Astronomy 1002

Planets, Stars and Galaxies

Section-1
Mon. & Weds. 3:35-4:50

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What is Astronomy?

- Astronomy is the study of objects beyond the Earth's atmosphere and of how these objects interact

- IMPORTANT: This is a science class!

- We will learn:

  - How we know about astronomy
  - What we know about astronomy
  - What we need to learn more about

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- Also IMPORTANT: This is NOT an astrology class! We will not learn about the constellations.

Astronomy 1002 Grades

- Grades will be determined by:
    - Quizzes   30%
    - 2 mid-term exams   20% each
    - Final Exam   30%
    - Extra credit   up to 10%

- There will be 12 quizzes randomly placed throughout the semester. We will drop the 2 lowest quiz grades.

- Extra credit can be earned by answering questions during class or by answering extra credit questions posted on the course webpage.

Getting Help

- **If you have questions, <u>ASK</u>!**
  - Ask during class
  - Send an email (<u>tadams@hep.fsu.edu</u>)
  - Call my office 644-7159
  - Come to my office hours
    - Mon. & Weds. 10-11 am
  - Set up an appointment
  - Stop by my office any time I'm in
  - Course website: <u>http://www.hep.fsu.edu/~tadams/courses/fall02/ast1002/</u>
- **Also, the textbook is a good place to get more information**

Scientific Method

- Based on testing and experimentation
  - Make a model (hypothesis)
  - Test the model
    - Observations
    - Experiments
  - Modify the model (if necessary)
  - Retest
    - Improved techniques
    - Better experiments
- Don't accept things on faith, look for evidence
- But remember, science is done by people

Cosmological Principle

- There is nothing special about out place in the universe

- The Universe is isotropic – it looks the same in all directions

- The Universe is homogeneous – any large volume looks the same as any other large volume at the same distance

  - Need to us a large volume since there are small scale variations (like us!)

- Without the cosmological principle, you can not study the universe as a whole, only the parts you can see

"Laws" of Nature

- **The rules describing how the Universe behaves**
  - The ultimate promotion for a model
- **Same rules apply everywhere**
  - For example, gravitation, motion, etc.
- **Subject to modification**
  - e.g. Newton's laws governing motion
    - Work perfectly well for objects not moving really fast
    - For really fast moving objects, need Einstein's theory of relativity

Big and Small Numbers

- **Really big and really small numbers are hard to understand…**
  - Examples, how many are 1, 10, 100, 1000, 10000, 100000, 1000000,… ?
    - Have you ever seen a million of anything?
  - We will often use powers of 10 for large and small numbers
    - $1{,}000{,}000 = 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 10^6$
  - Each factor of 10 is one <u>order of magnitude</u>

Big and Small Numbers

- Really big and really small numbers are hard to understand and work with…
  - It takes a LOT of zeros to write some numbers
    - A million billion is 1,000,000,000,000,000
  - Easier to use powers of 10
    - A million billion has 15 zeros which is 10^{15}
    - 5 million billion is 5×10^{15}
  - Small numbers use negative powers of 10
    - A million billionth is 10^{-15}

Measuring Distance

- **Metric units**
  - Meters (m) and kilometers (km)
    - 1 meter = 3.281 feet
    - Kilometer = 1000 meters = 10^3 meters = 0.6 miles\
    - 1 millimeter = 0.001 meters = 10^{-1} meters
- **Astronomical Unit (AU)**
  - Distance from the Sun to Earth
  - 150 million kilometer
- **Lightyear (LY)**
  - Distance light travels in 1 year
  - Light travels at 3×10^8 m/s in a vacuum
    - 186,000 miles/second
    - 7 times around the Earth in a second
  - So in a year, how far does light travel?

Lightyear

- There are about 3×10^7 seconds in a year
  - 60 s/min x 60 min/hr x 24 hr/day x 365 days/year ~ 3.15×10^7 s/yr
- Light travels at 3×10^8 m/s (or 186,000 miles/s)
- So,

