

# Our Place in the Universe

8/31/2009

# Opening Discussion

- What did we talk about last class?
- Have you seen anything interesting in the news?
- Do you have any questions about the reading?
- Minute Essay responses
  - Wikipedia on space.
  - Insignificance of our existence?
  - Birthdays

# Scales of Distance

- In astronomy we routinely deal with very large distances. To help show you how big, let's consider a 10 billionth ( $1:10^{10}$ ) scale model of our solar system.
- At this scale, the Sun is roughly the size of a grapefruit (13.9 cm diameter). The Earth is about the size of a small ball bearing (1.3 mm diameter).
- Where is the “edge of the solar system”? Where is the nearest star? How big is our galaxy? How does this make you feel?

# Units of Distance

- On Earth we measure distances in kilometers/miles or in meters/feet.
- Just as you don't talk about the distance between two cities in feet or how tall you are in miles, in astronomy we typically use different units for measurements.
- In planetary science the primary unit is the astronomical unit (AU). That is the average distance of the Earth from the Sun or about 150 million km.
- A light-year is the distance light travels in a year or about 9.46 trillion kilometers.

# Light

- Light is very special in astronomy for many reasons. Some are obvious, others are less so.
- One very special feature of light is that everyone sees light traveling at the same speed, regardless of their inertial frame. Light travels at 299,792,458 m/sec ( $\sim 3 \times 10^8$  m/s).
- In groups, work out how far a light minute is in km. Roughly how many light minutes are in an AU?

# How big are these numbers?

- We will often talk about numbers that are extremely large or small in this course. Having some way to try to understand how large they are is critical.
- To help with this lets switch to time instead of distance. How many seconds are in a year? How many seconds will you likely live?
- Moving at walking speed, how long would it take you to walk a light-second? Can you walk the distance from the Earth to the Sun in a lifetime?

# Galaxies and the Universe

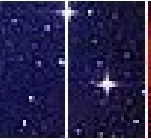

- Our own galaxy, the Milky Way, is roughly 100,000 light-years across and contains more than 100 billion stars.
- The Universe is vastly larger than our galaxy. In fact, there are more than 100 billion galaxies in the Universe. Following that logic there are roughly  $10^{22}$  stars in the Universe, many of them much like our own Sun.
- Feel free to try to think of how big  $10^{22}$  is. It is so large that it is hard for the human brain to grasp or to come up with good examples of.

# Scales of Time

- Not only are lengths in astronomy large, so are timescales. The Universe is roughly 14 billion years old. Our solar system formed about 4.6 billion years ago.
- Your book goes through a really nice “scaling argument” looking at the history of the Universe as being a single year.
- In this analogy, how many years does one second represent?
- What parts of this analogy did you find surprising? Do you think that intelligent life is common in our galaxy? Why?



# Graphic for Time

January	February	March	April	May	June	July	August	September	October	November
										
New Year's Day: The Big Bang	Milky Way forms						Sun and planets form	Oldest known life (single celled).	First multi-cellular organisms	
December										
1	2	3	4	5	6	7	8	9	10	11
12	13	14	15 Cambrian Explosion (burst of new life forms)	16	17 Emergence of first vertebrates	18 Early land plants	19	20 First four-limbed animals	21 Variety of insects begin to flourish	22
23	24 First dinosaurs appear	25 First mammalian ancestors appear	26	27 First known birds	28	29 Dinosaurs wiped out by asteroid or comet	30	31		
		10:15am Apes appear		9:24pm First human ancestors to walk upright		10:48pm Homo erectus appears		11:54pm Anatomically modern humans appear		11:59:45pm Invention of writing
		11:59:50pm Pyramids built in Egypt		1 second before midnight: Voyage of Christopher Columbus						

# Minute Essay

- What was the most surprising thing you learned from the reading for today or in class?
- Remember to read 1.3 and 1.4 for next class.