

Astronomical distances and sizes are very very large. So, astronomers use different units.

One "Astronomical Unit" (AU)

average distance between Sun and Earth

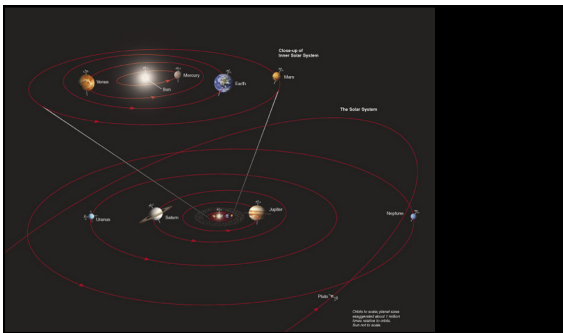
- 93,000,000 miles
- 150,000,000 km
- 1.5×10^8 km

Distance Light Travels in One Year is a "Light-year" (LY)

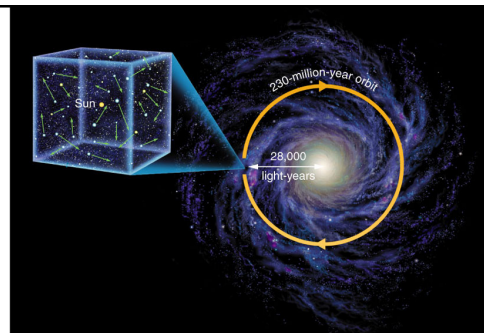
- 9.46×10^{12} km
- 63,000 AU or 6.3×10^4 AU



At the scale of the size of a planet or moon we describe things in terms of kilometers (km)



At the scale of the Solar System distances are described in terms of the Astronomical Unit or AU (ave. distance from Earth to the Sun).



At the scale of the Milky Way Galaxy distances are described in terms of Light-years which is the distance light travels in one year.

The Universe in a Classroom

Scale I: 1 / 31.7 million (1 cm = 317 km)

- Earth's diameter 12,800 km = 40 cm (Earth Ball)
- Moon's diameter 3,480 km = 11 cm (grapefruit)
- Earth-Moon separation 400,000 km = 12 m
- On this scale, the Sun is about 4.7 km (3 miles) away

<http://www.naic.edu/~gibson/scale>

The Universe in a Classroom

Scale II: 1 / 15 billion (1 cm = 150,000 km = 0.001 AU)

- Earth-Moon distance 2.5 cm
- Sun's diameter 1,400,000 km = 9.3 cm
- Earth-Sun separation 150,000,000 km = 10 m
- On this scale, Alpha Centauri is about 2,000 km away

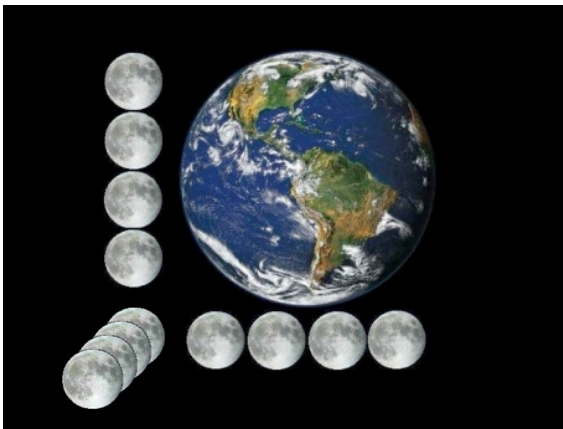
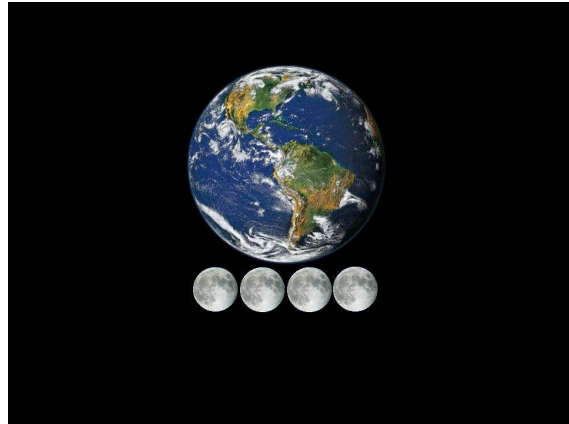
<http://www.naic.edu/~gibson/scale>

The Universe in a Classroom

Scale III: 1 / 1.627 quintillion (1 cm = 16,270,000,000,000 km = 0.65 light-years)

