ASTR 1020
Introductory Astronomy 2: Stars & Galaxies
January 18, 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.

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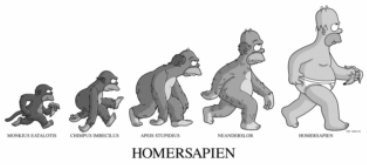
Astronomy Video of the Day

The Simpson's version of the Powers of Ten



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MasteringAstronomy

- The course ID for Astr 1020 in *MasteringAstronomy* is **ASTR1020SP08**

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Homework

- Reading: Chapter 4, sections 4.1- 4.4; summary of key concepts.
- *Intro to MasteringAstronomy* (complete by Jan. 21) & begin *Scales of the Universe* (complete by Jan. 28). Located at website: ***http://www.masteringastronomy.com***
- Register your clicker.

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Today's Class: More on Sizes and Scales and Time

Reading: Chapter 1, sections 1.1 and 1.2

- Scales in space
- Looking Back in Time
- Scales in Time
- History of the Universe

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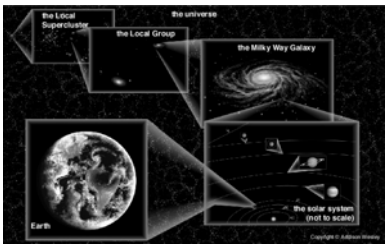
Powers of 10

26 powers of 10: 10^{26}



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Measuring cosmic distances

- Most useful measure is based on the speed of light = 300,000 km/sec.
- Like saying “I live 30 min from Boulder”.
- Constant speed for light traveling in space.
- Nothing travels faster through space

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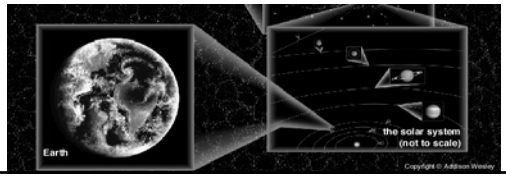
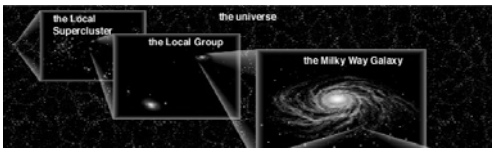
Measuring distances with light:

- Earth-Moon = 1.5 light-seconds
- Earth-Sun (a.k.a. astronomical unit, or AU) = 8 light minutes
- Solar system = light hours



- Nearest stars = over 4 light-years
- Milky Way= 100,000 light years = 10^5 ly
- Local group = several million light years =10^6 ly
- Observable universe = 14 billion ly = 1.4×10^{10} ly



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Over astronomical distances, even light takes a lot of time (from a human’s perspective!) to travel between the stars

This means that what we SEE in the distant universe is light that has traveled a long time.

Our image of the universe is a delayed image. In looking out into space, *we are also looking back in time.*

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What we SEE is always delayed by the speed of light. In the classroom, our view of each other is only about 10^{-5} seconds (= 0.00001 sec) old, so we barely notice.

Satellite communications- noticeable delays.

Delay in Communications between Mars and Earth: t = 2 x D/c = 507 sec = 8.4 minutes (D= Mars-Earth distance = 7.6×10^7 km; c = speed of light = 3×10^5 km/sec).

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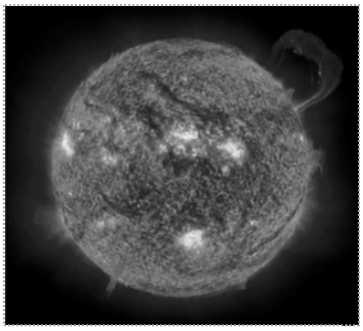
Clicker Question: The image of the Sun is ____ old?

a) 1 second.
b) 1 minute.
c) 8 minutes.
d) 1 month.
e) 1 year.



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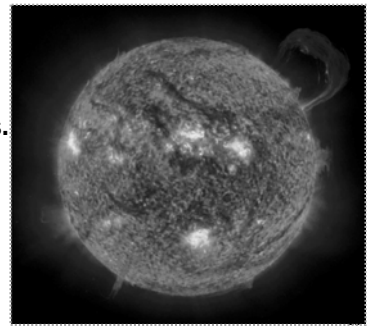

- The image of a galaxy spreads across 100,000 years of time.
- Try to think of what we SEE NOW as different from what may EXIST now.

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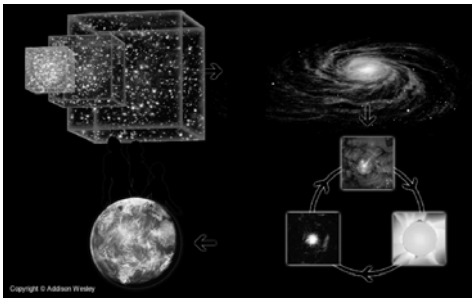
A Brief History of the Universe



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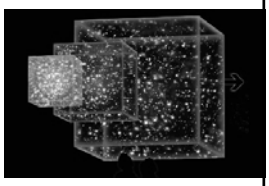
- About 14 billion years ago, everything was unbelievably hot and dense.
- Conditions were too extreme for normal matter to exist
- Then space started to expand. This beginning is called the Big Bang.



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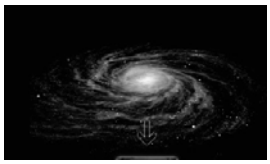
After the universe cooled, hydrogen gas and other normal matter formed.

Gravity began to pull this gas into balls that became stars. Gravity pulled the stars into larger structures called galaxies

Gravity keeps galaxies and stars about the same size, but the universe is STILL expanding and galaxies are getting farther away from each other.



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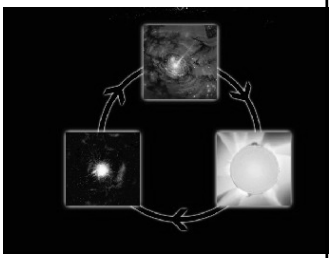
The stars process hydrogen into other elements via nuclear fusion.

Supernovae explosions disperse these other elements throughout the universe.

This is the origin of nearly all elements- including all of the carbon, oxygen, etc. in your body



Stars form, burn hydrogen into other elements and explode to disperse the Material to make new stars

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Inside galaxies, planetary systems form around some stars, made of the recycled elements from previous generations of stars

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History of the Universe- how long did this all take?

Use a 12 month calendar as a model for the 14 billion year history since the Big Bang:

- 1 Jan: Big Bang
- Late on Jan 1st, hydrogen forms
- Mid-Feb, Milky Way galaxy forms

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- Feb-August- stars are born and die in the Milky Way. Build-up of heavy elements in the galaxy.
- Sept 3rd: Sun and solar system form

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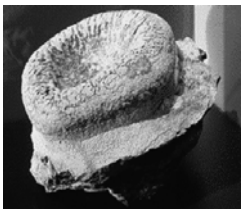
Late Sept: life begins…

- Dec 26th - Dec 30th : dinosaurs



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- Dec 31st, 9pm: human ancestors walked upright.
- 11 sec ago: Egyptian Pyramids.
- 0.05 sec ago: you were born.

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The Big Bang was about 14 billion years ago.

→There is a limit to how far out we can SEE, equal to about 14 billion light years.

→The 14 billion light years in all directions is the "observable universe."

→The actual universe may actually be MUCH bigger, or infinite. We simply run out of time to see it.

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