right) \\ &= 9,460,000,000,000 \text{ km} \end{aligned}$$

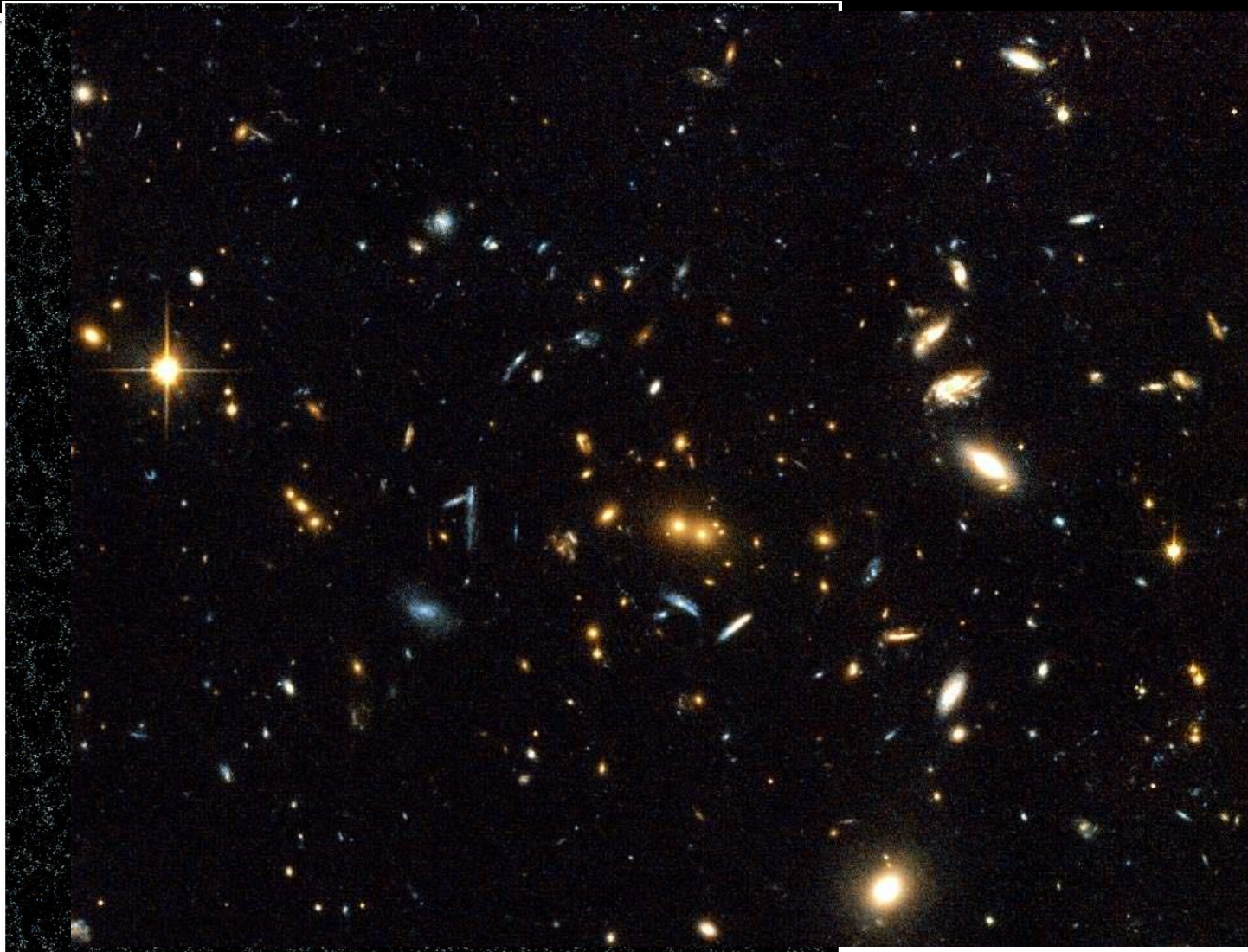
Where do we fit in the Universe?

How far does
light travel in
a year?