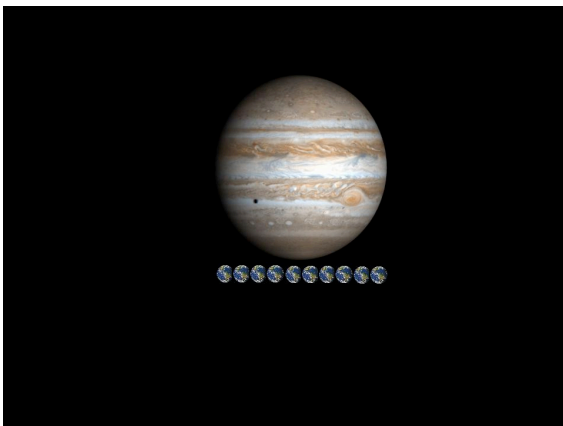
- Sun-Alpha Centauri separation = 2.5 cm
- The Solar Neighborhood (starts fill in the classroom)
- Diameter of the Milky way galaxy is about 560 m (5 football field)
- Thickness of the disk is about 52 m (17-floor building)

<http://www.naic.edu/~gibson/scale>



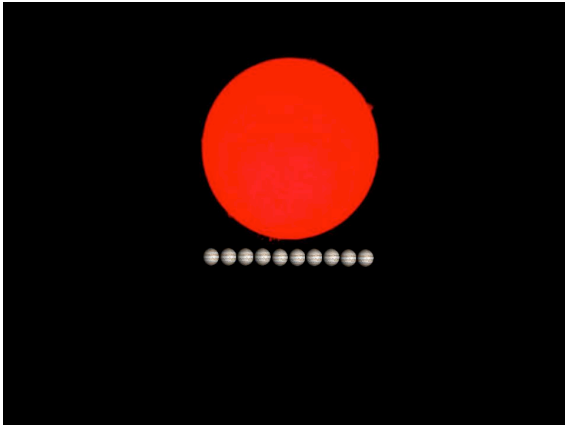
Earth is 4 Moons wide.

Earth has $4 \times 4 \times 4 = 64$ times the Moon's volume but 82 times the Moon's mass.

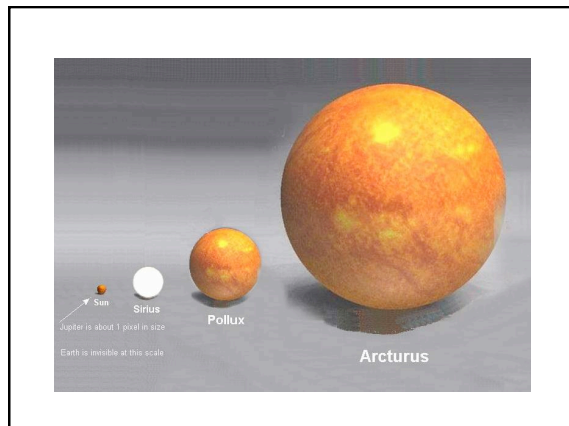
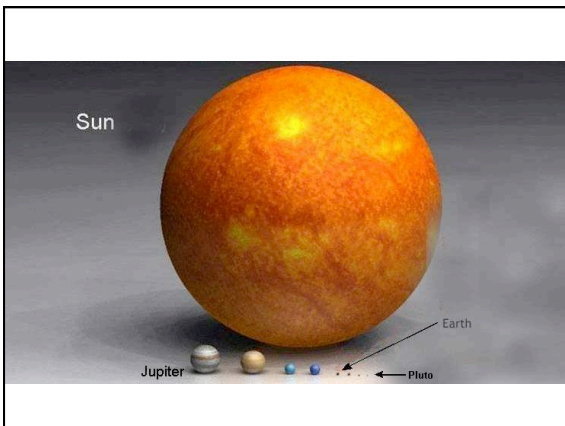
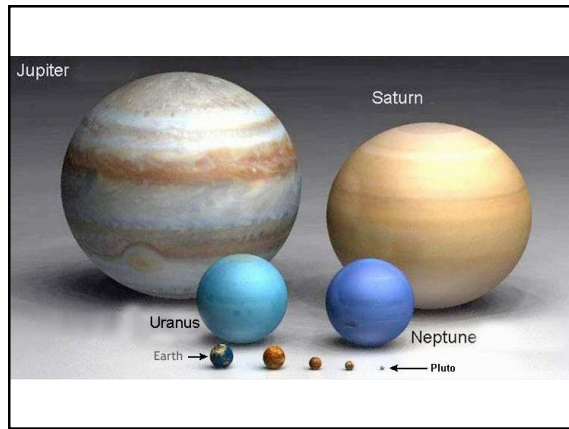
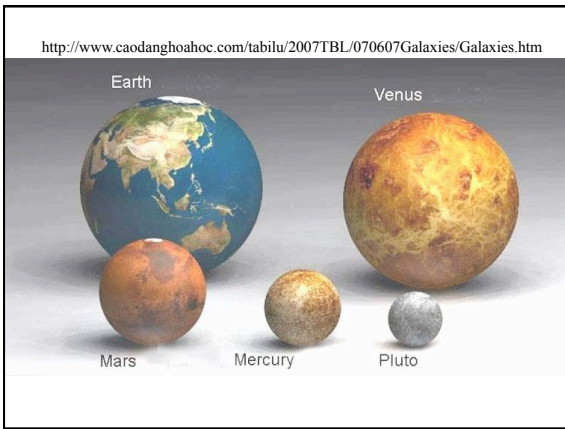


