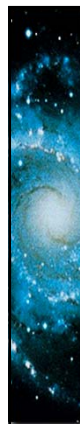


## Chapter 1


### The Scale of the Cosmos



### Guidepost

How can we study something so big it includes everything, even us? The cosmos, or the universe as it is more commonly called, is our subject in astronomy. Perhaps the best way to begin our study is to grab a quick impression as we zoom from things our own size up to the largest things in the universe.

That cosmic zoom will answer a fundamental question for us: *Where are we in the universe?*



### Guidepost (continued)

Another question to be answered is "How does your life span and human history fit into the age of the universe?"

Finally, "Why should you study astronomy?"

While we study the solar system, we will observe the process by which we learn. That process, science, gives us a powerful way to understand not only the solar system and the universe but also ourselves.

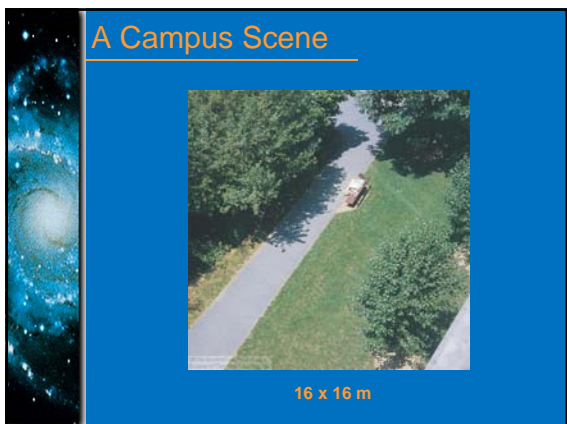


### Scales of Size and Time

Astronomy deals with objects on a vast range of size scales and time scales.

Most of these size and time scales are way beyond our every-day experience.

Humans, Earth, and even our solar system are tiny and unimportant on cosmic scales.



### The Landscape of Pennsylvania

100 miles x 100 miles

### Earth

Diameter of Earth: 12,756 km

### Earth and Moon

Distance Earth → moon: 384,000 km

### Earth Orbiting Around the Sun

Distance sun → Earth = 150,000,000 km

### Earth Orbiting Around the Sun (2)

In order to avoid large numbers beyond our imagination, we introduce new units:

1 Astronomical Unit (AU)  
= Distance sun → Earth = 150 million km

### Our Solar System

Approx. 100 AU

### (Almost) Empty Space Around Our Solar System

Sum

Pluto in January 1979

Annual Figure 1 of

Mercury  
Venus  
Earth  
Mars  
Jupiter  
Saturn  
Uranus  
Neptune  
Pluto

Pluto in March 1989

Approx. 10,000 AU

### The Solar Neighborhood

Sum

Approx. 17 light years

### The Solar Neighborhood (2)

Sum

Approx. 17 light years

New distance scale:  
1 light year (ly) =  
Distance traveled by light  
in 1 year  
= 63,000 AU =  $10^{13}$  km  
= 10,000,000,000,000 km  
(= 1 + 13 zeros)  
= 10 trillion km

Nearest star to the sun:  
Proxima Centauri, at a  
distance of 4.2 light years

### The Extended Solar Neighborhood

Sum

Approx. 1,700 light years


### The Milky Way Galaxy

Diameter of the Milky Way: ~ 75,000 ly

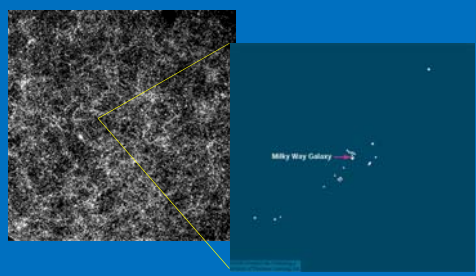
### The Local Group of Galaxies

Milky Way Galaxy

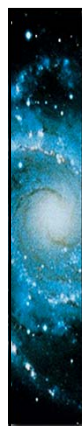
Distance to the nearest large galaxies:  
several million light years



### The Universe on Very Large Scales




Clusters of galaxies are grouped into superclusters. Superclusters form filaments and walls around voids.



### When is now?

The universe is much older than we are, some 13.7 billion years old that began with a Big Bang. Evidence for this origin for the universe is

- The universe is expanding.
- There is cosmic background radiation.
- There are a lot of simple elements (hydrogen and helium).



### Why Study Astronomy?

We study astronomy to:

- understand how you fit into the history of the universe;
- understand how science works to help us understand our world, solar system and the entire universe; and
- learn about the wonders of our solar system and the continuing series of discoveries being made right now!