Astronomy 1001 Syllabus

Sec 1 T,Th 9:45 AM, Tate B20
Sec 2 T,Th 1:00 PM, Tate B50

- Syllabus: on Canvas
- Lecture notes: will be posted on Canvas
- Exams: Tuesday, February 25, Thursday, April 2, and Monday, May 11
- Textbook & Mastering Astronomy: see Canvas

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Astronomy 1001

First Assignments:

- Read the Syllabus
- Bring your questions to Lecture on Thursday

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Astronomy 1001

First Assignments: Problem

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Astronomy 1001 Labs

There are NO Ast 1001 labs this week.

Ast 1001 labs start next week.

Your Ast 1001 labs do not meet this week.

There are NO Ast 1001 labs this week.

Do not go to your Ast 1001 labs this week.

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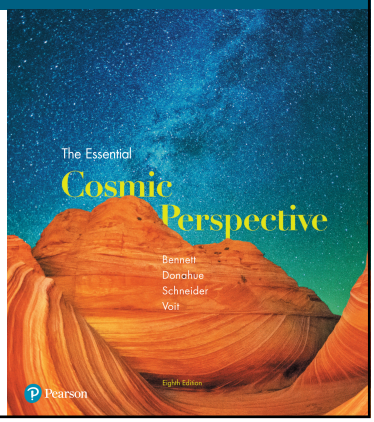
Lecture Outline

Chapter 1: A Modern View of the Universe



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1.1 The Scale of the Universe

Our goals for learning:

- What is our place in the universe?
- How big is our universe?

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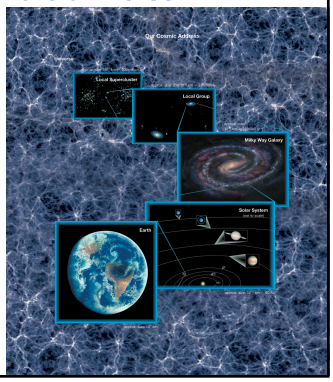
What is our place in the universe?

Our "cosmic address"



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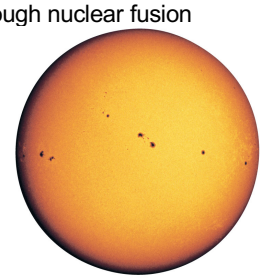
Star

A large, glowing ball of gas that generates heat and light through nuclear fusion



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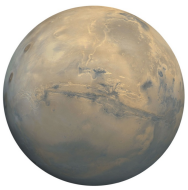
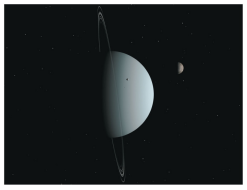
Planet



Mars



Uranus

A moderately large object that orbits a star; it shines by reflected light. Planets may be rocky, icy, or gaseous in composition.

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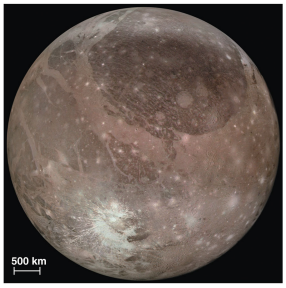
Moon (or satellite)



Ganymede (orbits Jupiter)

An object that orbits a planet

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Asteroid

A relatively small and rocky object that orbits a star

Mathilde

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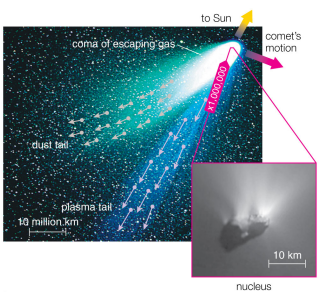
Comet



A relatively small and icy object that orbits a star

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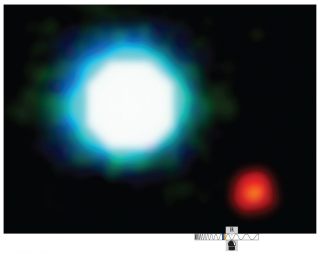
Solar (Star) System

A star and all the material that orbits it, including its planets and moons



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Nebula

An interstellar cloud of gas and/or dust

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Galaxy

A great island of stars in space, all held together by gravity and orbiting a common center

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Universe

The sum total of all matter and energy; that is, everything within and between all galaxies

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Looking back in time

- Light travels at a finite speed (300,000 km/s).