6 trillion miles

It could circle the
earth 240,954,178
times in a year

It can get around the
earth 7.48 times in
one second



How can we know what the universe was like in the past?

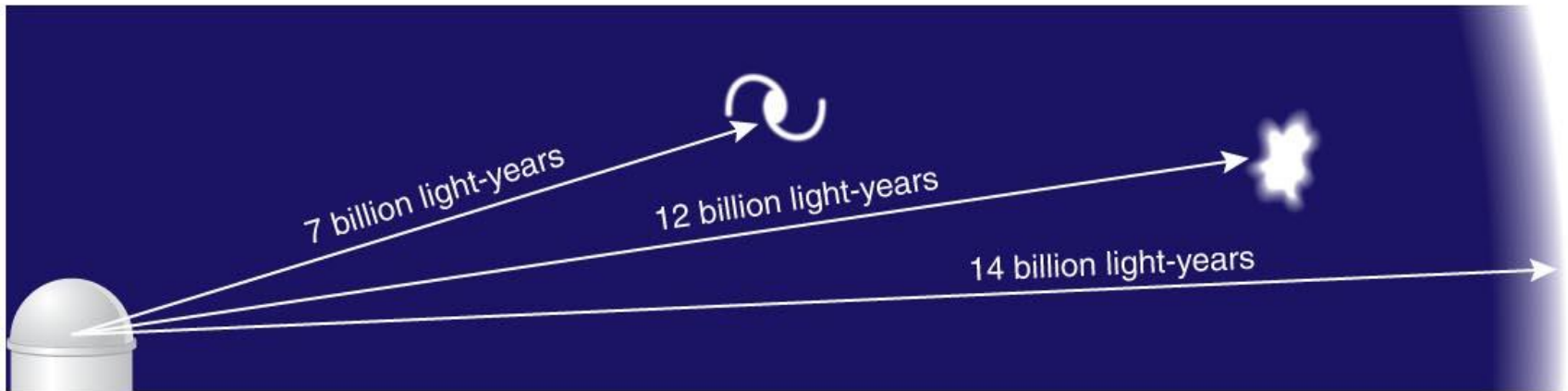
- Light travels at a finite speed (300,000 km/s).

Destination	Light travel time
Moon	1 second
Sun	8 minutes
Sirius	8 years
Andromeda Galaxy	2.5 million years

- Thus, we see objects as they were in the past:
*The farther away we look in distance,
the further back we look in time.*

