Astro 301/ Fall 2005

(48310)

Introduction to Astronomy

Instructor: Professor Shardha Jogee

TAs: David Fisher, Donghui Jeong, and Miranda Nordhaus

Lecture 4 + 5: Tu Sep 13, Th Sep 15

Topics in class last week

-- Important astronomical objects and concepts
Building blocks of matter: protons, electron neutrons and atoms
Stars: Energy Generation
Death of Stars: Planetary Nebulae, Supernovae Remnants
Why is human life 'star stuff'?
Different types of Nebulae
Planets, Brown Dwarfs, Moons and our Solar system
Galaxies and the Milky Way
The Local Group, Clusters of Galaxies ß end of last week
Superclusters, voids and filaments

Topics in class this/next week

-- Distances: From the infinitesimal to the grandest scales

-- Timescales : From the earliest epochs to the present day
Cosmic timeline of major events in the history of the Universe

-- The Four Fundamental Forces
-- The Force of Gravity and Netwton's Universal Law of Gravitation
-- Electromagnetic Forces
-- Strong and Weak force

-- Relating Motion to Forces: Newton's Three Laws of Motion
-- Motions of electrons, planets, stars, and galaxies
-- Hubble's Law and the Expansion of the Universe

Lecture 4

Announcements

- Quiz 1 today. 10 minutes.

Keep your quiz until the end of the allocated time and be quiet to let others work.

When time is up, pass your quiz from left to right, and pile them at end of the table

- Homework 1 handed today. Due in-class, next Tue

The Local Group

See In-class notes

Brightest members of Local Group?

Closest galaxy neighbors of Milky Way? Interactions of Milky Way?

LMC; Irr;

Size = 30,000 ly Dist = 0.16×10^{6} ly

Merger of 2 spirals of similar mass can produce a dramaticallly different system!

(Stars=yellow, blue=gas, time shown = 1 Gyr)

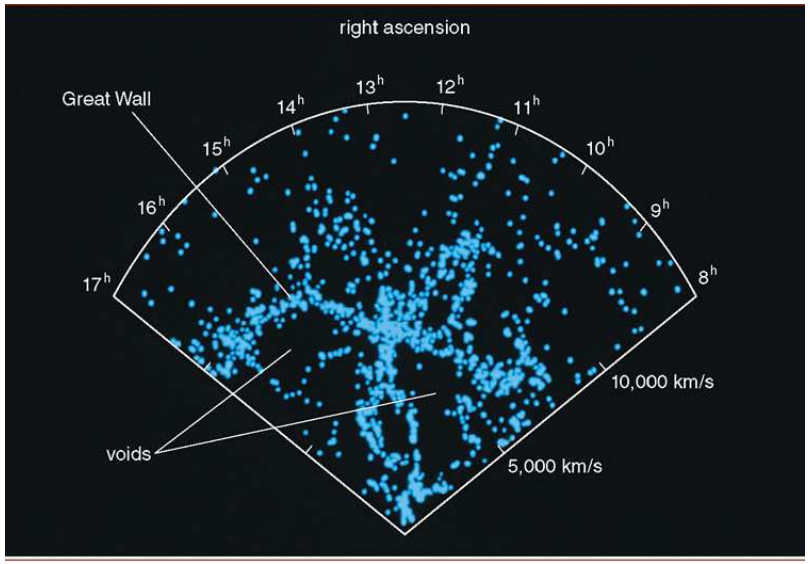
Clusters of galaxies (see in class notes)

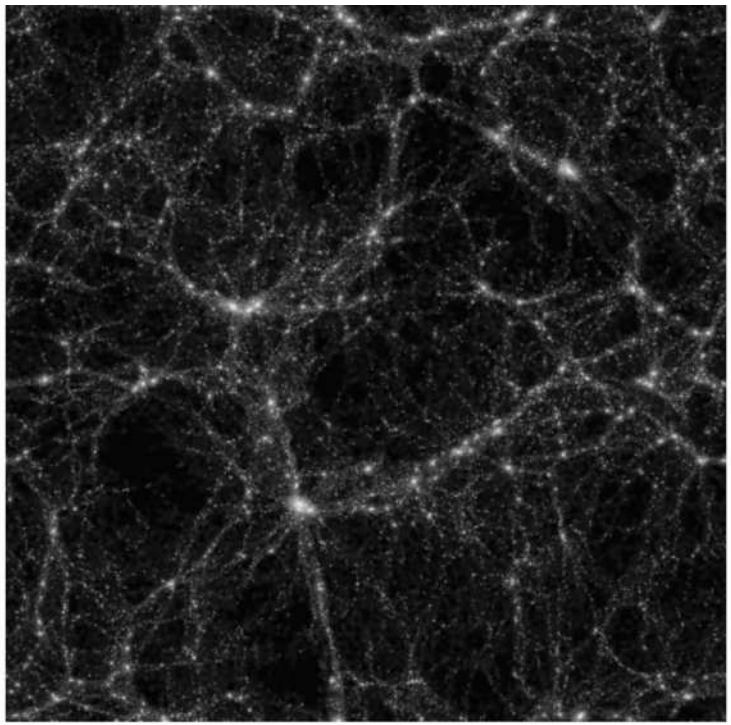
Virgo = closest cluster of galaxies at 60 million ly away ; contains> 100 galaxies
Human face?

Abell 2218 cluster of galaxies

Region shown = 1.4 x 10^6 lyr

Superclusters, Filaments, and Voids in the Cosmic Web





Large-scale structure: sheets, voids, filaments/walls

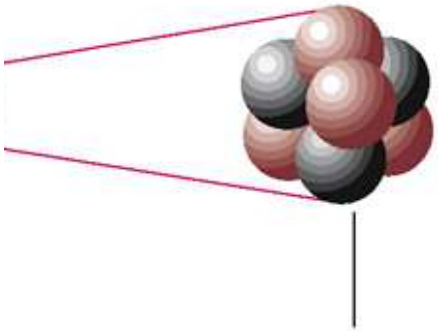
Superclusters = 10 million lyr = 10^{23} m or 10^{7} lyr
Fliaments = 10 x larger even….

