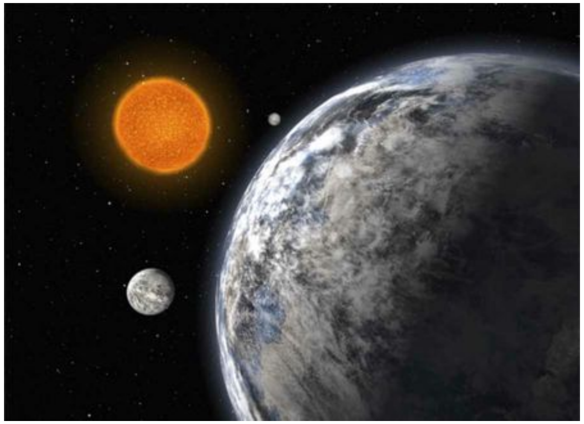
AST 301
Introduction to Astronomy
Unique number 47520

Instructor: John Scalo
Teaching Assistant: Julie Hollek



AST 301: Preliminaries

1. Intro, basics of course, syllabus

2. The course web site

3. The Textbook

4. The “Mastering Astronomy” or “Textbook” web site

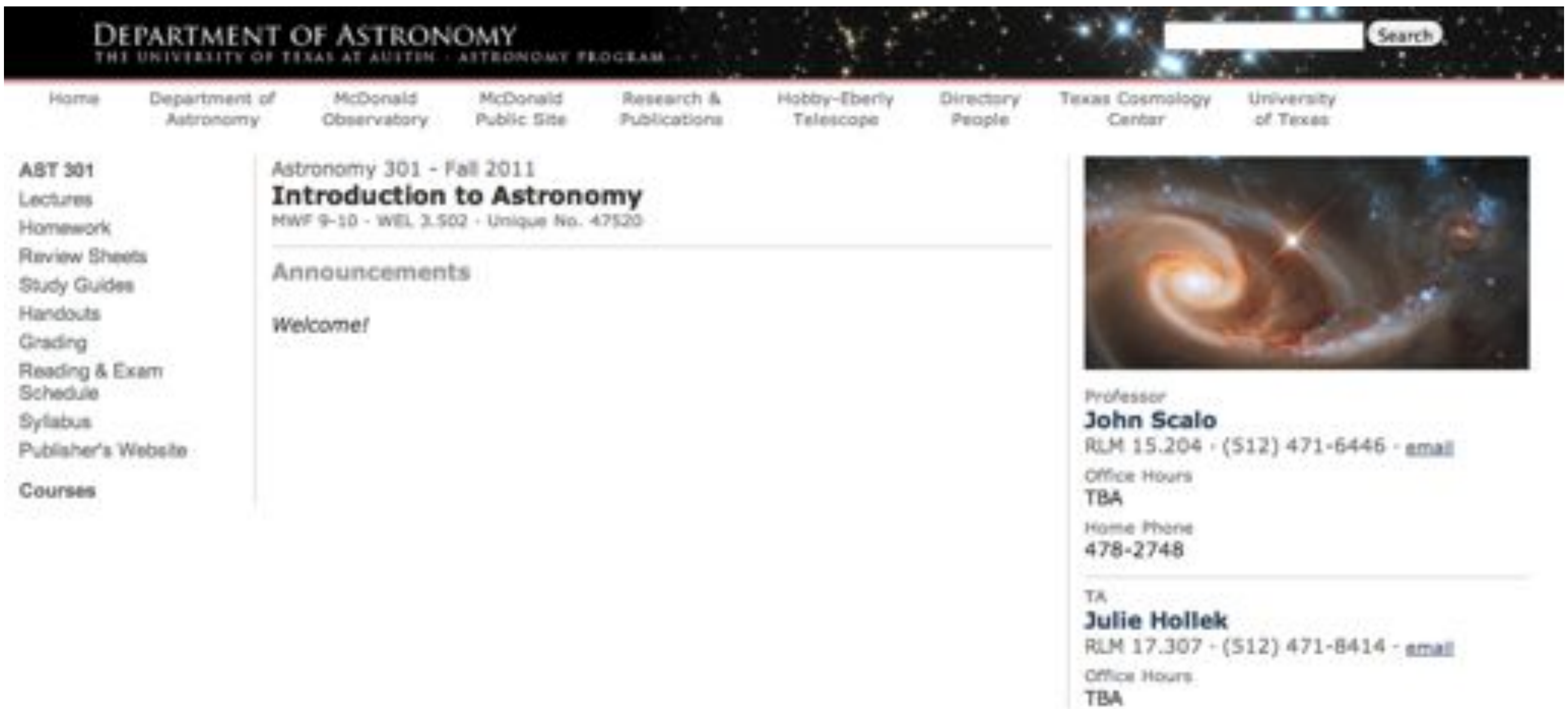
....