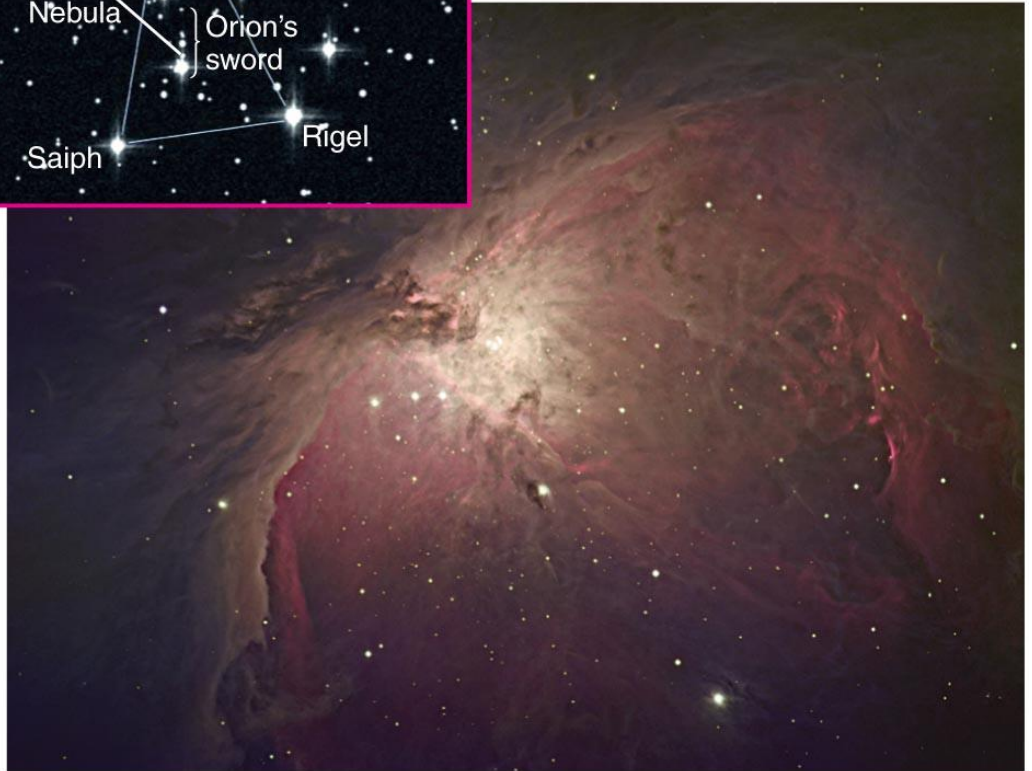
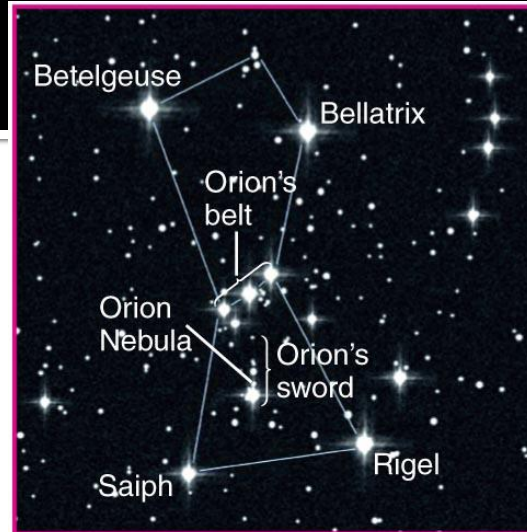
* Light can circle Earth 8 times in one second

- At great distances, we see objects as they were when the universe was much younger.



Example:

We see the
Orion Nebula as
it looked 1,500
years ago.

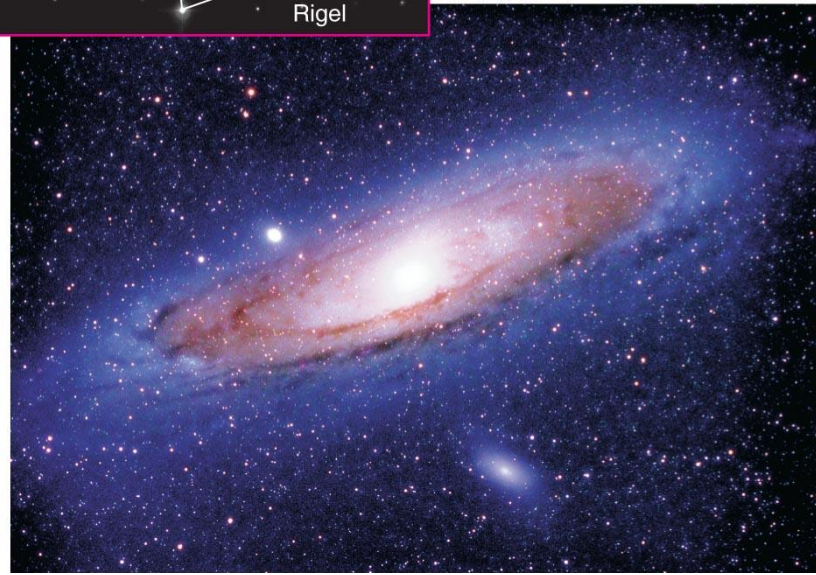
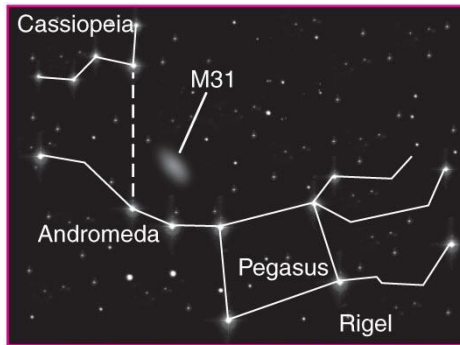


Example:

This photo shows the Andromeda Galaxy as it looked about 2 1/2 million years ago.