Overview: From the Infinitesimal to the Grandest Scales

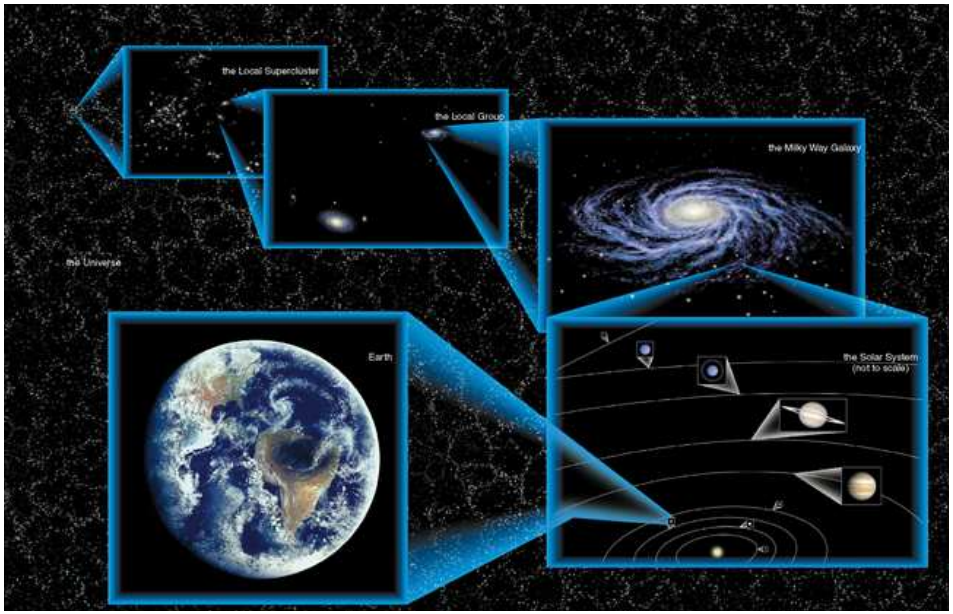
Overview: From the infinitesimal to the grandest scales

- In-class demo: Zooming 26 orders of magnitude (part 2)

- See in-class summary table From the size of hydrogen nuclei to the edge of the visible Universe : 10^{-15} m to 10^{26} m



Nucleus: Contains positively charged pr otons (red) and neutral neutrons (gray).