Destination	Light travel time
Moon	1 second
Sun	8 minutes
Sirius	8 years
Andromeda Galaxy	2.5 million years

- Thus, we see objects as they were in the past:

The farther away we look in distance, the further back we look in time.

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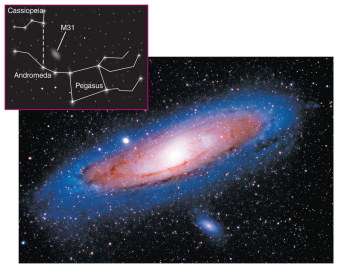
Example:

This photo shows the Andromeda Galaxy as it looked about 2 1/2 million years ago.

Question: When will we be able to see what it looks like now?



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Definition: Light-Year

- The **distance** light can travel in 1 year
- About 10 trillion kilometers (6 trillion miles)

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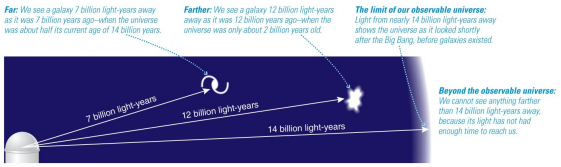
- At great distances, we see objects as they were when the universe was much younger.



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Thought Question

Why can't we see a galaxy 15 billion light-years away?
(Assume the universe is 14 billion years old.)

A. No galaxies exist at such a great distance.
B. Galaxies may exist at that distance, but their light would be too faint for our telescopes to see.
C. Looking 15 billion light-years away means looking to a time before the universe existed.

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How big is the universe?

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How big is Earth compared to our solar system?

Let's reduce the size of the solar system by a factor of 10 billion; the Sun is now the size of a large grapefruit (14 cm diameter).

How big is Earth on this scale?

A. an atom
B. a tip of a ballpoint pen
C. a marble
D. a golf ball

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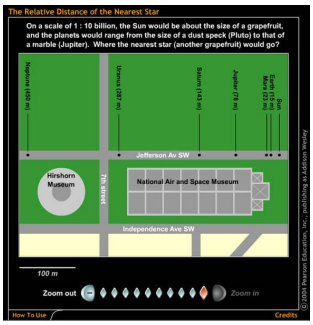
The scale of the solar system

- On a 1-to-10 billion scale:
  - Sun is the size of a large grapefruit (14 centimeters).
  - Earth is the size of a tip of a ballpoint pen, 15 meters away.



PLAY Relative Distance of the Nearest Star

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How far away are the stars?

On our 1-to-10 billion scale, it's just a few minutes' walk to Pluto.

How far would you have to walk to reach Alpha Centauri?

A. 1 mile
B. 10 miles
C. 100 miles
D. the distance across the United States (2500 miles)

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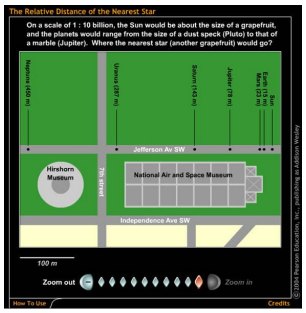
Answer: D, the distance across the United States



PLAY Relative Distance of the Nearest Star

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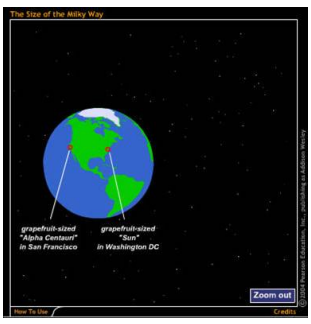
How big is the Milky Way Galaxy?

The Milky Way has about 100 billion stars. On the same 1-to-10 billion scale…



PLAY The Size of the Milky Way

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Thought Question

Suppose you tried to count the more than 100 billion stars in our galaxy, at a rate of one per second…

How long would it take you?

A. a few weeks
B. a few months
C. a few years
D. a few thousand years

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How big is the universe?

