Lectures 1 & 2: Plan

• Introduction
• Syllabus
• Scale of the Universe
• Scientific Method
ASTR 100: Introduction

• An ambitious project: to survey our known Universe in one short semester!

• Main goals:
  — Make you appreciate astronomy and sciences in general!
  — Understand the universe that we live in
  — Focus on major concepts in astronomy
  — When possible, tie those concepts into issues relevant to your life (e.g., global warming, how special planet Earth is to our continued survival)
“Powers of Ten” Video on course website
http://www.astro.umd.edu/~veilleux/ASTR100/spring16/

- If size of the carbon nucleus \( \equiv 1 \)
- Size of carbon atom = \( 10,000 = 10^4 \)
- Human = \( 100,000,000,000,000 = 10^{14} \)
- Size of the known Universe = 
  \( 10,000,000,000,000,000,000,000,000,000,000,000,000 = 10^{40} \) !!!
Scale of the Universe

A. Earth-Moon System

Earth’s diameter = \( D_E = 12,800 \text{ km} \)

Moon’s diameter = \( D_M = 3,500 \text{ km} \)

\[ \Rightarrow \quad D_M \sim \frac{1}{4} D_E \]

Distance Earth-Moon = \( d_{E-M} \)

\[ = 384,000 \text{ km} \]

\[ d_{E-M} \sim 30 \, D_E \]
BEWARE!

Lunar Eclipse Geometry

Sun

Earth

Moon

Penumbra

Umbra
Scale of the Universe

B. Solar System

Distance Earth – Sun = \( d_{E-S} \)
\[ \sim 150 \times 10^6 \text{ km} \]
\[ \equiv 1 \text{ Astronomical Unit (AU)} \]

\[ \rightarrow d_{E-S} \sim 400 \ d_{E-M} \]

Sun’s Diameter = \( D_S \)
\[ = 1.4 \times 10^6 \text{ km} \]

\[ \rightarrow D_S \sim 100 \ D_E \]
\[ \rightarrow d_{E-S} \sim 100 \ D_S \]
Our Star – The Sun
Our Solar System

\[ D_{\text{Sun}} \sim 10 \ D_{\text{Jupiter}} \sim 100 \ D_{\text{Earth}} \]
View of Solar System from Above

\[ d_{\text{Sun-Pluto}} \sim 40 \text{ AU} \]
“Milky Way – like” Galaxy

* POSITION OF SOLAR SYSTEM
Scale of the Universe

C. Milky Way Galaxy

*System of 100 billion stars like our own Sun*

1 light-year = distance travelled by light in 1 year
   = (speed of light) x (1 year)

speed of light (c) = 300,000 km/sec
   ~ 7 trips around the world / sec
   ~ 1 trip to the Moon / sec
Scale of the Universe

C. Milky Way Galaxy (cont’d)

\[
1 \text{ year} = 365 \text{ days/yr} \times 24 \text{ hours/day} \times 60 \text{ min/hr} \\
\times 60 \text{ seconds/min} \\
= 3 \times 10^7 \text{ sec}
\]

\[
1 \text{ light-year} = 300,000 \text{ km/sec} \times 3 \times 10^7 \text{ sec} \\
= 3 \times 10^5 \text{ km/sec} \times 3 \times 10^7 \text{ sec} \\
= 9 \times 10^{12} \text{ km} \sim 10^{13} \text{ km} \\
= 10 \text{ trillion kilometers} \\
= 6 \text{ trillion miles}
\]
Scale of the Universe

- Distance Earth-Moon = 1 light-second
- Distance Earth-Sun = 8 light-minutes
- Distance Sun-Pluto = 6 light-hours
- Distance to the closest star = 4 light-years
- Size of the Milky Way Galaxy = 80,000 light-years
  = 140 million x (size of Solar System)
Each galaxy contains billions of stars and many stars have planets.
Scale of the Universe

D. Known Universe

• **Millions of galaxies**
• **Thousands of clusters of galaxies**
• **Clusters of clusters of galaxies**
• **Quasars at a distance of a few billion light-years**
  ~ nearly a million times the size of the Milky Way

→ **Lots of empty space in the Universe !!!**
Scientific Method

• Propose a hypothesis
• Test the hypothesis by experiment
• Accept or turn down hypothesis based on results of experiment

→ Scientific Debate!
Scientific Method
(Example)

• Propose a hypothesis: “the Earth is flat”
  - Rapper Booby Ray Simmons a.k.a. B.o.B., Twitter, 24-25 Jan 2016
    & Flat Earth Society (http://www.theflatearthsociety.org/cms/)

• Test the hypothesis by experiment:
  – Appearance of a large ship moving away on calm ocean?
  – Aristotle: A traveler who moves south will see stars that were
    previously hidden below the southern horizon
  – Aristotle: Shape of Earth’s shadow on the Moon during lunar
    eclipse
  – Modern experiment: Picture of Earth taken from the Moon
    (Apollo mission) or satellites…

• Accept or turn down hypothesis based on results of experiment
  → Rejected!