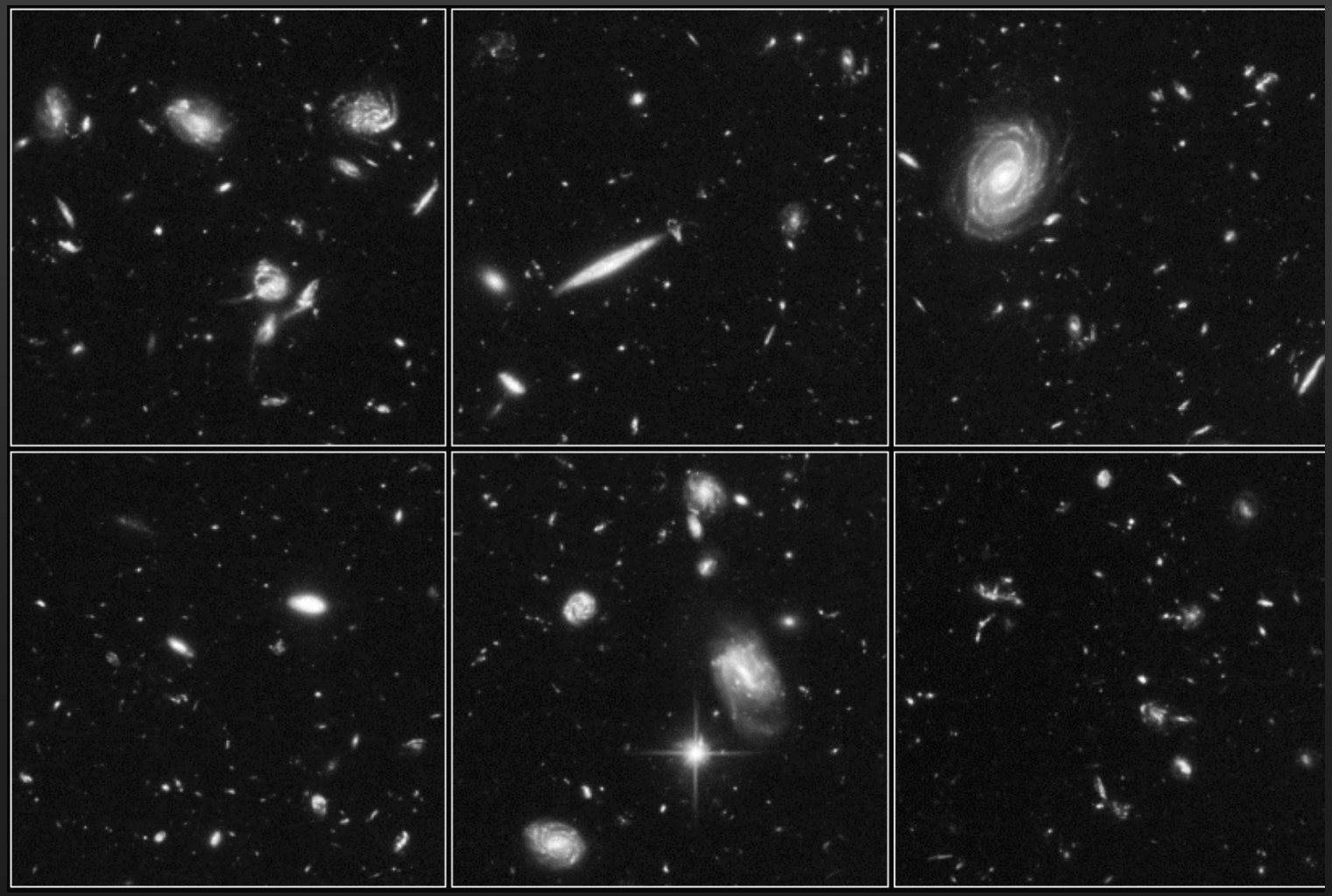


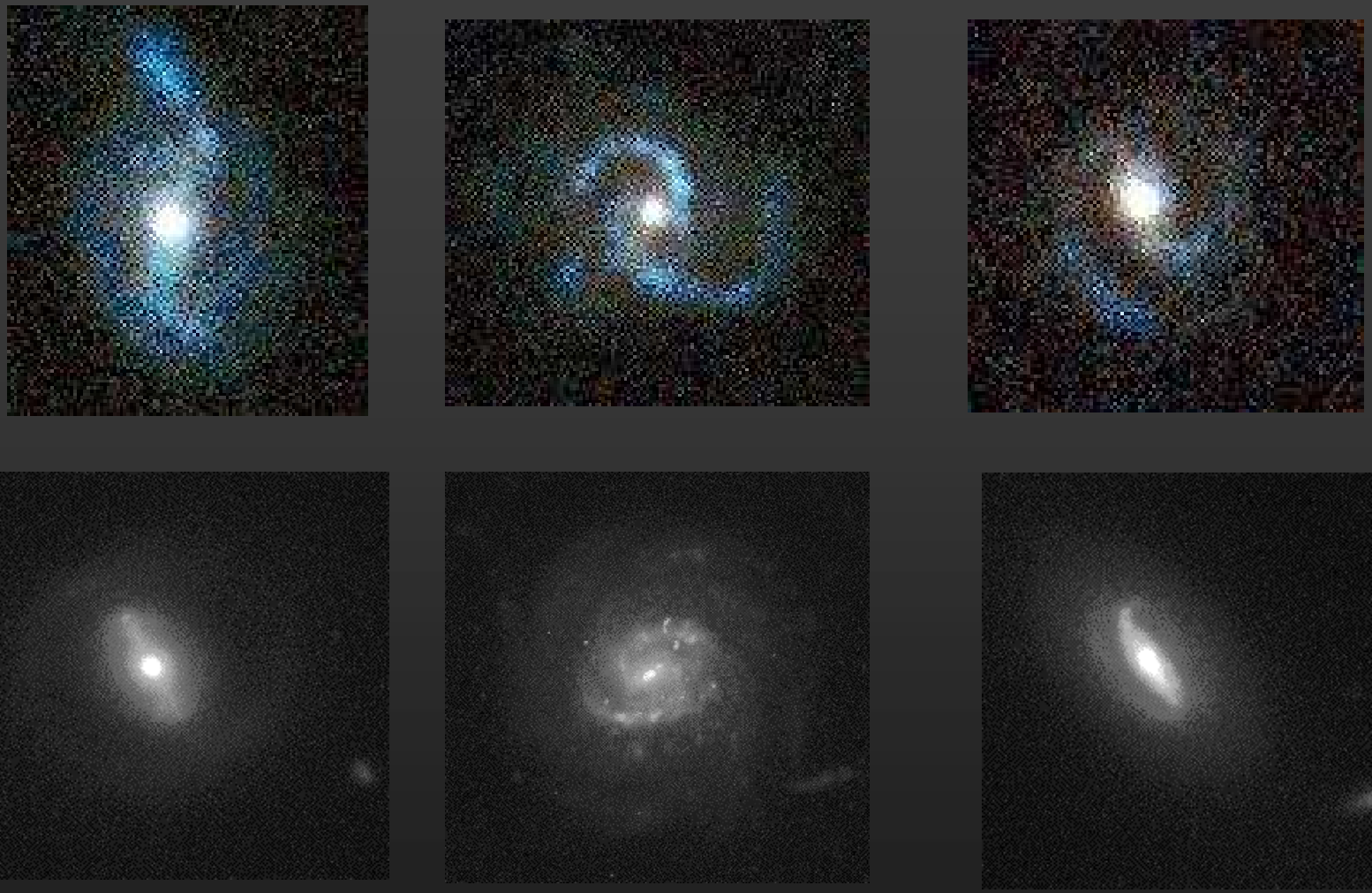
- In-class movie: Powers of 10

Overview: From the Earliest Epochs to the Present Day

See in-class summary table : From the Big Bang to the Present day

The Hubble Ultra Deep Field (HUDF) is ***the deepest visible-light image of the Universe.*** The small red objects and small distorted blue objects in this image are believed to be some of the very first galaxies or proto-galaxies that formed about 11 to 13 Gyr ago.





Barred spiral galaxies already abundant at lookback times of 5 to 8 Gyr
(Jogee et al 2004, ApJ, Sep issue)

Lecture 5

Announcements

- Your quiz grade will be posted on e-Gradebook next Th.