- The Milky Way is one of about 100 billion galaxies.
- 10^{11} stars/galaxy x 10^{11} galaxies = 10^{22} stars

It has as many stars as grains of (dry) sand on *all* Earth's beaches.

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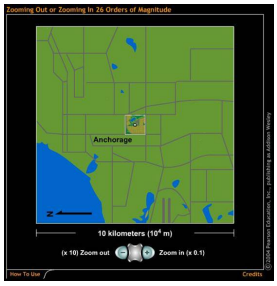
- Now let's step through the universe in powers of 10.



PLAY Zooming Out or Zooming In 26 Orders of Magnitude

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What have we learned?

- What is our place in the universe?
  - Earth is part of the solar system, which is in the Milky Way Galaxy, which is a member of the Local Group of galaxies in the Local Supercluster.
- How big is the universe?
  - The observable universe dwarfs our Milky Way Galaxy, which in turn dwarfs our solar system. Scale models can help with visualizing such distances.

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1.2 The History of the Universe

Our goals for learning:

- How did we come to be?
- How do our lifetimes compare to the age of the universe?

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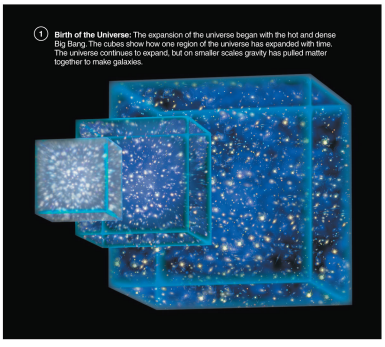
How did we come to be?



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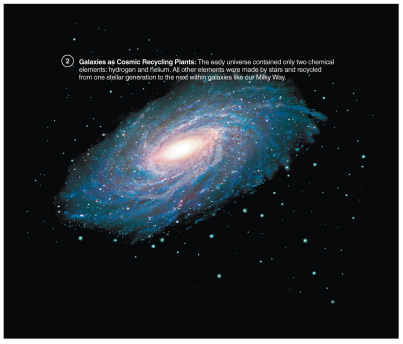

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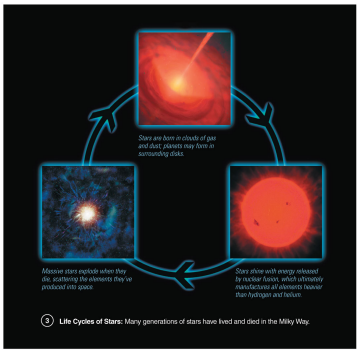

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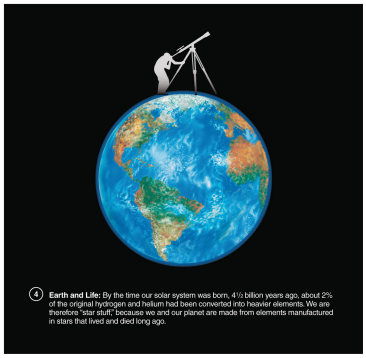

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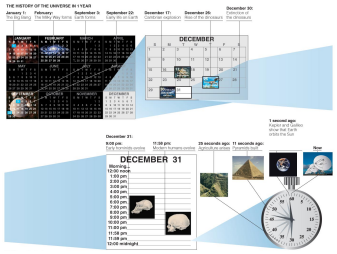
How do our lifetimes compare to the age of the universe?

- The cosmic calendar: A scale on which we compress the history of the universe into 1 year



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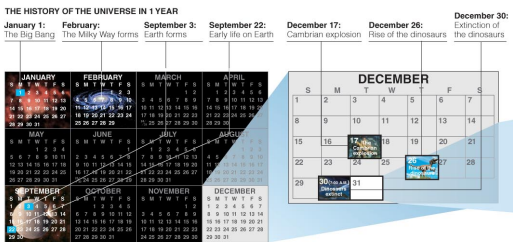

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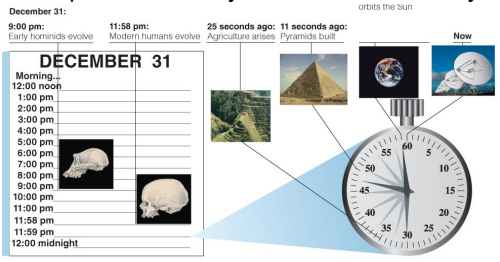

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What have we learned?