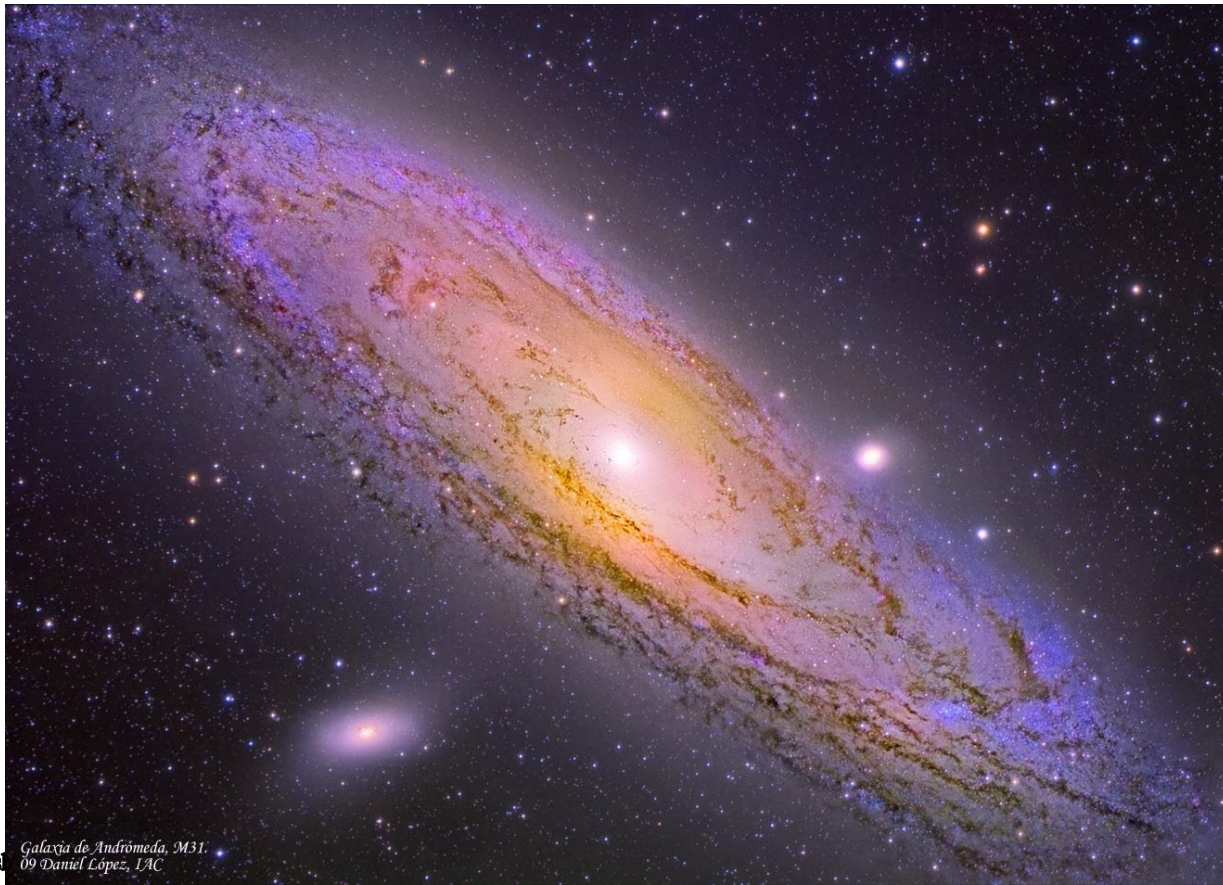
Question: When will be able to see what it looks like now?

