

## ISP 205 Section 1 Visions of the Universe

- Instructor: Ed Loh, [Loh@pa.msu.edu](mailto: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](http://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

click

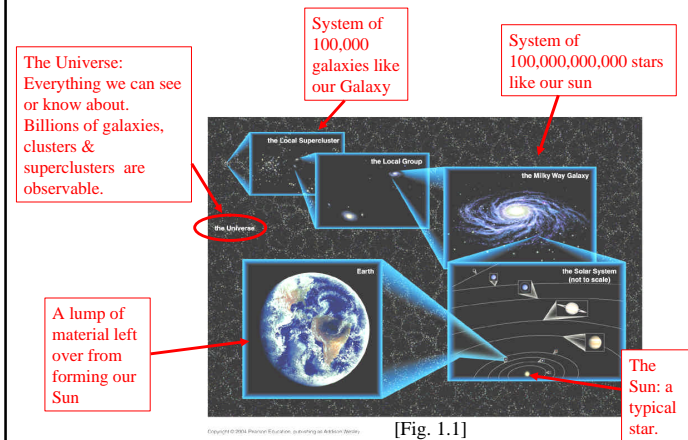
## Major Sections

1. **Laws of physics. Copernican revolution & the birth of science.**
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

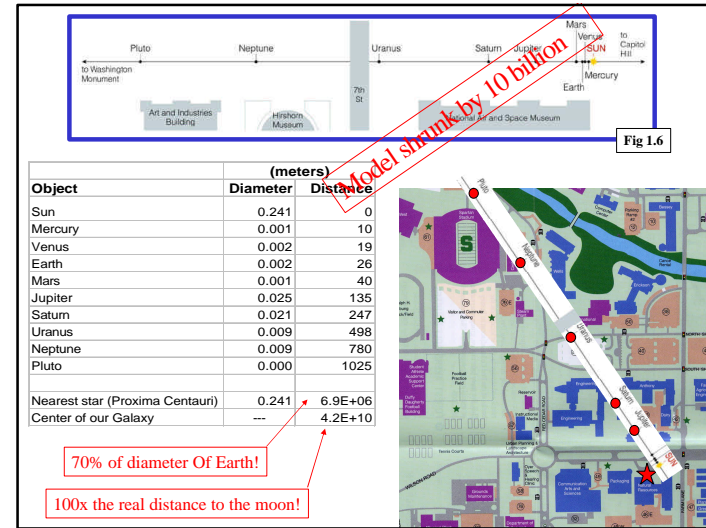
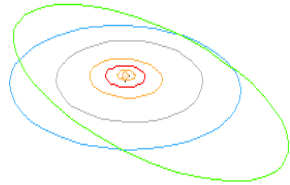
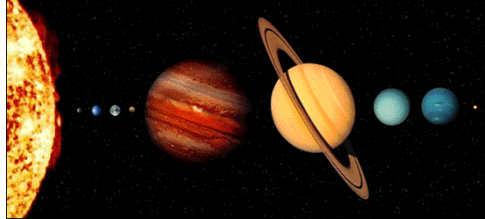
1. Newton figured out the first body of scientific laws on
  - a. Electricity
  - b. Planets
  - c. Genetics
  - d. Motion
2. The oxygen nuclei in the air
  - a. Always existed
  - b. Formed in the sun from simpler nuclei such as hydrogen
  - c. Formed in other stars
  - d. Formed in plants
3. Most of the universe is made of
  - a. Hydrogen
  - b. Helium
  - c. Dark matter
  - d. Dark energy

## Quick tour of the Universe

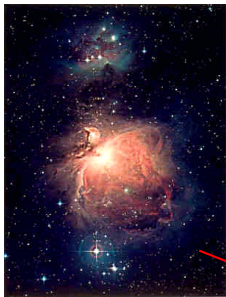


## The Solar System

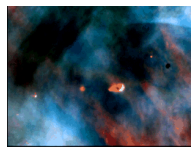
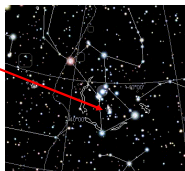
- Sun
- 9 planets
- 65+ moons
- comets
- asteroids
- dust
- gas
- cosmic rays
- other non-descript junk



## 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

- $\sim 10^5$  (100,000) stars
- formed  $\sim 10^{10}$  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.



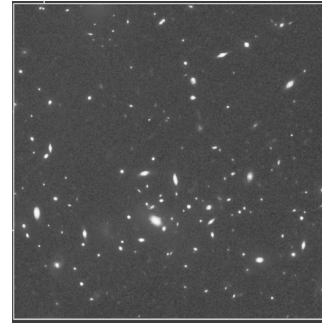
- Galactic ecology
- This is source of all chemical elements



except Hydrogen (H)  
Helium (He)  
Lithium (Li)

made in "big bang"

## Clusters of galaxies

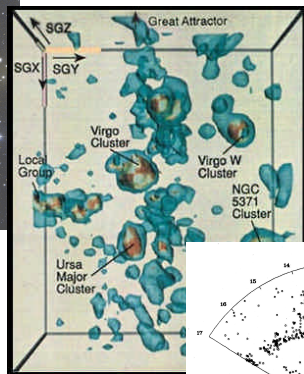


The distant galaxy cluster  
MS1054-0321

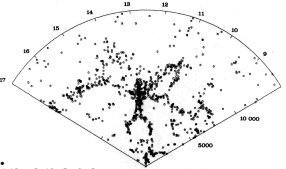
- Contents: thousands of galaxies and trillions of stars
- Mass: the equivalent of several thousand of our Milky Ways
- Distance: 8 billion light-years from Earth.

Hubble Space Telescope image

## Clusters of thousands of galaxies



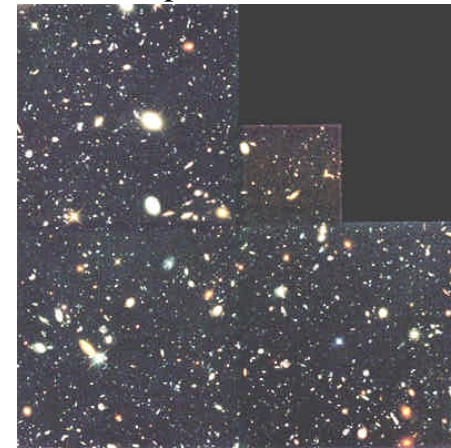
Superclusters



...and giant soap bubbles in space.

## The Hubble Deep Field

- 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.



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