ASTR 1120
General Astronomy: Stars and Galaxies

Section 001
G1B20  TR 2:00-3:15

Instructor: Webster Cash
TA: Robyn Levine

http://casa.colorado.edu/~wcash/APS1120/APS1120.html
Website

http://casa.colorado.edu/~wcash/APS1120/APS1120.html
All homework and announcements made through this website.
Other useful features and links

Text: The Cosmic Perspective

Bennett, Donahue, Schneider and Voit
Addison Wesley

Recitation:

Once per Week by TA
Time and Place: TBD
Grades
(Unfortunate, but that’s the system)

Exams:
   In-Class Exams (200)
   Final Exam – 1:30pm May 7, 2003 (200)

Homework: (100)
   Written Exercises to be turned in for grade
   Observatory Trip
COURSE SCHEDULE (HIGHLY APPROXIMATE)

1 January 14 Intro., Scientific Notation
Scale of the Universe
2 21 Gravity
Laws of Motion
3 28 Nature of Light
Nature of Light
4 February 4 Formation Solar System
Sun
5 11 Sun
Telescopes
6 18 Exam #1
Stars
7 25 H-R Diagram
H-R Diagram
8 March 4 Binary Stars
Stellar Structure
9 11 Stellar Evolution
White Dwarfs
10 18 Exam #2
Neutron Stars
11 25 Spring Break
Spring Break
12 April 1 Black Holes
The Milky Way
13 8 Interstellar Medium
Galaxies
14 15 Galaxies
Expansion of the Universe
15 22 Exam #3
AGN's & Quasars
16 29 Cosmology
The Big Bang
17 May 7 Final
Scientific Notation

an atomic nucleus is \(0.000000000000001\) m
a galaxy is \(200000000000000000000\) miles away

So awkward we MUST use scientific notation

an atomic nucleus is \(10^{-15}\) m
a galaxy is \(2 \times 10^{19}\) miles away
Scientific Notation (2)

1 = 10^0
10 = 10^1
100 = 10^2
1000 = 10^3

2000 = 2x10^3
.0035 = 3.5x10^{-3}

0.1 = 10^{-1}
.01 = 10^{-2}
.001 = 10^{-3}
etc

(nx10^p)x(mx10^q) = (nxm)x10^{p+q}

2.5x10^{19} \times 3.0x10^{-5} = 7.5x10^{14}

\frac{2.4x10^{19}}{8x10^7} = 0.8x10^{12} = 8x10^{11}
# Size of Things

<table>
<thead>
<tr>
<th>Centimeters</th>
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<th>Centimeters</th>
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<tbody>
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<td>thumbtack</td>
<td>$10^{-2}$</td>
<td>sand grain</td>
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<td>baseball</td>
<td>$10^{-4}$</td>
<td>DNA</td>
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<tr>
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<tr>
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<td>kilometer</td>
<td>$10^{-15}$</td>
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<td>$10^9$</td>
<td>World</td>
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<tr>
<td>$10^{11}$</td>
<td>Moon’s Orbit</td>
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<tr>
<td>$10^{13}$</td>
<td>Distance to Sun</td>
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<tr>
<td>$10^{15}$</td>
<td>Solar System</td>
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<tr>
<td>$10^{18}$</td>
<td>Nearest Stars</td>
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<tr>
<td>$10^{23}$</td>
<td>Milky Way Galaxy</td>
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<td>$10^{25}$</td>
<td>Nearest Galaxies</td>
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<tr>
<td>$10^{29}$</td>
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</table>
Explaining the Universe

Science: Model or Explanation
Test
Correction
Iterate
“Truth” -- All that’s left

Model of the Universe Myth
Measurement
Modern Science
All That’s Left

Universe Unfolded on Itself in Space and Time

Big Bang and Expanding Universe
about 12 Billion Years ago

Formed Galaxies from gas

Formed Stars and Planets

Earth & Sun about 4.6 Billion Years Old

In this course we will explain why we think these things about the universe. Plus more....
Question:
Why Are Our Atoms Arranges this Way?

e.g. Why are our atoms on a planet, not in a black hole?

HISTORY IS DESTINY

Make assumption about initial state of matter and then follow what happens.

eg solar system was a gas cloud that collapsed due to gravity
Sun and Earth formed at same time
Formation of the Solar System

Universe is about 12 Billion Years old \( (3 \times 10^{17}\text{s}) \)
Milky Way 10 Billion Years old
Sun and Planets – 4.6 Billion Years old
  Sun has done about 25 orbits of Milky Way

Stars are being formed all the time -- some young, some old

Stars are formed from clouds of gas
Starts as Thin Cloud

Ensuing High Density Shocks Is Site of Collapse

Spins Up Like Ice Skater
Swirling Gas

Falls into “Disk Stability”
99.9% Ended in Sun (0.1% in Jupiter)
Probably the Same Around All Stars -- Planets are Common

Shoots Planet-Size Bullets into Space
Lots of Stars

• 100 Billion Stars in Milky Way
• 100 Billion Stars in Visible Universe

• Almost an Avagadro’s Number in Universe!
Catastrophe Theory

- Theory In Vogue When I was in Grade School – (1950’s ouch!)
- Two Stars Stray Near Each Other
- Close Orbit Pulled Gas from Sun
- Gas Formed Planets
- Predicts Planets Very Rare (Collisions Rare)
- Astronomy Advanced Hugely in 20th Century
Some Physics

• Scientific Method
• Hypothesis and Experiment
• THERE IS A TRUTH!!!
  “I Think Therefore I Am”
• If Experiment Shows Theory Wrong Then Its Wrong
• Doesn’t Mean Theory is Right
Galileo

• First Great Modern Scientist
• Quantitative Analysis
• Tenacious Pursuit of Truth
• Challenged Aristotle and Church
• Used Telescopes to Demolish Old Solar System View
• Persecuted In Italy – Celebrated Elsewhere
Isaac Newton (1643-1727)

- Greatest Scientist of All Time
- Quantitative Prediction
- Mechanics, Optics, Math – Theory & Observation

Two Basic Concepts

Mass – Amount of Matter (Not Weight)
Inertia – Tendency of Objects to Have Unchanged Motion
Newton’s Laws

• Law #1: A body at rest or in motion remains that way unless acted upon by an outside force.

• Law #2: \( a = \frac{F}{m} \)

• Law #3: For every action there is an equal and opposite reaction.