2.5 million years from now. But not much will happen in that time.



Galaxy

A great island of stars in space, all held together by gravity and orbiting a common center



*Galaxia de Andr meda, M31.
09 Daniel L pez, IAC*

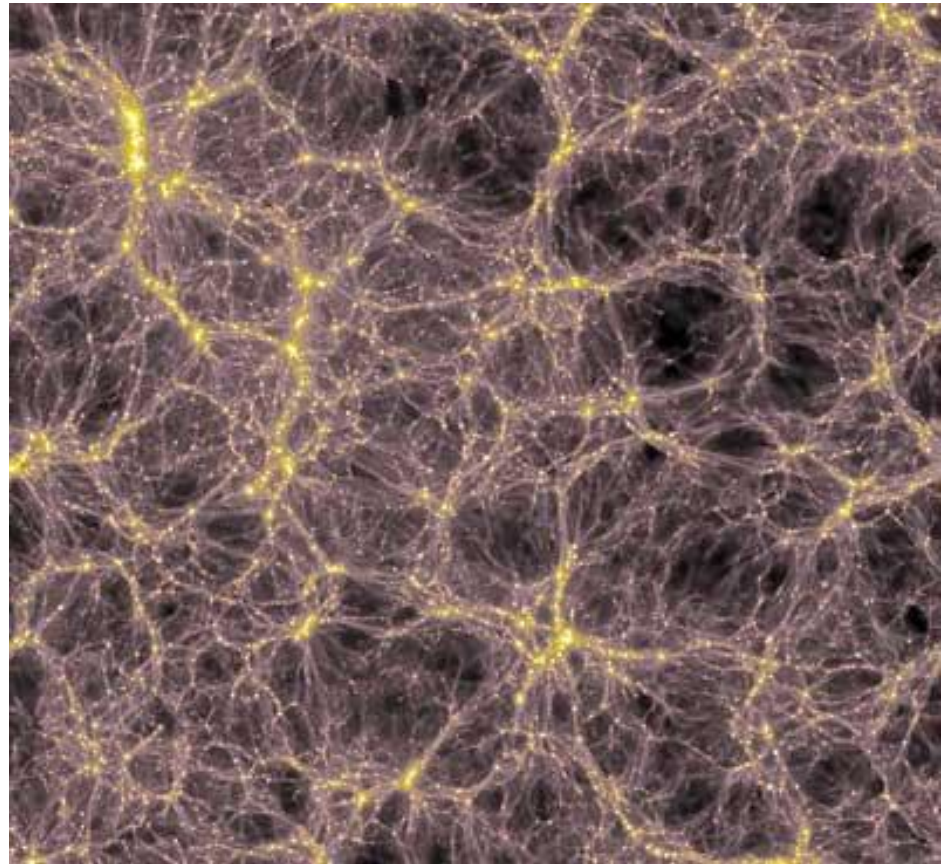
Galaxy

How far across do you think the Milky Way Galaxy is?

