

CHANGE OF KOMATSU'S OFFICE HOURS

(Previous)

Tuesdays & Thursdays 3:30 to 4:30

(New)

Tuesdays 4:45 to 5:30

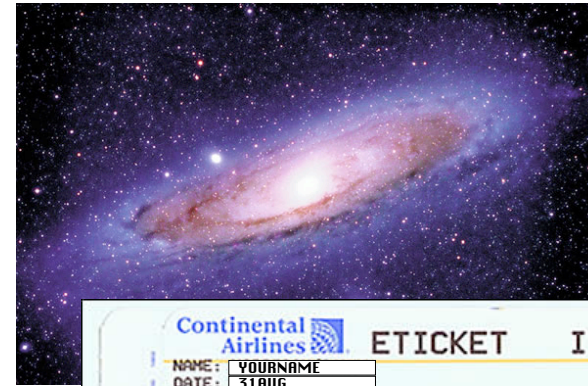
Thursdays 3:30 to 4:30

Briefing

Welcome to the Cosmic Tour:
Some Guide Lines

Objectives: Establish the Big Picture

- Lecture 1: August 31
- Lecture 2: September 2



*Welcome
Aboard!!*

AST 301

Continental Airlines		ETICKET I		Continental Airlines	
NAME: YOURNAME	DATE: 31AUG	ONEPASS:	02 710715-4	NAME: YOURNAME	DATE: 31AUG
FLIGHT: NW 816Y	GATE: B19	SEAT: 7D	0 10 FLIGHT: NW 816Y	ONEPASS: 2.5 MILLION	MILEAGE: LIGHT YEARS
PLEASE PROVIDE OPTIONAL CONTACT INFORMATION ON THE REVERSE OF THIS BOARDING PASS.			GATE: B19 SEAT: 7D		
BOARDING PASS			DEPART: 1430		
			ARRIVE: AUSTIN		
			BOARD TIME: 1400		
			ANDROMEDA GALAXY		

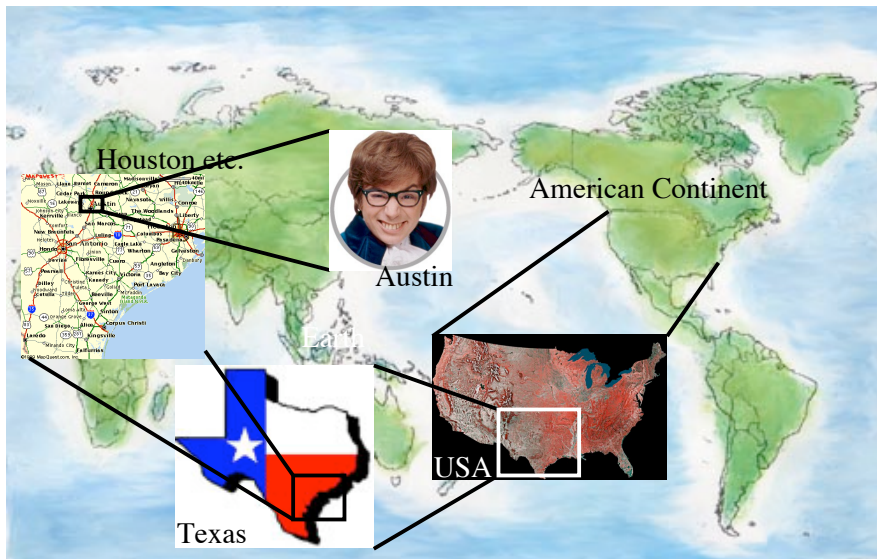
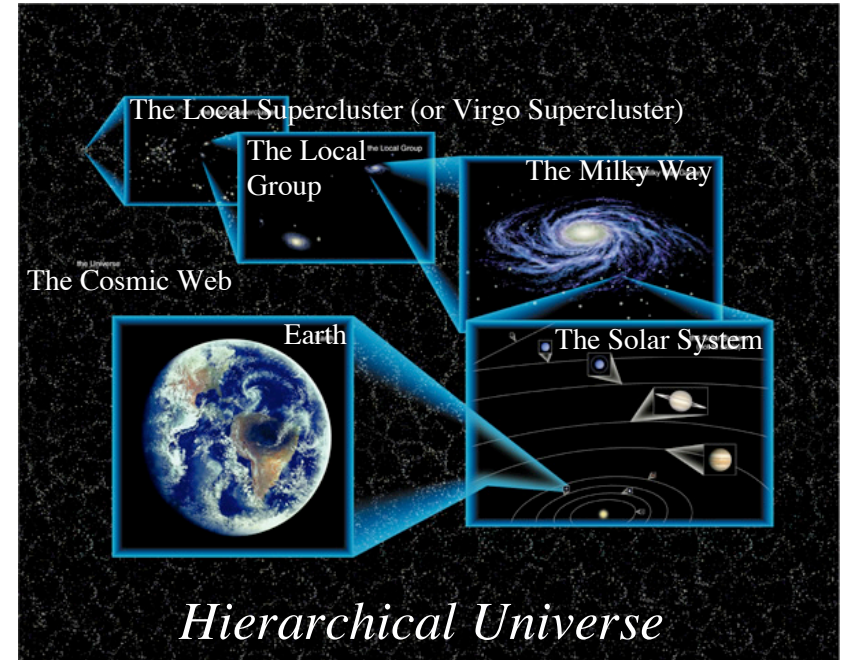
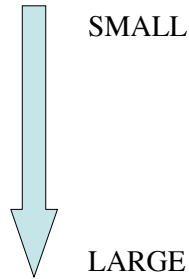
Lecture 1
Our Place in the Universe

