

**ASTR 1020**  
**Introductory Astronomy 2:**  
**Stars & Galaxies**  
January 16, 2008

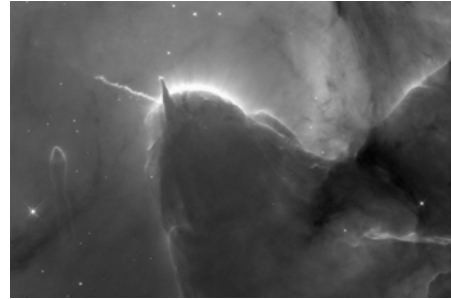
Professor Jack Burns

Newcomers - All class info is at website:  
<http://solo.colorado.edu/~jaburns/Astr1020Sp08/index.html>

Notes from last class are now posted on the class website.

1

Astronomy  
Picture of the Day



Trifid Pillars & Jets  
Credit: J. Hester (Arizona St. U) et al., *HST*, *NASA*

2

**MasteringAstronomy**

- All homework will be assigned via the online system *MasteringAstronomy*.
- Stay up with class assignments in conjunction with the reading.
- The course ID for Astr 1020 in *MasteringAstronomy* is **ASTR1020SP08**

3

**Homework**

- Reading:
  - Chapter 1.
  - Summary of Key Concepts, p. 21-22.
- *Intro to MasteringAstronomy* (complete by Jan. 21). Located at website: <http://www.masteringastronomy.com>
- Your grade will be based on completion of the tutorial and exercises.
- Grades are tracked automatically online. Nothing to hand in!!!
- Start this exercise now in case of technical problems.
- Register your clickers!

4

**Free Planetarium Show**

- **Colorado Skies: Messenger & Mercury** with Ms. Addie Dove.
- Thursday, January 17<sup>th</sup> at 8:00 pm.
- Fiske Planetarium.
- 1 extra credit bonus point on final grade when you attend a show this semester (be sure to sign sheet when you leave).



5

**Today's Class: Brief Tour of the Universe; Sizes and Scales**

Reading: Chapter 1, sections 1.1 and 1.2

- Scales in space

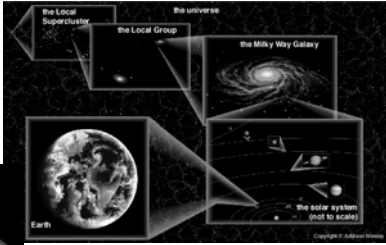


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6

## What we'll be Studying

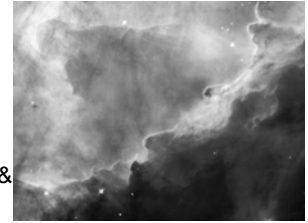
- Sizes and scales: finding your way through the universe



7

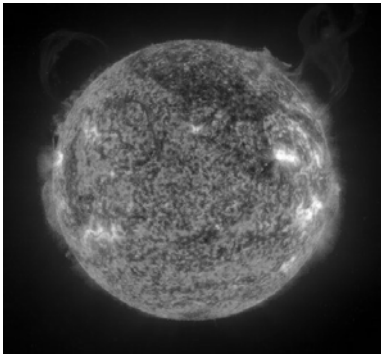
## Review of Gravity & Light

- What are they?
- How do we use them to understand sizes, masses, and composition of stars & galaxies.