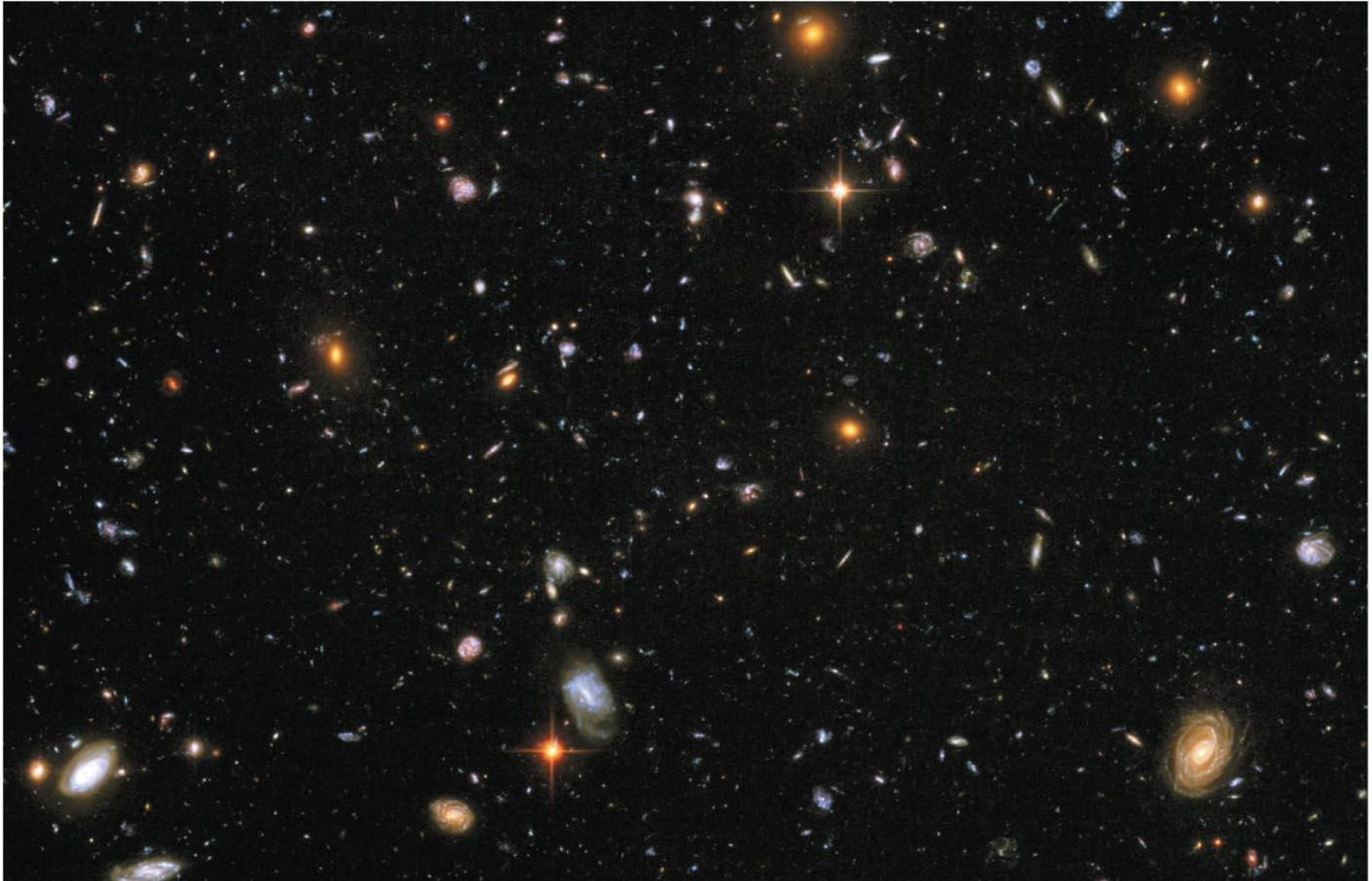


Universe

The sum total of all matter and energy; that is, everything within and between all galaxies