Reading: Chapter 1

Our Cosmic Address

- Hierarchical Universe

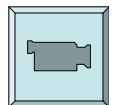
- Earth-Moon System
- The Solar System
- The Milky Way Galaxy
- The Local Group
- The Local Supercluster
- The Cosmic Web, The Universe



Hierarchical Globe

Our Global Address

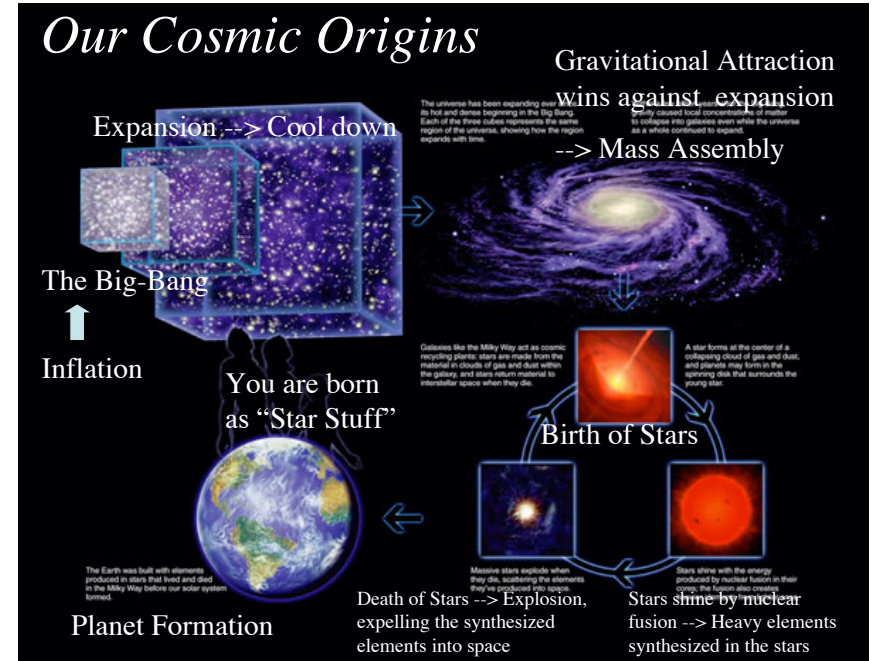
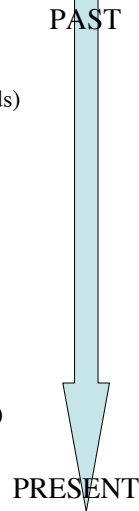
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|--|---|
| <ul style="list-style-type: none"> • Hierarchical Globe – Austin – Houston and Cities Around – Texas – The United States – American Continent – Earth | <ul style="list-style-type: none"> • Hierarchical Universe – Earth-Moon System – The Solar System – The Milky Way Galaxy – The Local Group – The Local Supercluster – The Cosmic Web, The Universe |
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Our Cosmic Origins