5. Important preliminaries:
   - Scientific notation
   - Graphs
   - Adjusting to strange units.
   - Distances, angles, sizes in astronomy.

Course web site:

Through Astronomy Department:

http://www.as.utexas.edu/astronomy/education/fall11/scalo/301.html



Buying and using the right version of the textbook

Our textbook is *Astronomy Today*, by Chaisson and McMillan, **7th edition.**
You *must* purchase the 7th edition—if you want to have the correct page and problem numbers, *as well as online access code*.

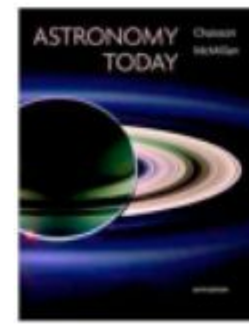
The textbook comes in two *versions*: a **single-volume,** very expensive hardback (the book shown 2nd from the left below), or the same book divided into **two volumes**, of which *we are using only Vol2 Stars and Galaxies* (the book on the far left).

7th edition.

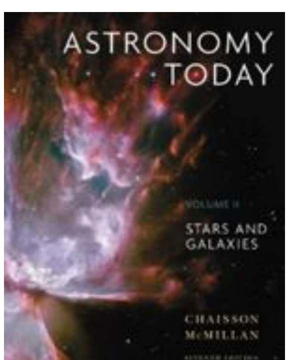
Don't buy the full version.

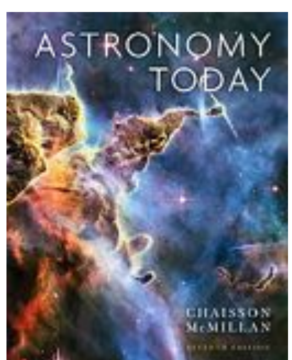
ONLY buy v.2 of the two-volume version. WITH access code.

6th edition, full version, looks like this. Vol. 2 looks like this. <u>*Don't buy them!*</u>



$$





$$$$

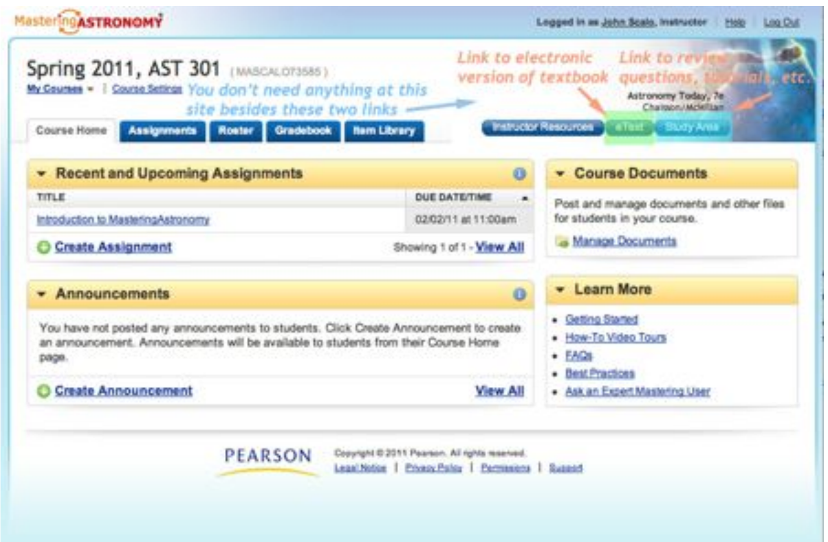
Textbook web site: "Mastering Astronomy"

