AST 301

Introduction to Astronomy
INTRODUCTION TO ASTRONOMY

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Text: Stars and Galaxies by Seeds and Backman, 9th Edition at Co-op

Notes: http://www.as.utexas.edu/astronomy/education/fall15/lambert/301.html

Grades: see Class Notes I
3 quizzes, 6 homeworks and a final

Monday, December 14
9am - noon
Goal

• To present a contemporary view of the origin and evolution of the Universe and its principal components.

• To illustrate how a science works and matures.
  – Not just facts but indications of how we acquire and interpret facts.
  – Astronomy is a science.
    Astrology is not.

• A complete survey except the solar system.
The Scale of The Cosmos

- Solar System
- Our Galaxy
- Local Group of Galaxies
- Local Supercluster of Galaxies
- Beyond to the Observable Limit
The solar System

Earth
Diameter = 13,000 km

Solar System
Sun + 8 Planets + Pluto and friends

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1 Astronomical Unit (AU)

150 million km
8 light minutes

UT

Neptune
Pluto
Sun
Hot gas, mostly hydrogen and helium

Diameter
= 1,400,000 km
= 110 Earth diameters

Mass
= $2 \times 10^{30}$ kg
= 330,000 Earth masses

Temperature
= 6,000 k at surface
= 15 million k at center
Stars

• Sun is a typical star but...
• Masses from 0.1 to 100 M_{sun}
• Radii from a few kms to size of Earth’s orbit
• Surface temperature from 1,000 K and down to 100,000 K and up
The Galaxy

• ~ 100 trillion stars + gas/dust
• Star-to-star separations ≈ few light years (mostly)
• Stars DO NOT collide
• Stars may be double, triple, ... in clusters
• Gas between stars
Our Galaxy and the Universe

• We are in the LOCAL GROUP of ~ 30 galaxies spread over a few million light years
• The Local Group is in the local SUPERCLUSTER of ~ 100 groups spread over 100 million light years
• Universe is made up of many superclusters out to about 10 billion light years, all expanding away from each other
• Galaxy – Galaxy separations are often such that Galaxy collisions occur
Time Scales

- Age of Universe
  \[ \approx 14 \text{ billion years} \]
- Age of Sun
  \[ \approx 4.5 \text{ billion years} \]
- Age of Earth
  \[ \approx 4.5 \text{ billion years} \]
IF 1 COSMIC YEAR ≡ 14 BILLION YEARS

AUG 13 : EARTH FORMS
DEC 13 : INVERTEBRATE LIFE
DEC 25 : DINOSAURS
DEC 30 : DINOSAURS DIED
DEC 31, 9pm : EARLIEST HUMANS

11pm 59m 30s : AGRICULTURE
47s : PYRAMIDS
59s : KEPLER/GALILEO/NEWTON
59.9s : ASTRONOMY 301
Scientific Notation

HOW DO WE HANDLE VERY LARGE AND VERY SMALL NUMBERS?

\[
\begin{align*}
10^0 & \equiv 1 \\
10^1 & \equiv 10 & 10^{-1} & \equiv 1/10 \\
10^2 & \equiv 100 & 10^{-2} & \equiv 1/100 \\
10^3 & \equiv 1000 & 10^{-3} & \equiv 1/1000 \\
10^4 & \equiv 10000 & 10^{-4} & \equiv 1/10000 \quad \ldots \\
\end{align*}
\]

\[
\begin{align*}
10^2 \times 10^3 & = 10^5 & \{ \text{ADD EXPONENTS} \} \\
100 \times 1000 & = 100,000 & \{ \text{ADD EXPONENTS} \} \\
10^2 \times 10^{-1} & = 10^1 \equiv 10 & \{ \text{ADD EXPONENTS} \} \\
100 \times 1/10 & = 10 & \{ \text{SUBTRACT EXPONENTS} \}
\end{align*}
\]
21.4 \equiv 2.14 \times 10
214 \equiv 2.14 \times 10^2

\ldots

0.214 \equiv 2.14 \div 10 \equiv 2.14 \times 10^{-1}
0.0214 \equiv 2.14 \div 10^2 \equiv 2.14 \times 10^{-2}

\frac{6240}{3.12} = \frac{6.24 \times 10^3}{3.12} = 2 \times 10^3 \equiv 2000

\frac{6240}{3.12 \times 10^{-2}} = \frac{6.240 \times 10^3}{3.12} = 2 \times 10^5

0.031 = 3 - (-2) = 3 + 2 = 5

\frac{6.240 \times 10^3}{3.12 \div 10^2} = 2 \times 10^5

OR USE A CALCULATOR!
BASIC POINT!

- $6 \times 10^{+20}$ is a large number
  6 followed by 20 zeros

- $6 \times 10^{-30}$ is a very small number
  0.0 ........ 06
  29 zeros
  $6$
  $10^{30}$
## SCIENTIFIC NOTATION – PREFIXES

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Symbol</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>giga</td>
<td>G</td>
<td>$10^9$</td>
</tr>
<tr>
<td>mega</td>
<td>M</td>
<td>$10^6$</td>
</tr>
<tr>
<td>kilo</td>
<td>k</td>
<td>$10^3$</td>
</tr>
<tr>
<td>centi</td>
<td>c</td>
<td>$10^{-2}$</td>
</tr>
<tr>
<td>milli</td>
<td>m</td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>micro</td>
<td>μ</td>
<td>$10^{-6}$</td>
</tr>
<tr>
<td>nano</td>
<td>n</td>
<td>$10^{-9}$</td>
</tr>
</tbody>
</table>
ASTRONOMICAL DISTANCES

• Astronomical unit (AU) is the radius of the Earth’s orbit around the sun
  1 AU \approx 150 \times 10^6 \text{ km}
  = 8 \text{ light minutes}

• Light year (ly) is the DISTANCE light travels in one year
  1 \text{ ly} \approx 10^{13} \text{ km}
  \approx 63,000 \text{ AU}

• Parsec (pc) is the distance at which 1 AU subtends 1 arcsec
  1 \text{ pc} \approx 3.3 \text{ ly}
  \approx 200,000 \text{ AU}