• Cosmic History

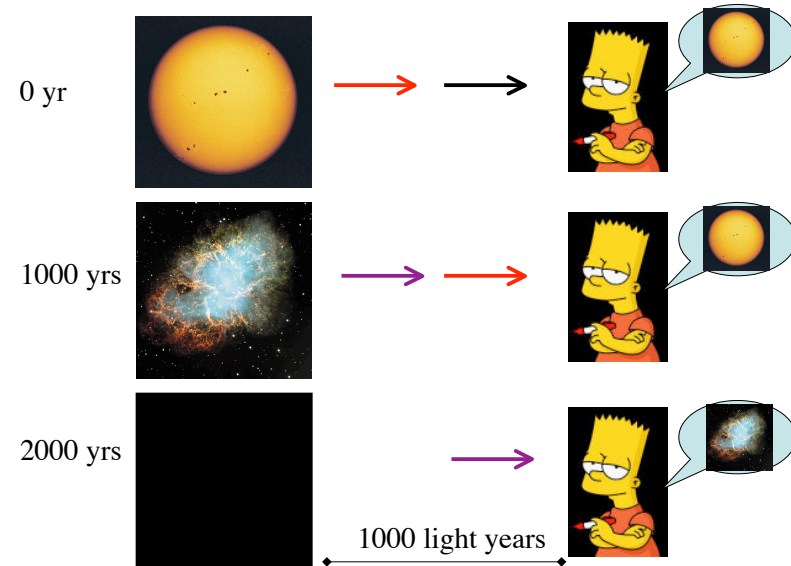
- Very Early Stage (**A fraction of a second**)
 - Inflation (rapid expansion of the Universe after birth)
 - The Big Bang (Very Hot! The Universe cools as it expands)
- The Plasma Universe (**~380,000 years**)
 - Filled with photons, protons, electrons
 - Formation of Hydrogen atoms
- The Dark Age (**~200 million years**)
 - Assembly of matter into "Proto-galaxy clouds"
 - Formation of first stars ends the Dark Age
- Galaxy Formation (**~1 billion years**)
- Stellar Evolution (**~a few to 10 billion years**)
 - Production of "heavier" elements (Carbons, Oxygens, etc)
- Planet Formation (**~a few to 10 billion years**)
 - The Earth comes into existence



Farther Away -- Seeing into the Past

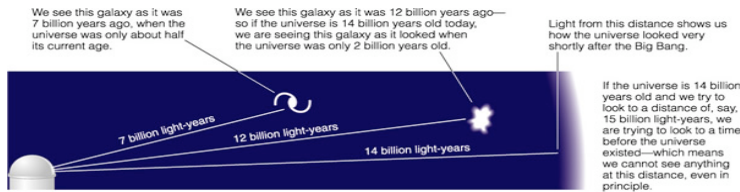
- Fundamental Properties of Light
- Light has a finite speed
 - The speed of light = 300,000 km per second = 675 million miles per hour!
 - Light can circle the Earth nearly 8 times in one second
- NOTHING BEATS LIGHT
 - Nothing travels faster than light.
- Seeing into the past
 - It takes 8 minutes for light to travel from the Sun to the Earth --> *The Sun is 8 light-minutes away*
 - The Orion nebula is 1,500 light-years away
 - The Andromeda Galaxy is 2.5 million light-years away

What We See is an Old Picture



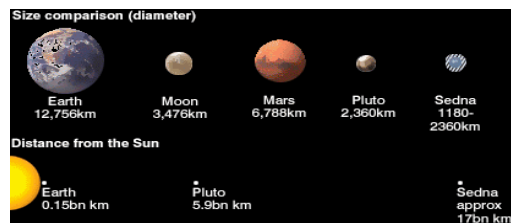
The Cosmic Horizon

- The finite speed of light gives the concept of the “observable” Universe.
 - The age of the Universe at present is about 14 billion years.
 - We cannot possibly see anything older, or further, than 14 billion years.
 - However, the actual size of the entire Universe is not limited to the size of the horizon --- it can be much larger, but we cannot determine it by any observational means, because nothing travels faster than light.