Universe

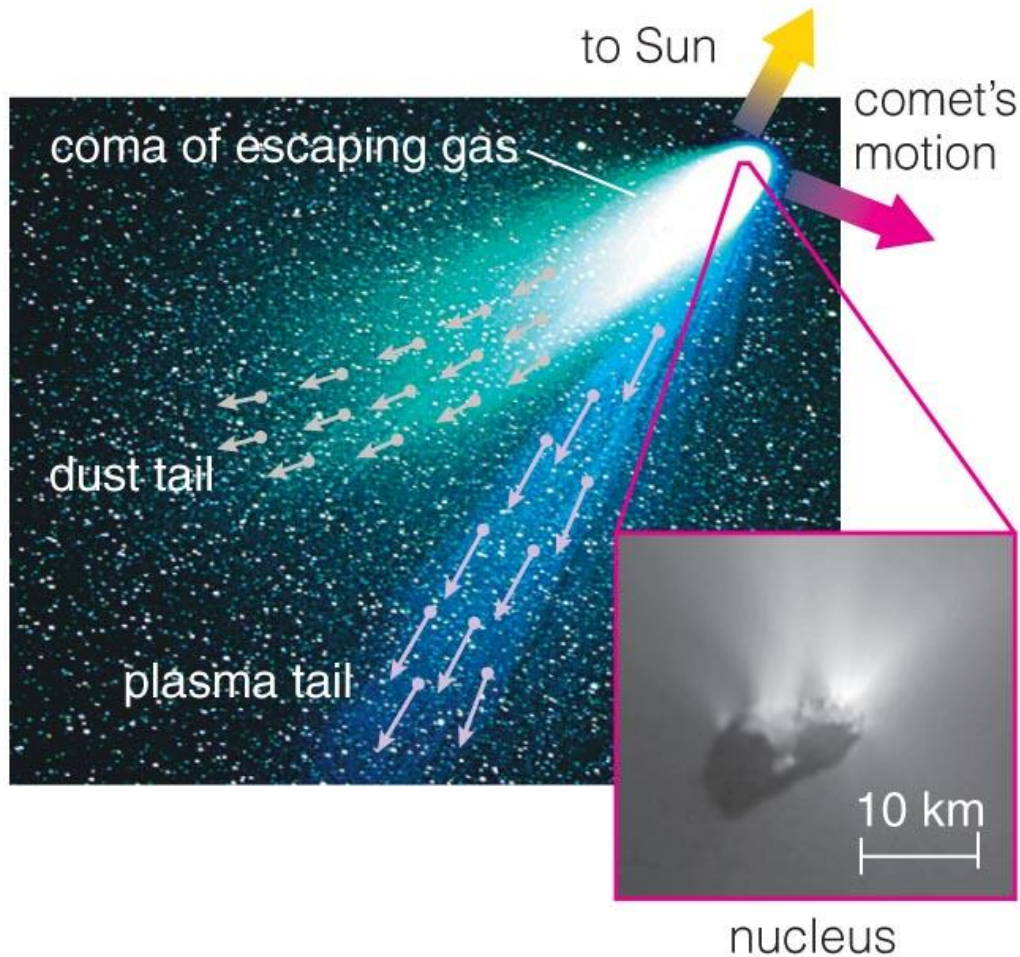


Asteroid

A relatively small and rocky object that orbits a star.



Comet



A relatively small and icy object that orbits a star.

How big is the Universe?

- 10^{11} stars/galaxy \times 10^{11} galaxies = 10^{22} stars



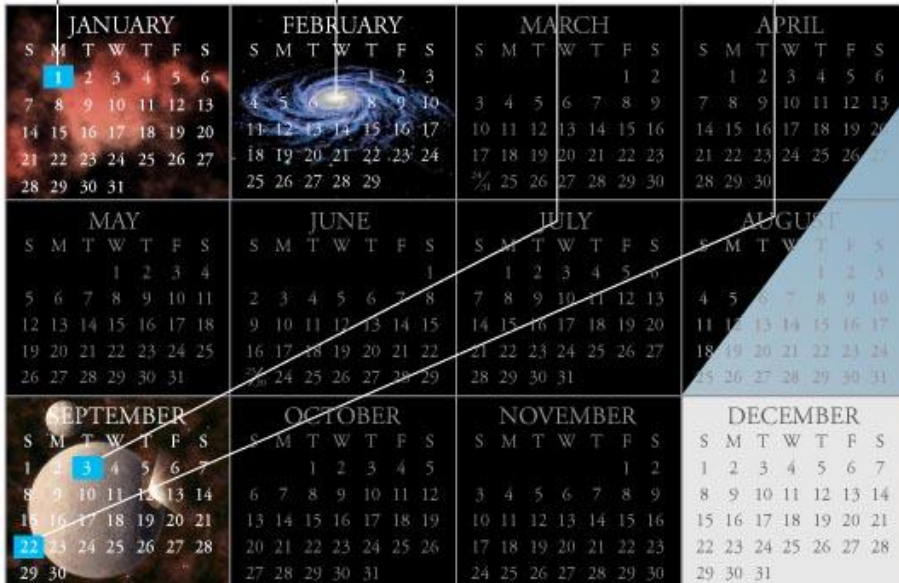
As many stars as grains of (dry) sand on *all* Earth's beaches...

