ISP 205 Section 1
Visions of the Universe

• Instructor: Ed Loh, Loh@pa.msu.edu (355-9200, ext. 2480)
• Office hours (1219 BPS), 12:30-15:00 Monday, Tues, Friday, or by appointment
• Course web site
  • www.pa.msu.edu/courses/isp205/sec-1
  • Lecture slides by the end of the day.
• ISP 205 Lab is not required
• Grading: 20% in-class exercises & homework, 45% three tests, 35% final exam.
• In-class exercises require clickers

Major Sections


2. Solar System & planets. How did the solar system form?

3. The stars. What powers the sun? What is the future sun? Where does oxygen come from?

4. The Universe: What is the universe made of? How old is the universe? The Big Bang.

Questions

1. Newton figured out the first body of scientific laws on
   a. Electricity
   b. Planets
   c. Genetics
   d. Motion

2. The oxygen nuclei in the air
   a. Always existed
   b. Formed in the sun from simpler nuclei such as hydrogen
   c. Formed in other stars
   d. Formed in plants

3. Most of the universe is made of
   a. Hydrogen
   b. Helium
   c. Dark matter
   d. Dark energy

Quick tour of the Universe

The Universe: Everything we can see or know about. Billions of galaxies, clusters & superclusters are observable.

System of 100,000 galaxies like our Galaxy

System of 100,000,000,000 stars like our sun

A lump of material left over from forming our Sun

The Sun: a typical star

[Fig. 1.1]
The Solar System

- Sun
- 9 planets
- 65+ moons
- comets
- asteroids
- dust
- gas
- cosmic rays
- other non-descript junk

<table>
<thead>
<tr>
<th>Object</th>
<th>Diameter (meters)</th>
<th>Distance (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>0.241</td>
<td>0</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.001</td>
<td>10</td>
</tr>
<tr>
<td>Venus</td>
<td>0.002</td>
<td>19</td>
</tr>
<tr>
<td>Earth</td>
<td>0.002</td>
<td>26</td>
</tr>
<tr>
<td>Mars</td>
<td>0.001</td>
<td>40</td>
</tr>
<tr>
<td>Jupiter</td>
<td>0.025</td>
<td>135</td>
</tr>
<tr>
<td>Saturn</td>
<td>0.021</td>
<td>247</td>
</tr>
<tr>
<td>Uranus</td>
<td>0.009</td>
<td>498</td>
</tr>
<tr>
<td>Neptune</td>
<td>0.009</td>
<td>780</td>
</tr>
<tr>
<td>Pluto</td>
<td>0.000</td>
<td>1025</td>
</tr>
<tr>
<td>Nearest star (Proxima Centauri)</td>
<td>0.241</td>
<td>6.9E+06</td>
</tr>
<tr>
<td>Center of our Galaxy</td>
<td>---</td>
<td>4.2E+10</td>
</tr>
</tbody>
</table>

70% of diameter of Earth!
100x the real distance to the moon!

The Orion Nebula
a present-day site of star formation

1500 ly away from us.
Recently-formed stars heat dense, opaque gas cloud.
A cavity has blown-out, so we can see in.

Hubble Space Telescope image of "proto-star" with surrounding disk.

The oldest stars

The globular cluster M10
- ~10^5 (100,000) stars
- formed ~10^10 years ago.
The galaxy

- Originally all gas
- Now \( \sim 10^{11} \) stars similar to our sun.
- Stars are born, evolve, then die.
- Material processed through stars.
  - Galactic ecology
  - This is source of all chemical elements except Hydrogen (H), Helium (He), Lithium (Li) made in “big bang”

Clusters of galaxies

- The distant galaxy cluster MS1054-0321
  - Contents: thousands of galaxies and trillions of stars
  - Mass: the equivalent of several thousand of our Milky Ways
  - Distance: 8 billion light-years from Earth.

Clusters of thousands of galaxies

- Tiny area of sky.
  - 1/12 angular size of full moon.
  - Among the faintest objects ever measured.
  - 10 days’ exposure with Hubble Space Telescope.
  - Only 20 stars.
  - Remaining 5000 objects are galaxies.

...and giant soap bubbles in space.

The Hubble Deep Field
4. Arrange in order of increasing distance.
   a. Orion nebula, Jupiter, center of Milky Way, Andromeda galaxy
   b. Jupiter, Orion nebula, center of Milky Way, Andromeda galaxy
   c. Center of Milky Way, Orion nebula, Jupiter, Andromeda galaxy
   d. Jupiter, Center of Milky Way, Orion nebula, Andromeda galaxy