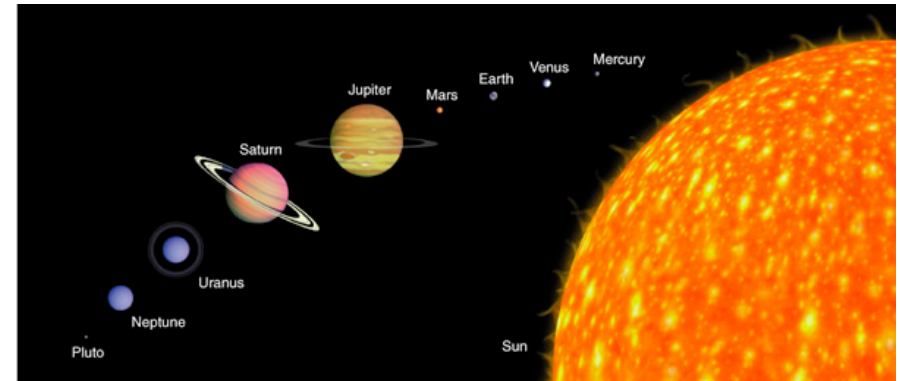
How many planets?

- **A: Still in Debate!!**
- Historically, nine.
 - Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto
- A big debate as to whether Pluto can be considered a planet
- Last year, a potential candidate for the 10th planet, “Sedna”, was discovered.
- Sedna vs Pluto
 - Similar size
 - 3 times more distant



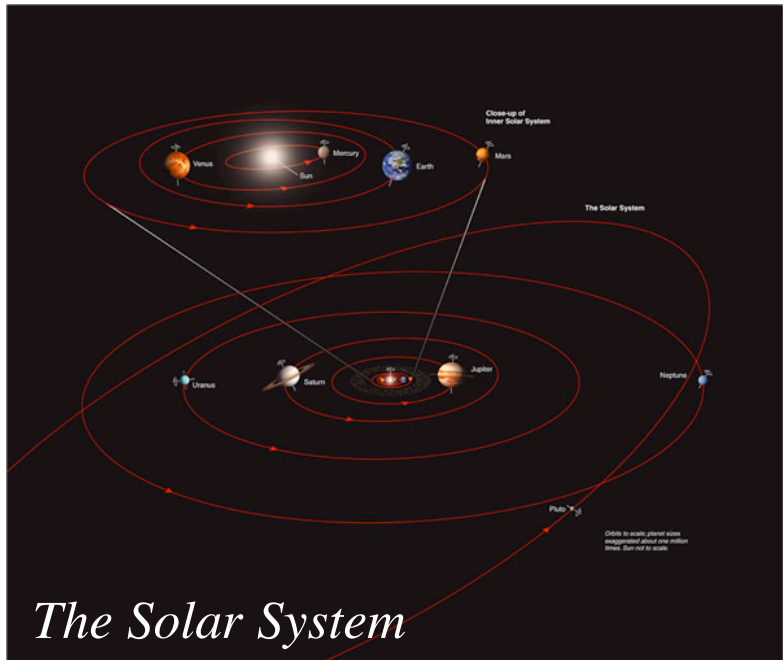
The Solar System

- Q: How many planets in the Solar System?
 - A: 8, B: 9, C:10



KBOs: Kuiper Belt Objects

- There are many objects orbiting beyond Pluto (or Neptune). Are they not planets? Why not?
- They are not called planets, because of their small sizes (~100km), compared to the size of Pluto ~2,400km; however, Pluto (and Sedna) itself may be just a bigger version of the KBOs.
- The peculiarity of Pluto can be seen from its orbit around the Sun: while the other planet’s orbits are nearly circular, Pluto’s is highly elongated, arguing for a different formation process for Pluto.



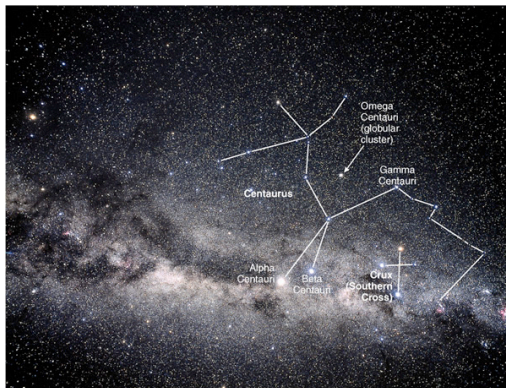
Emptiness of the Solar System

- A model on the National Mall, DC. The Sun is the gold sphere which is about the size of a grapefruit. Earth would be 15 meters away and only 1mm large. Pluto would be a speck and would be about 600m away. Most of the Solar System is empty!



Nearby Stars

- The nearest star is “Alpha Centauri”, which is **4.4 light-years** away.