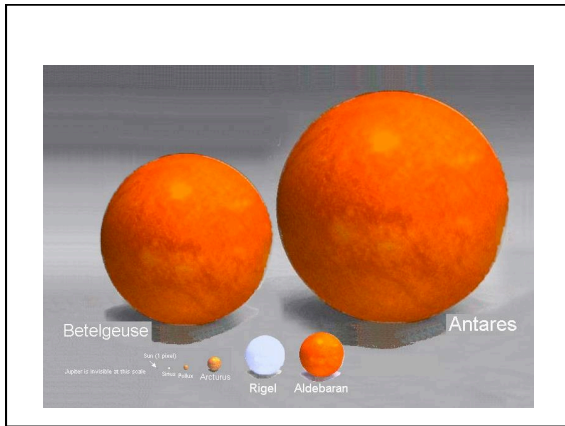
Jupiter is 10 Earth's wide.

Jupiter has $10 \times 10 \times 10 = 1000$ times Earth's volume but only 316 times Earth's mass.



The Sun is 10 Jupiter's wide.
The Sun has $10 \times 10 \times 10 = 1000$ times Jupiter's volume and 1000 times Jupiter's mass.



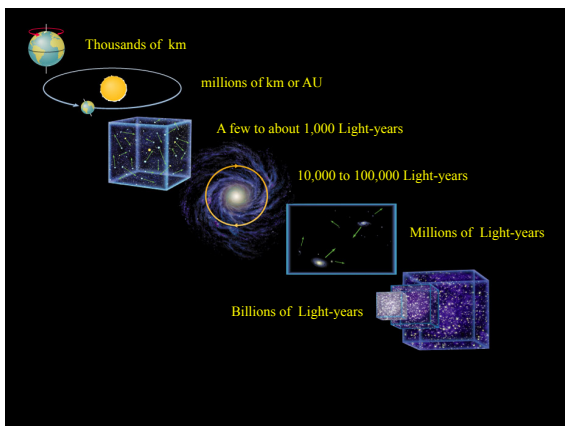
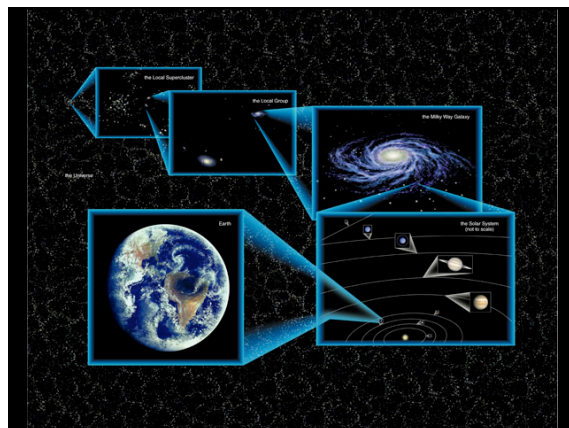


Our Sun moves randomly relative to the other stars in the local Solar neighborhood...

- typical relative speeds of more than 70,000 km/hr
- but stars are so far away that we cannot easily notice their motion

... And orbits the galaxy every 230 million years.

More detailed study of the Milky Way's rotation reveals one of the greatest mysteries in astronomy:



Are we ever sitting still?

How big is the Universe?

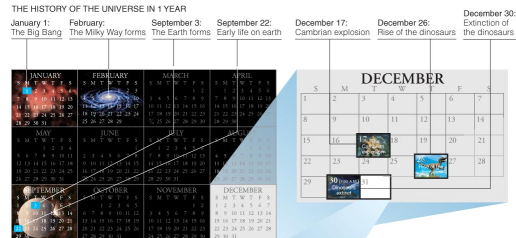
- The Milky Way is one of about 100 billion galaxies.
- 10^{11} stars/galaxy x 10^{11} galaxies = 10^{22} stars



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

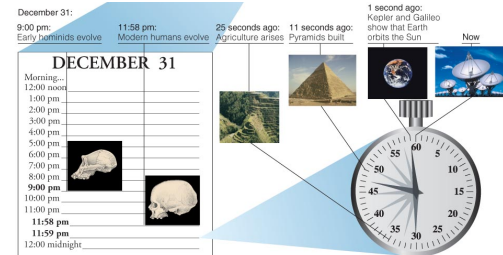
How do our lifetimes compare to the age of the Universe?

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



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.



In-class Activities: Looking at Distant Objects & Milky Way Scales

- Work with a partner!
- Read the instructions and questions carefully.
- Discuss the concepts and your answers with one another. Take time to understand it now!!!!
- Come to a consensus answer you both agree on.
- If you get stuck or are not sure of your answer, ask another group.
- If you get really stuck or don't understand what the question is asking, ask me.