- Homework 1 due back in-class, next Tue. See class website for help session
  http://www.as.utexas.edu/~sj/a301-fa05/

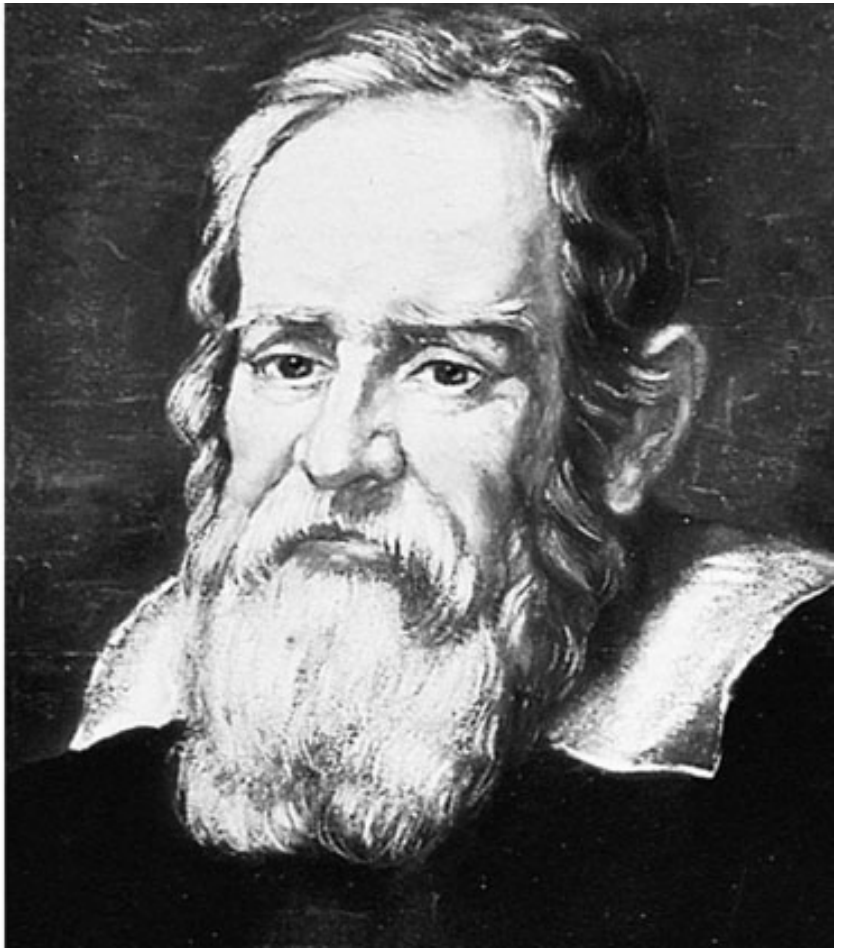
- The following student(s) should see me after class: Eric Chou

Merger of 2 spirals of similar mass can produce a dramaticallly different system!

(Stars=yellow, blue=gas, time shown = 1 Gyr)

Modern Astronomy: Heliocentric models

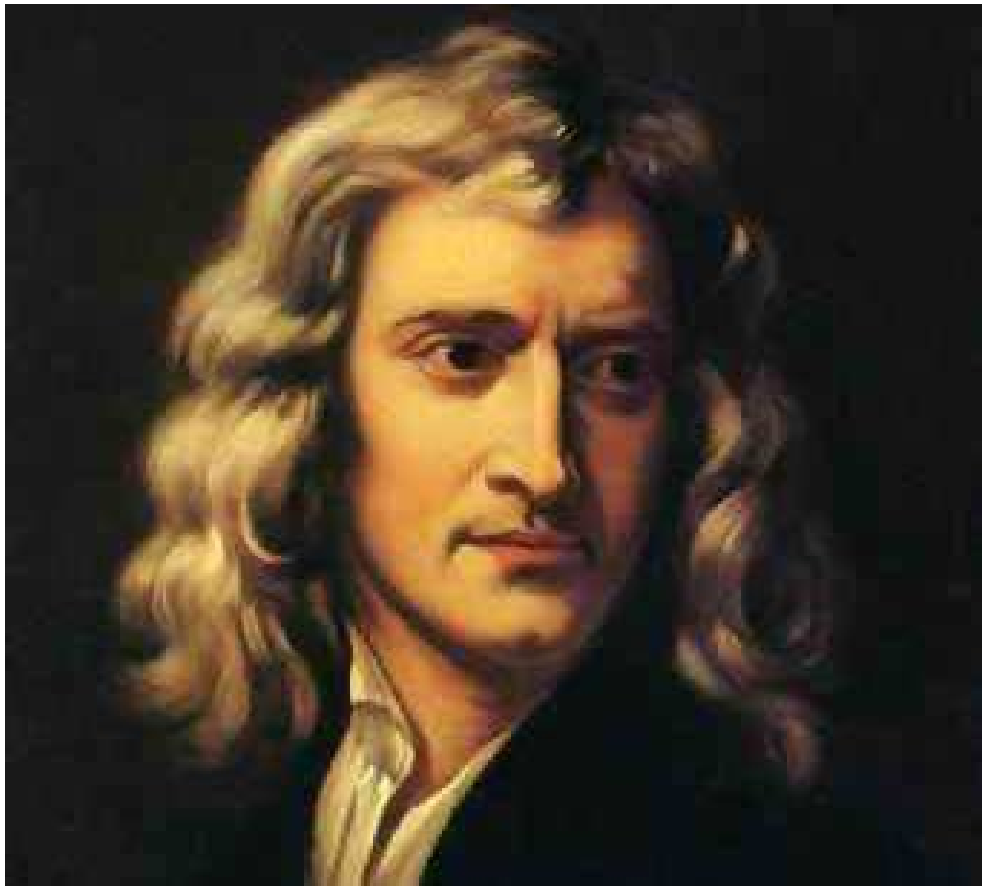
Johannes Kepler: 1571-1630



Galileo Galilei (1564-1642) Used newly invented telescope to prove Kepler's models