8

## The Sun



9

Stars of every size and color

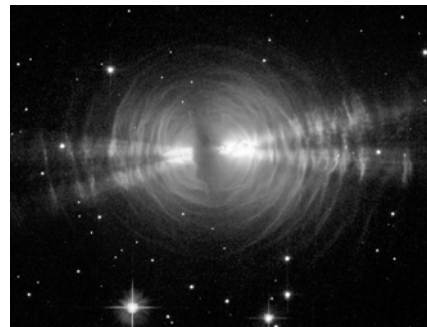


## Stellar Birth and Life



11

Star death: white dwarfs  
neutron stars and black holes



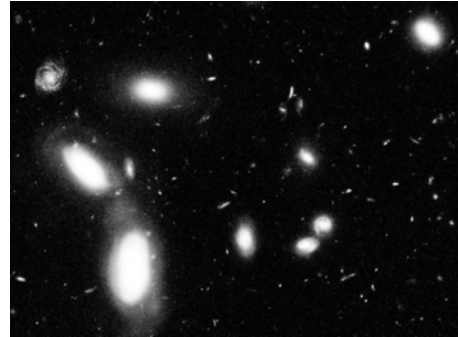
12

## Our Galaxy: The Milky Way



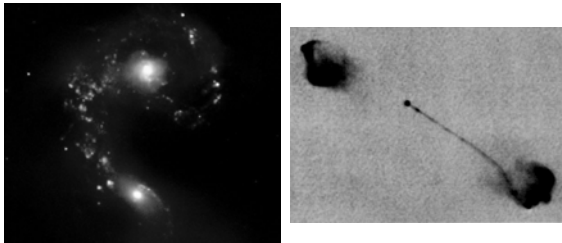
13

## Exploring a universe of galaxies



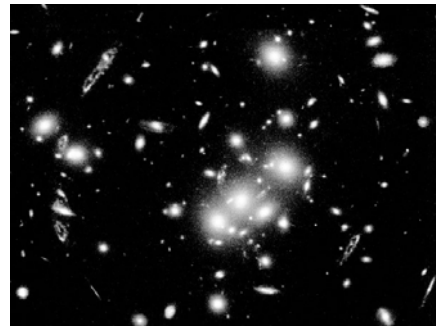
14

## Galaxy Evolution & Central Engines



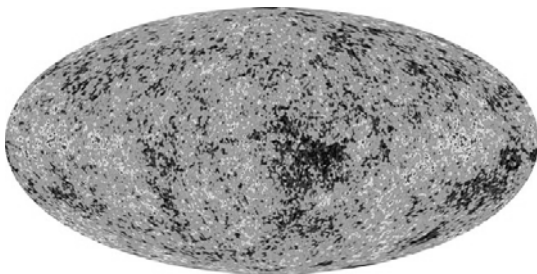
15

## Dark Matter, Dark Energy and the Fate of the Universe



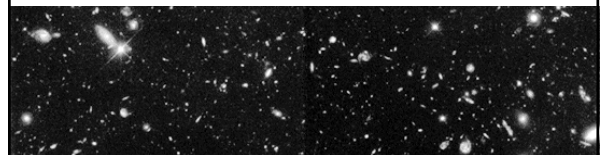
16

## The Big Bang



17

## Navigating the Universe: Sizes and Scales



"I don't pretend to understand the Universe. It's a great deal bigger than I am".

- Thomas Carlyle (1795-1881)

18

## Our Cosmic Address

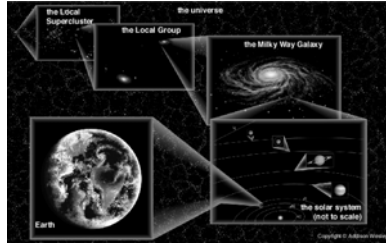
Earth

Sun/Solar System

Milky Way Galaxy

Local Group

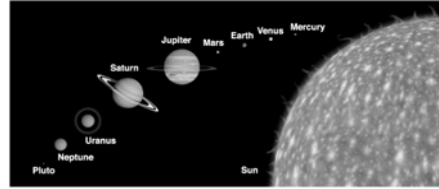
Local Supercluster



19

## Scale models of the Universe

- Scale Sun as a grapefruit (1:10,000,000,000,000)



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20

- Earth = pin, 15 meters from Sun.
- Mars = pin, 23 meters
- Jupiter = marble, 78 meters
- Pluto = tiny grain, 1/4 mile away
- See model near the Planetarium!



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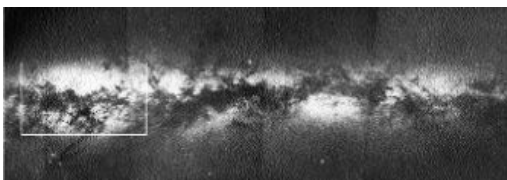
21

- On this scale, the nearest stars would be a system formed by a cantaloupe, a small apple and a kiwi fruit, located in Newfoundland, Canada
- There is essentially nothing in between

22

## New Scale for the Galaxy:

- Stars are microscopic located 2mm apart.
- Milky Way galaxy is 22 meters in diameter, contains 100,000,000,000's (100's of billions) of stars.



23

## Yet Another Scale for Everything Else

- Galaxies are 10 inch paper plates.
- Milky Way and nearest neighbor (Andromeda) are 5 meters apart.
- Galaxy groups and clusters contain 10's to 1000's of galaxies.

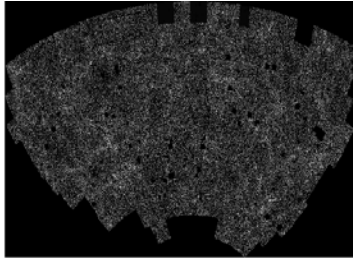


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Gravitational Lens in Abell 2218 HST - WFPC2  
1996-14 - ST ScI OPO - April 5, 1997 - W. Couch (UNSW), NASA

- Superclusters 50 meters across (size of buildings in our scale model) are the largest structures we see.
- Observable universe is about size of Boulder county on this scale.



In this image, each dot is an entire galaxy

25

### This is big stuff- how to grasp astronomical numbers?

- Powers of 10: count the number of zeros behind the digit (review Appendix C in text).
- 1000= 1 thousand =  $10^3$
- 1,000,000 = 1 million =  $10^6$
- 1,000,000,000 = 1 billion =  $10^9$
- 10,000,000,000,000,000,000,000 =  $10^{22}$   
= approximately the number of stars in the observable universe- more than the grains of sand on all the beaches on Earth.

26