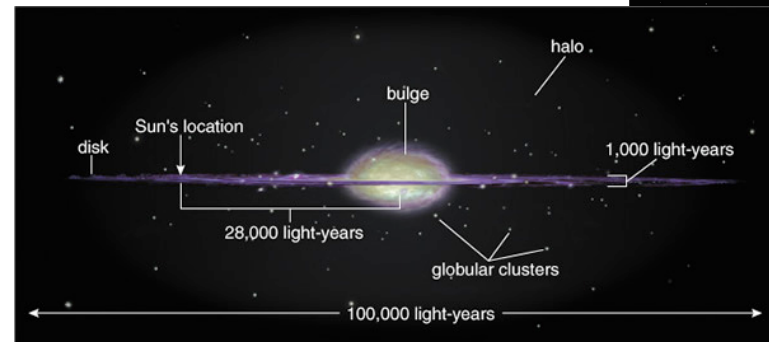
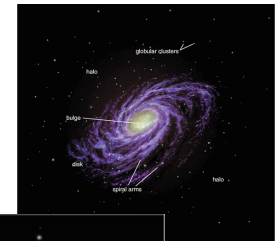


For comparison, the Sun is **8 light-minutes** away, and even Pluto is only **5.5 light-hours** away. Think about how far away the nearest star is! (1 year is 8600 hours.)

The book provides a nice analogy in daily life to understand how far away this is.

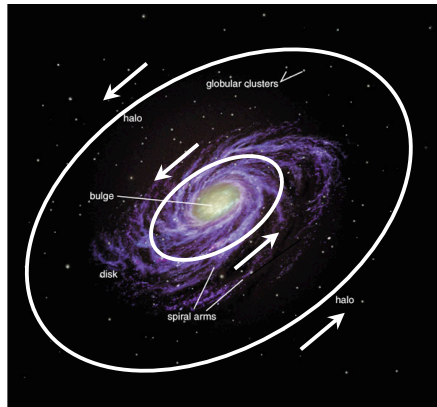
The Milky Way Galaxy

- The Milky Way is a spiral galaxy, containing around 100 billion stars.
- Our Solar System lies about **28,000 light-years(!)** from the Galactic Center.



Rotation of the Milky Way

- The spiral pattern is generated by rotation of the Milky Way. As we see later, the rotation speed at a given position is a good indicator of strength of gravity caused by matter inside it.



•The stronger the gravity (or more matter) is, the faster the rotation becomes.

•Thus, the outer part of the Milky Way should have a slower rotation speed; however, observations have shown that the rotation speed is actually constant over large radii.

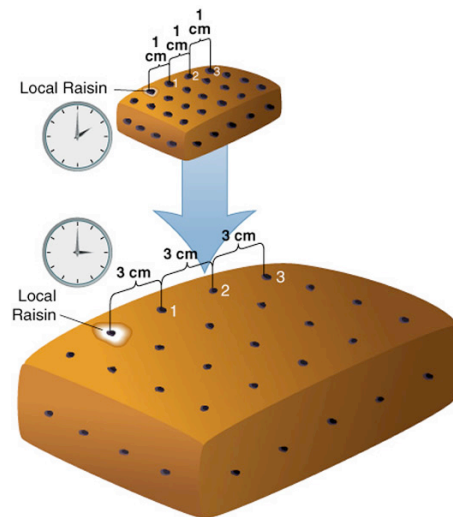
•Presence of invisible matter ---> Dark Matter!!

Dynamic Universe

- Everything is moving. Earth circles the Sun, the Solar System circles the center of the Milky Way, the Milky Way and Andromeda Galaxy are attracting each other in the Local Group. (They will eventually collide in 10 billion years.)
- If one gets out of the Local Group, then it appears that all other galaxies move away from us --- **evidence for the expansion of the Universe.**
 - Does it mean we are the center of the Universe? If not, why not?

The Expansion of the Universe

- Imagine that we are “Local Raisin”. As time goes by this raisin cake expands, making distance between raisins larger; however, there is no “central raisin” here.
- We are not the center of the Universe, just like raisins in a raisin cake.



Are We Alone?

- The observable Universe contains **100 billion galaxies**, each containing **100 billion stars**. How many stars? The book says that the number of stars in the Universe is about the same as the number of grains of sand on *all* beaches on Earth!
- Many, if not all, stars have planets, so the possibility of Earth-like planets is high. Searching for the Earth-like planets is one of the hottest subjects in Astronomy today.
- It is certainly plausible that there are (in fact, lots of) other lives on other planets, which are orbiting around billions of billions of billions of... stars out there.