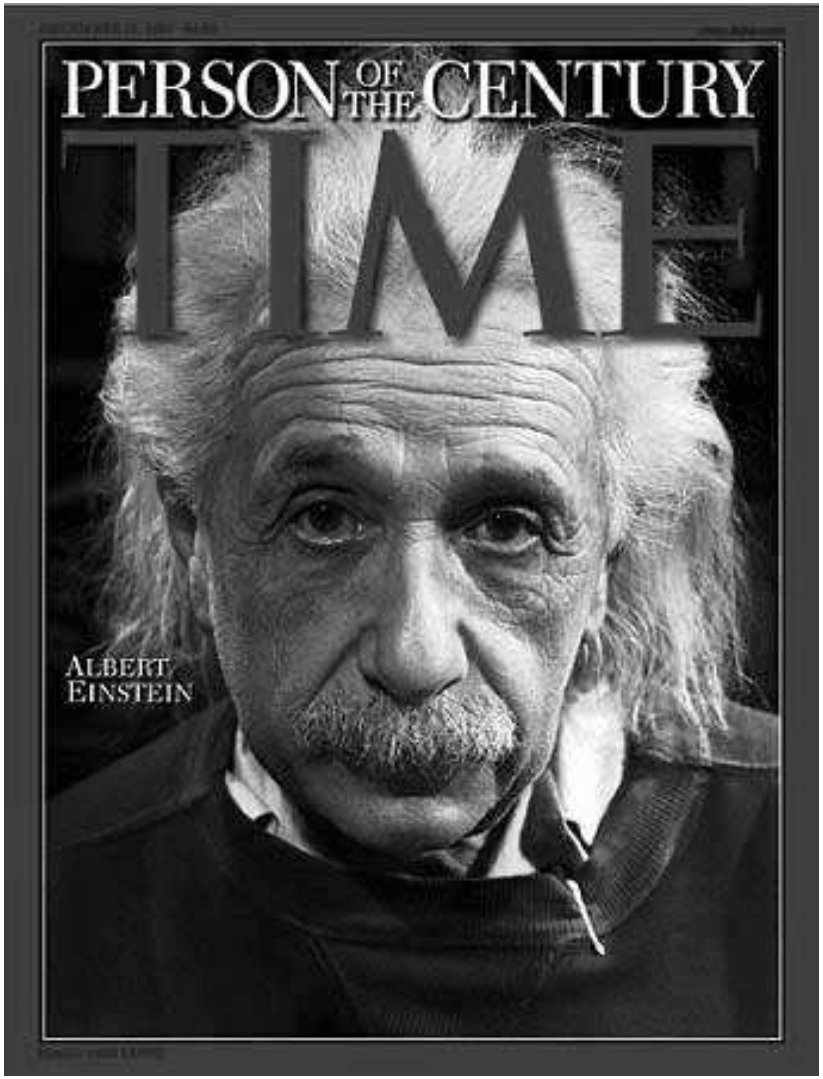
Earth and other planets orbit about the Sun!

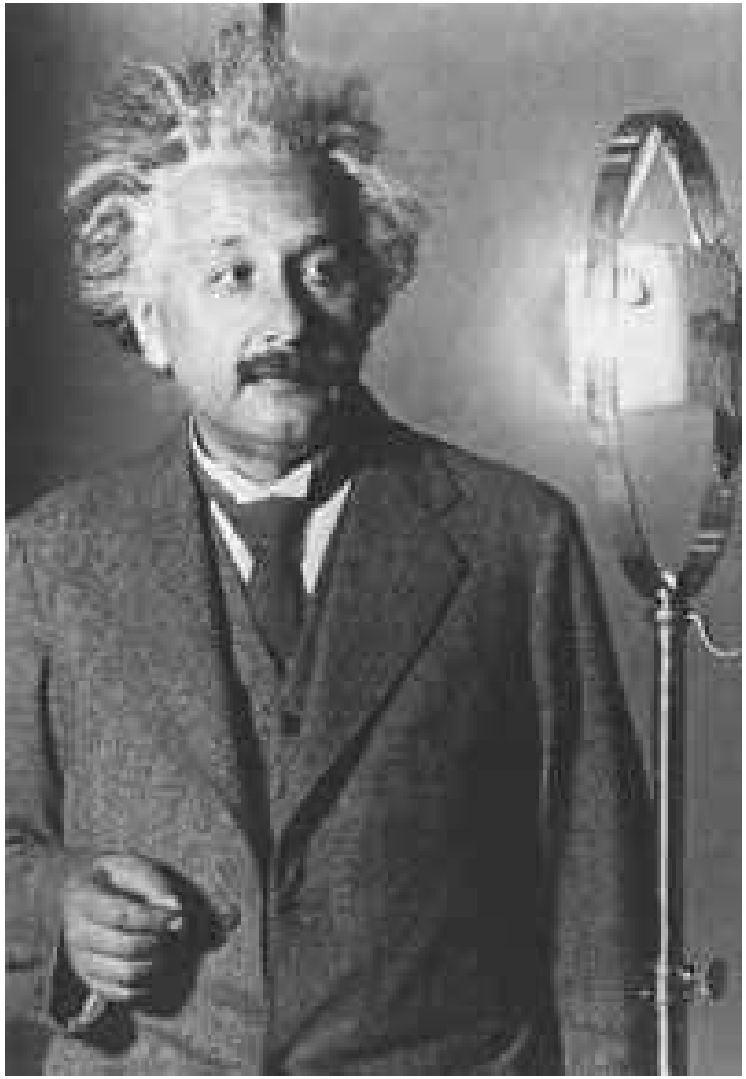
Newton's Law of Gravity and Laws of Motion