Used only for eText and Study Area links

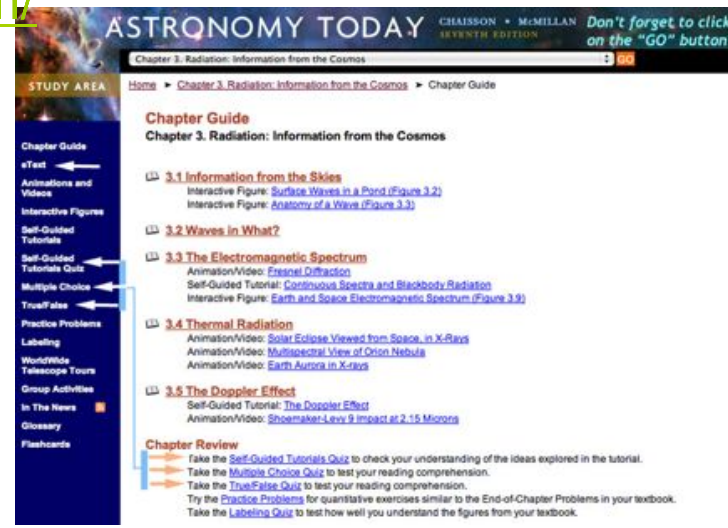
url: http://www.masteringastronomy.com/

"Course name" MASCALO83076

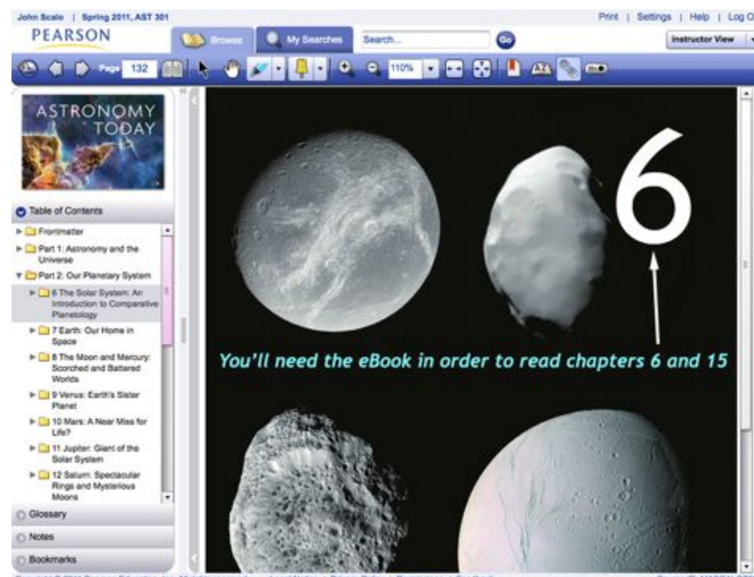
Home page



Study area



eText



Next topics:

Scientific notation; strange units

SCIENTIFIC NOTATION

Astronomy involves a huge range of scales, from atoms to planets to galaxies to the observable universe. We need a convenient way to refer to the numerical values of their properties.

The purpose: Avoid writing lots of zeros. **Scientific notation** for very large and small numbers (**read Appendix 1** in text)

Examples: 3×10^6 = 3 million, 4×10^{-3} = 0.004, ten thousand = 10^4

You can easily get used to it—try writing down a few yourself—e.g. two million, 3 one-thousandths, …

[*You will NOT have to manipulate scientific notation on exams or homework. You need to learn it in order to understand the reading and lectures.*]

STRANGE UNITS

→ Units are completely arbitrary, used just for convenience.

You don't give the distance from Austin to New York in inches, or your age in seconds, or your height in miles.

→ Example: Units of distance and size in this course (more detail on last two slides, 18 and 19).