- How did we come to be?
  - The matter in our bodies came from the Big Bang, which produced hydrogen and helium.
  - All other elements were constructed from H and He in stars and then recycled into new star systems, including our solar system.
- How do our lifetimes compare to the age of the universe?
  - On a cosmic calendar that compresses the history of the universe into 1 year, human civilization is just a few seconds old, and a human lifetime is a fraction of a second.

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1.3 Spaceship Earth

Our goals for learning:

- How is Earth moving in through space?
- How do galaxies move within the universe?

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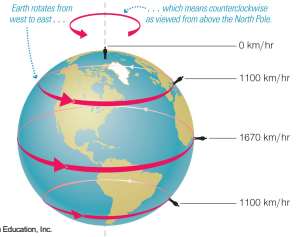
How is Earth moving through space?

- Contrary to our perception, we are not "sitting still."
- We are moving with the Earth in several ways, and at surprisingly fast speeds.



Earth **rotates** around its axis once every day.

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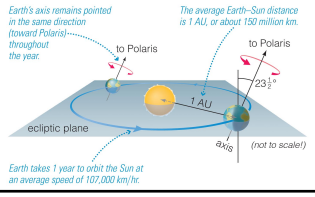
Earth orbits the Sun (revolves) once every year…

- at an average distance of 1 AU ≈ 150 million km.
- with Earth's axis tilted by 23.5º (pointing to Polaris).
- and rotates in the same direction it orbits, **counter-clockwise** as viewed from above the North Pole.



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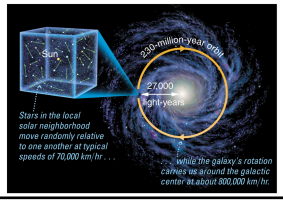
Our Sun moves randomly relative to the other stars in the local solar neighborhood…

- at typical relative speeds of more than 70,000 km/hr
- but stars are so far away that we cannot easily notice their motion
- and it orbits the galaxy every 230 million years.



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More detailed study of the Milky Way's rotation reveals one of the greatest mysteries in astronomy…

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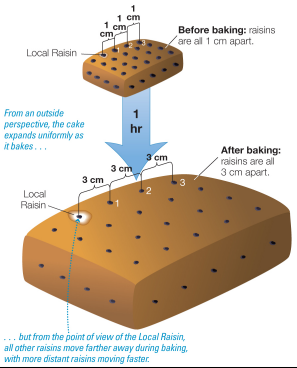
How do galaxies move within the universe?

Galaxies are carried along with the expansion of the universe. But how did Hubble figure out that the universe is expanding?



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Hubble discovered that…

- all galaxies outside our Local Group are moving away from us.
- the more distant the galaxy, the faster it is racing away.

Conclusion: We live in an expanding universe.

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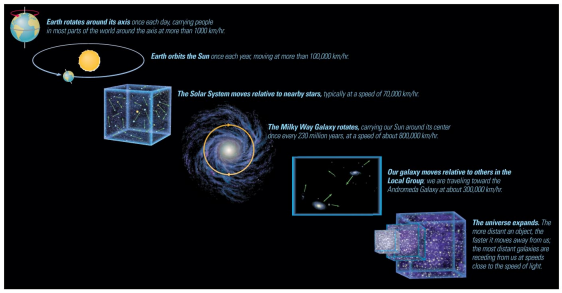
Are we ever sitting still?



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What have we learned?

- How is Earth moving in our solar system?
  - It rotates on its axis once a day and orbits the Sun at a distance of 1 AU ≈ 150 million km.
  - Stars in the local neighborhood move randomly relative to one another and orbit the center of the Milky Way in about 230 million years.
- How do galaxies move within the universe?
  - All galaxies beyond the Local Group are moving away from us with expansion of the universe: the more distant they are, the faster they're moving.

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