Isaac Newton

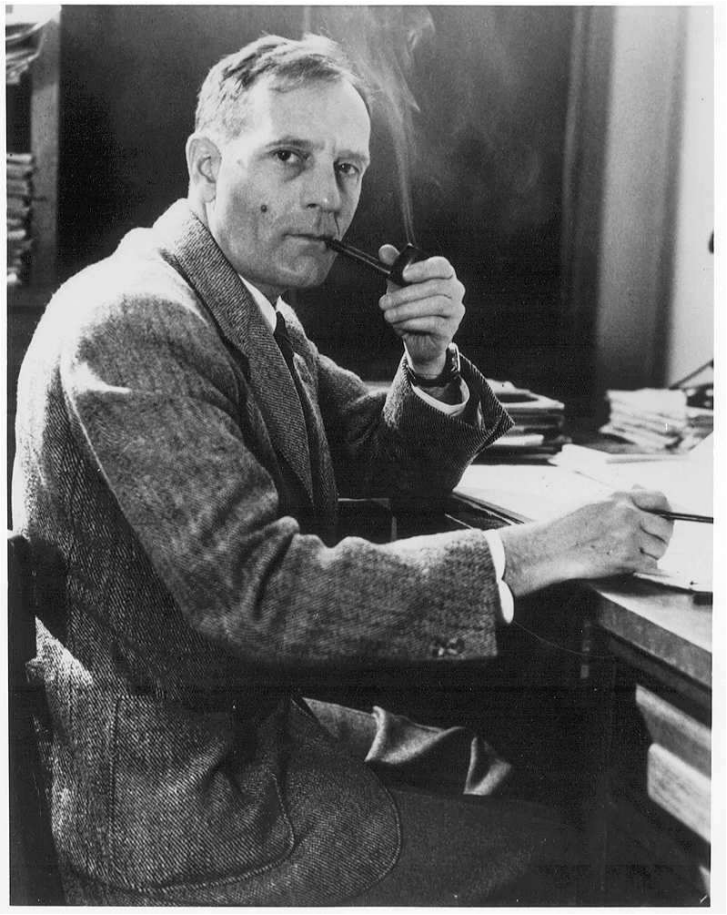
- Unified "the Earth and the Heavens" with his laws of gravity and motion.
- Principia ((Mathematical Principles of Natural Philosophy) in 1687





Albert Einstein

- Theory of Special Relativity 1905
- Theory of General Relativity 1916
- The Nobel Prize in Physics 1921



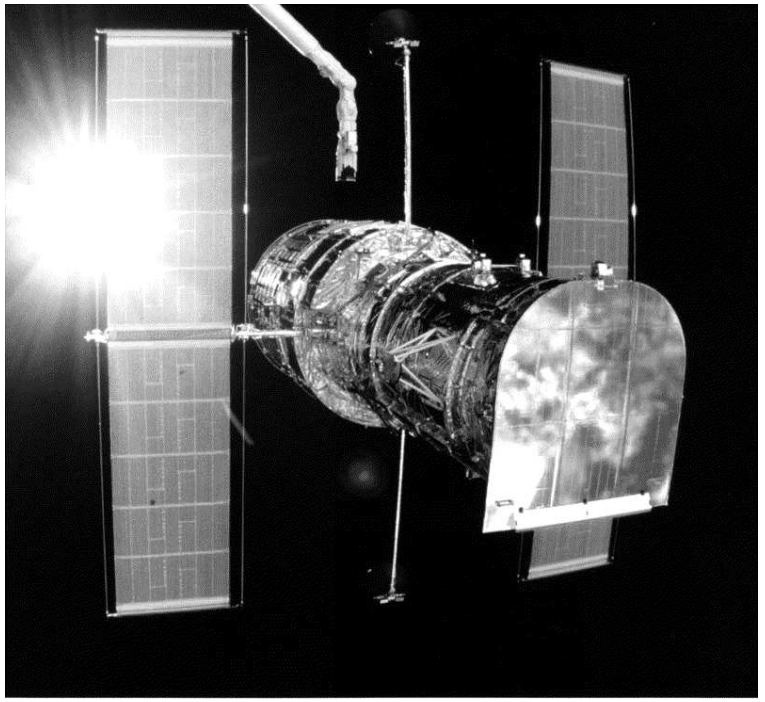
Edwin Powell Hubble (1889-1953)

“At the last dim horizon, we search among ghostly errors of observations for landmarks that are scarcely more substantial. The search will continue. The urge is older than history. It is not satisfied and it will not be oppressed.’’

He showed

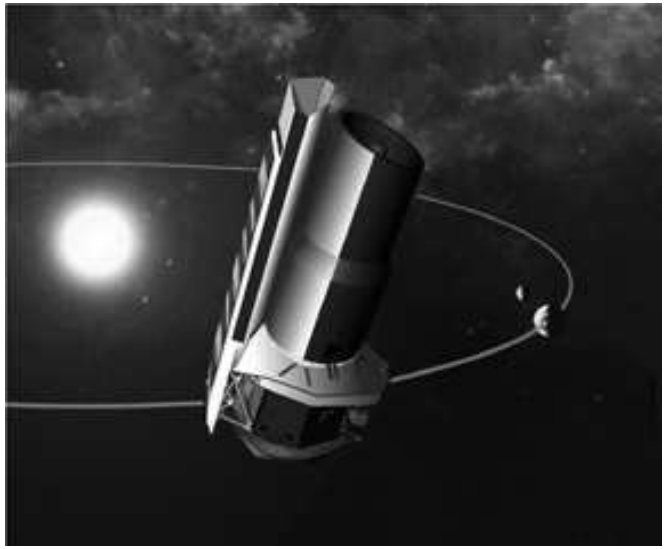
- Beyond the Milky Way, other galaxies actually exist!
- the Universe is expanding… a discovery that is the basis of modern cosmology .