How do our lifetimes compare to the age of the Universe?

- The Cosmic Calendar: a scale on which we compress the history of the universe into 1 year.

THE HISTORY OF THE UNIVERSE IN 1 YEAR

January 1: The Big Bang
 February: The Milky Way forms
 September 3: The Earth forms
 September 22: Early life on earth
 December 17: Cambrian explosion
 December 26: Rise of the dinosaurs
 December 30: Extinction of the dinosaurs



How do our lifetimes compare to the age of the Universe?

- The Cosmic Calendar: a scale on which we compress the history of the universe into 1 year.

December 31:

9:00 pm:
Early hominids evolve

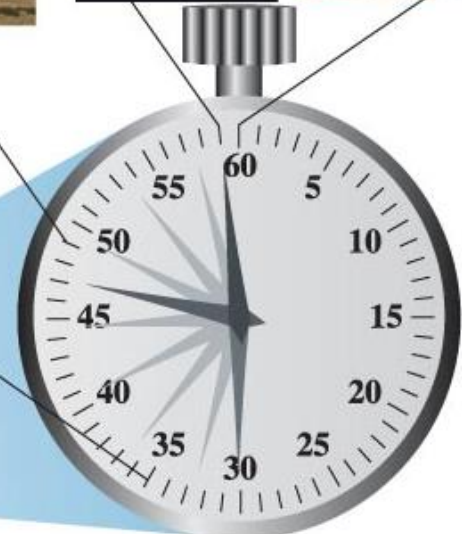
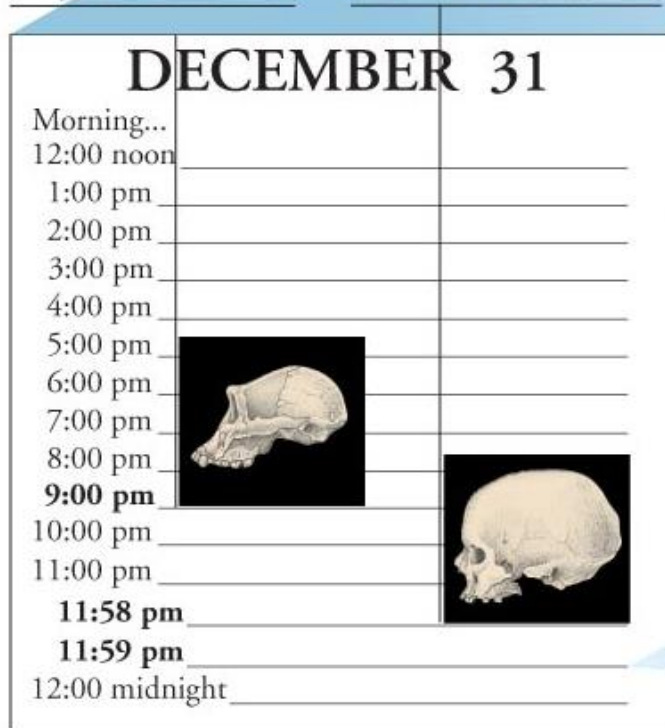
11:58 pm:
Modern humans evolve

25 seconds ago:
Agriculture arises

11 seconds ago:
Pyramids built

1 second ago:
Kepler and Galileo
show that Earth
orbits the Sun

Now



Universe

How big is the universe?

14 billion light years worth is all we can see.

14 billion light years of light makes up the
visible universe!

And it is still expanding!

Quiz: (Put on a half sheet and turn in at the end of class)

1. If the Earth were the size of a basketball, how big would the Moon be?
2. If the Sun were at one end of a football field, and Pluto was at the other, where would Earth be?
3. What's the biggest difference between a comet and an asteroid?