3×10^8 m/s x 3×10^7 s = 9×10^{15} m = 9×10^{12} km
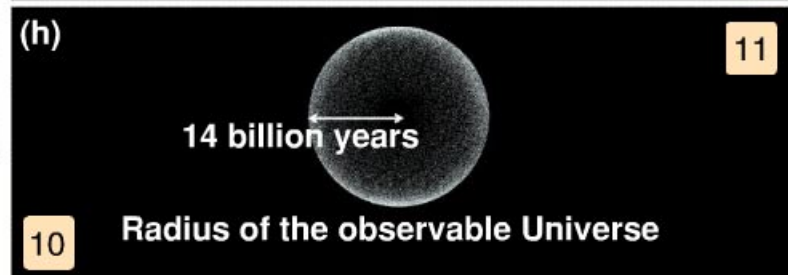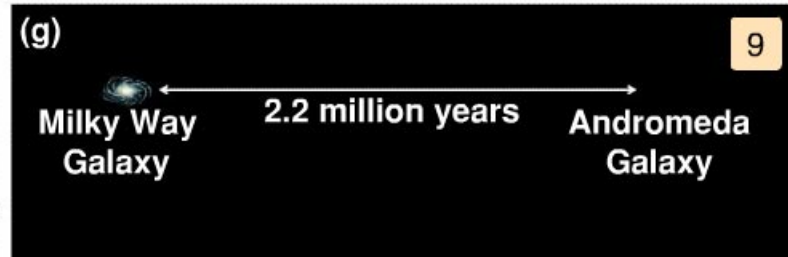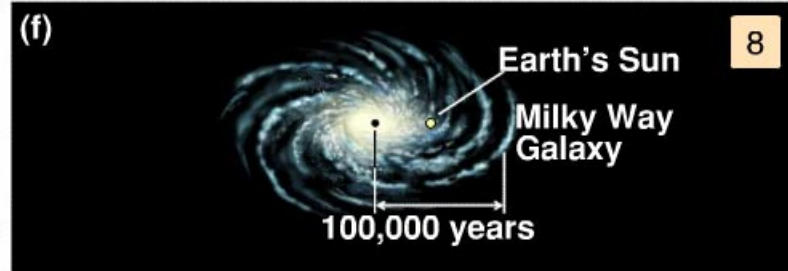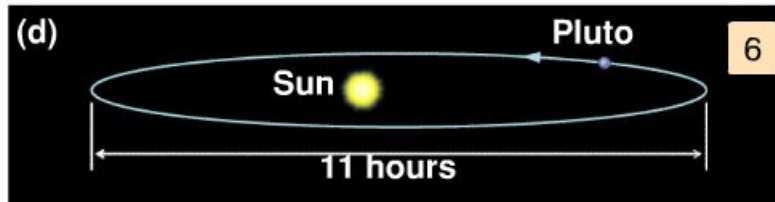186,000 miles/s x 3×10^7 s = 5.6×10^{12} miles

Lightyear (cont)

- Actually, 1 LY = 9.46 x 10^{15} m
  - Ten trillion kilometers
  - 236,000,000 times around the Earth
- Sounds far, but we'll see some really far distances
  - The nearest star is 4.3 LY away
- It takes light one year to travel 9.46 x 10^{12} km
  - If you were 1 LY away and flashed a light, we wouldn't see it for a year
  - The starlight we see tonight was emitted by the stars many years ago
  - Looking into the sky is looking at what happened in the past. The further away you look, the farther back in time
- The sun is 8 lightminutes away from us
  - If the sun exploded right now, we wouldn't know for 8 minutes

Tour of the Universe

(a) Earth's circumference ⅟₇ second — 1

(b) Earth — 1.25 seconds — Moon — 3, 2

(c) Sun — 8.3 minutes — Earth — 5, 4

(d) Pluto — Sun — 11 hours — 6

(e) Sun — 4.2 years — Proxima Centauri, the closest star to our Sun — 7

(f) Earth's Sun — Milky Way Galaxy — 100,000 years — 8

(g) Milky Way Galaxy — 2.2 million years — Andromeda Galaxy — 9

(h) 14 billion years — Radius of the observable Universe — 11, 10

Tour of the Universe

- **Planets**
  - Earth, Jupiter, Mars, Venus, Saturn, ...
- **Stars**
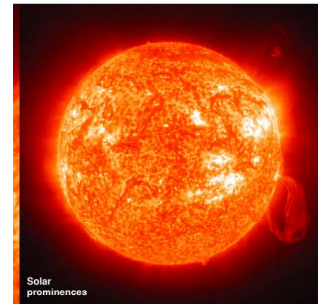 - The Sun, North Star, Alpha Centauri,...
- **Types of Stars**
  - Supernova, White Dwarf, Red Giant,...
- **Types of Galaxies**
  - Spiral, Elliptical, Dwarf, Radio,...
- **Types of Structure in the Universe**
  - Galaxies, Nebula, Clouds, Superclusters,...

Solar prominences

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Summary

- Astronomy 1002 is a science class in which we will study what the universe is made of
- There are a wide range of objects out there, including planets, stars and galaxies
- Next time we will start learning how these objects move around relative to each other
- This class can be one of the most interesting courses you take at FSU
- ENJOY!