NASA's Three Great Observatories



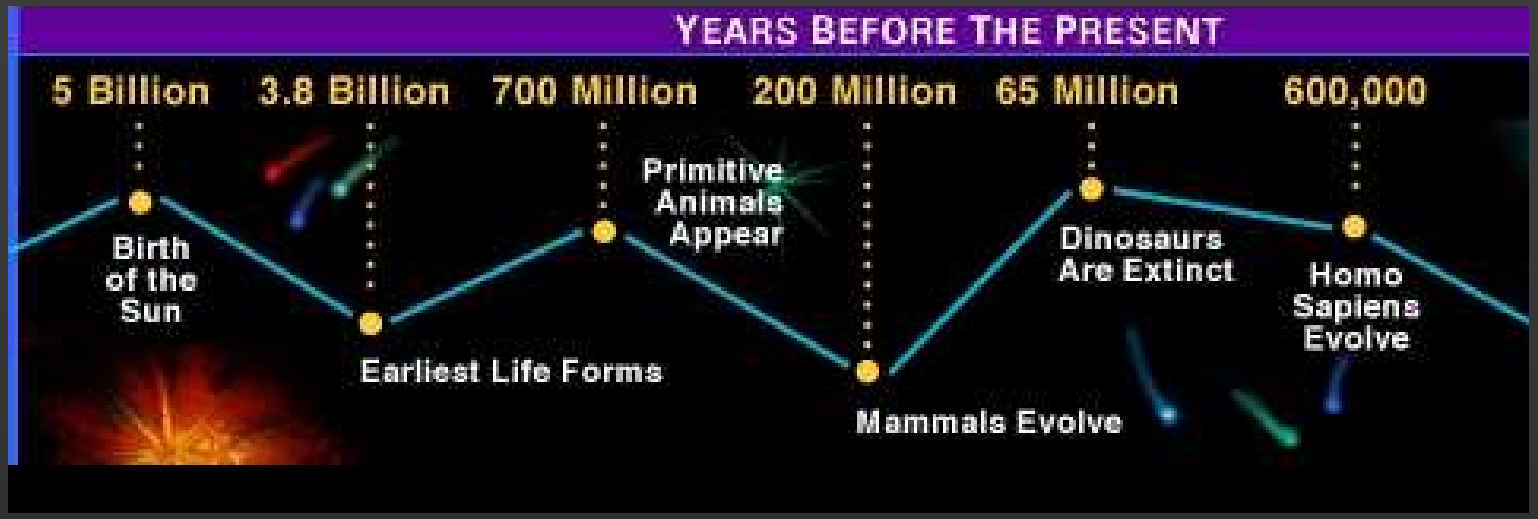
• Hubble Space Telescope (HST) launched in 1990
Works at ultraviolet, optical and infrared wavelengths

•Chandra X-ray Observatory (CXO) launched in 1999: Works at X-ray wavelengths



Spitzer Space Telescope (SST) launched in 2004 Works at mid to far infrared wavelengths : penetrates the dust

See in-class table: From the Big Bang to the Present day 10^{-43} s to 10^{17} s



In a mock-calendar where the age of the Universe (13.7 Gyr) is represented by one year, from Jan 1 to Dec 31

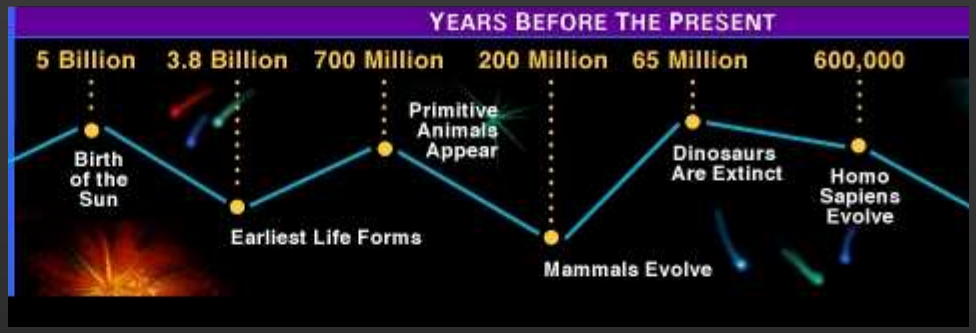
the epoch where Homo Sapiens evolve (600,000 yrs ago) would be only in the last 23 min of Dec 31.

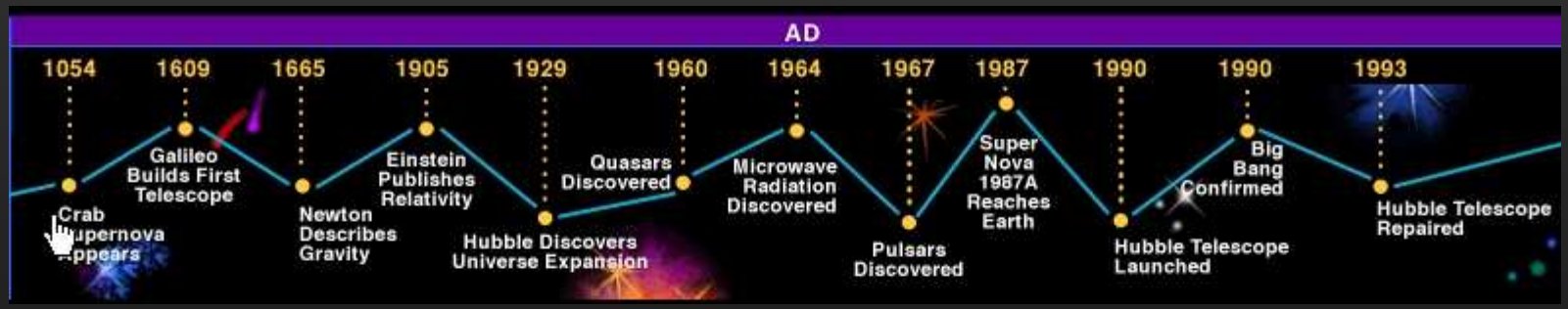
the time when civilisation appeared (11,000 yrs ago) would be only in the last 25 seconds of Dec 31…..a mere blink of an eye away.

the epoch of major cultural and scientific development (400 yrs) would be in in the last second of Dec 31

The Last Century: A Privileged Era

Although we (humans) have been around for 'a mere blink of an eye' (600,000 years) , compared to the age of the Universe (13.7 billion years) , we have made tremendous progress in understanding our origin and evolution, especially in the last century

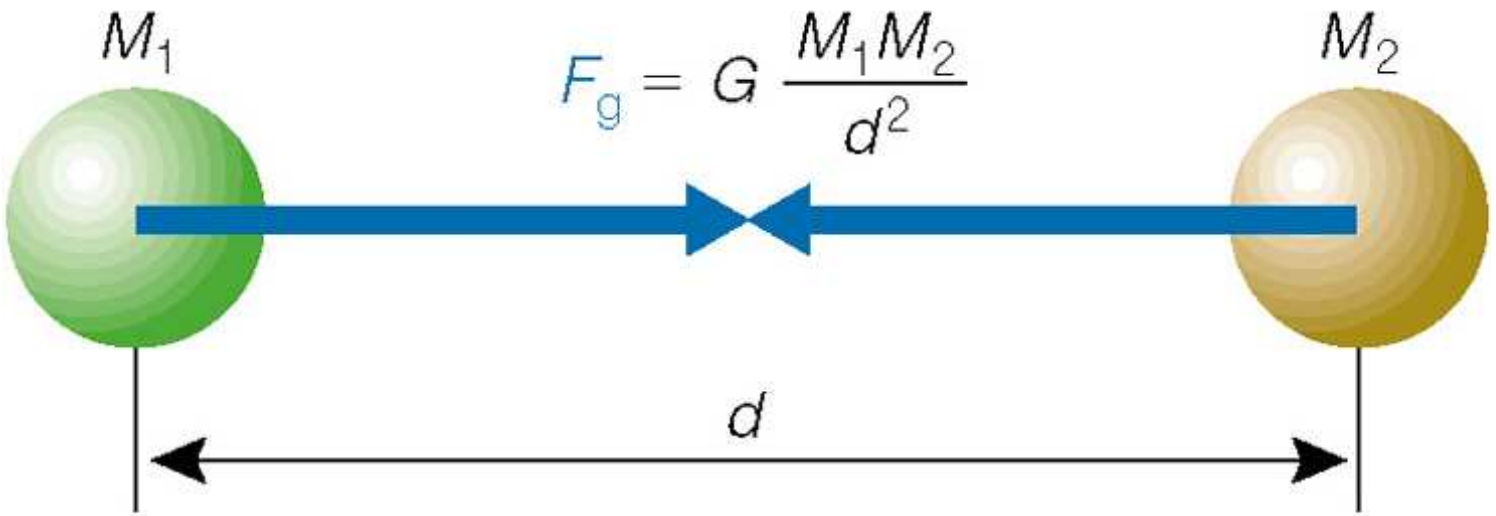




Einstein's theory of relativity, Expansion of Universe discovered by Edwin Hubble, Big Bang confirmed with COBE, dark matter and dark energy discovered, Hubble Space Telescopoe and other NASA Great Observatories launched …

The Four Fundamental Forces

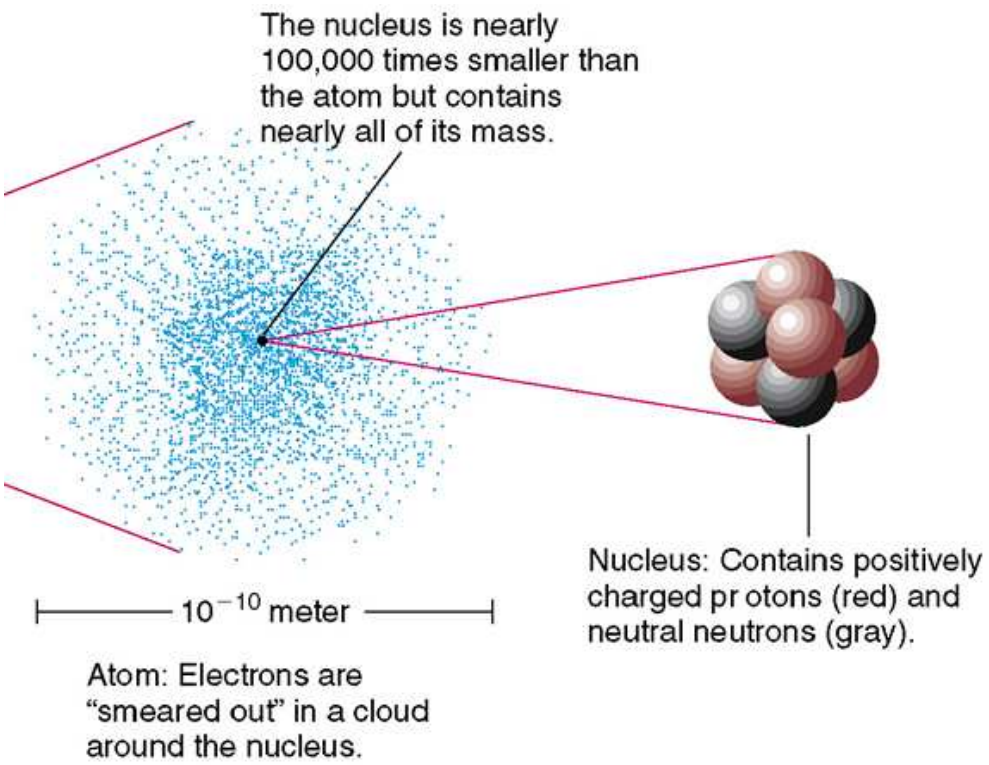
Gravity and Electromagnetic Forces



Gravitational, electric, and magnetic forces are inverse square law forces

F prop to $1/d^2$

Forces in an Atom



A carbon nucleus
= 6p+ and 6n

A carbon atom s made of 6 e-
orbiting a tiny carbon nucleus

-- See in-class notes: Forces acting are gravity , EM between e- p+
, EM between p+ p+, Strong Forces, Weak Forces