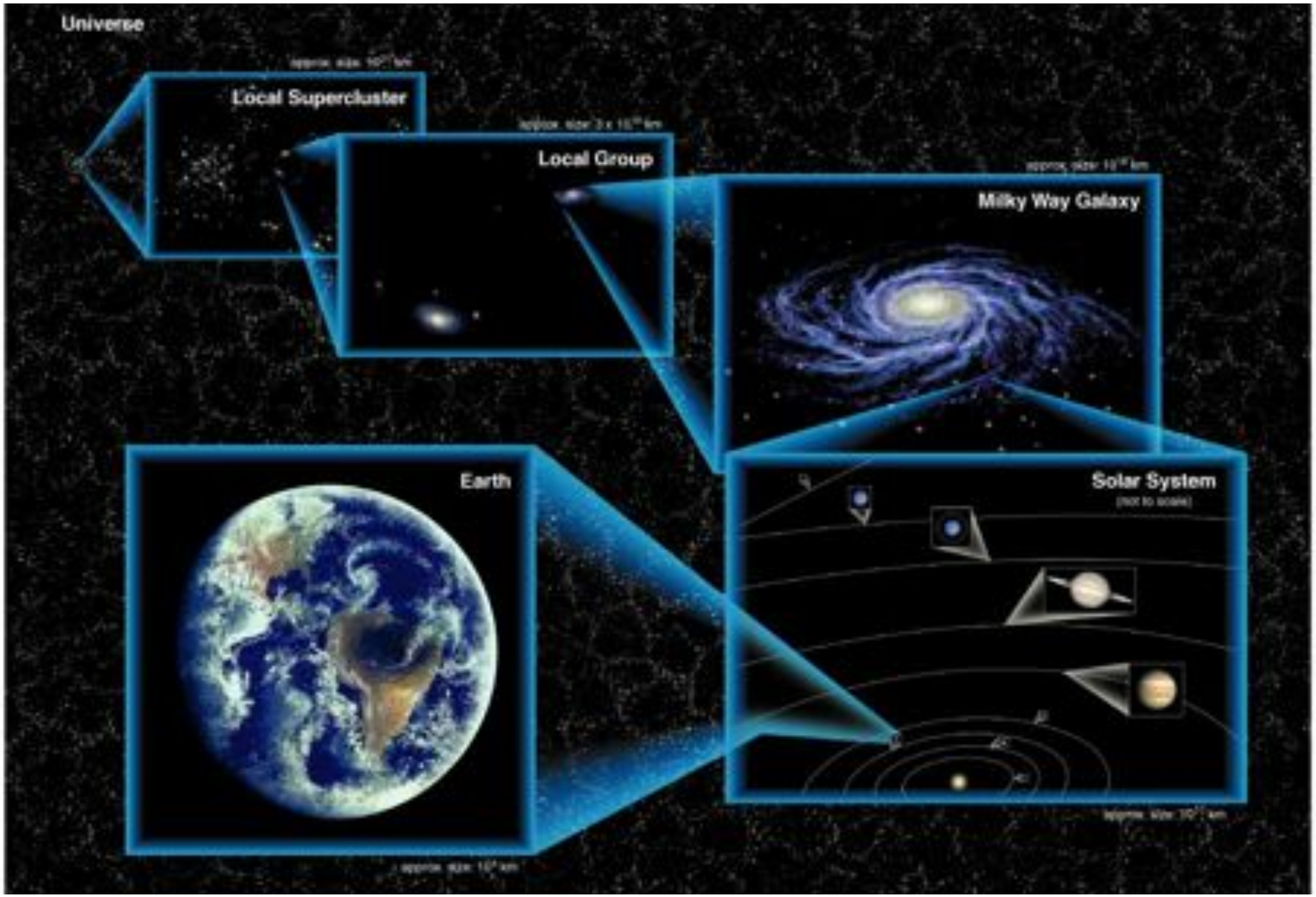
→ Example: Masses of stars and galaxies.

→ *What unit would you use to express the mass of the planets in our solar system?*

→ Skim Appendix 2 on the subject of units.

Strange units will not be a problem for you if you simply familiarize yourself by using them.

Range of size scales in the universe requires the use of a variety of **units of distance** --kilometer (km), astronomical unit (AU), parsec(pc), kiloparsec (kpc), megaparsec (Mpc)



Next topics:
Constellations
(and why we need distances)

Constellations: meaningless but convenient

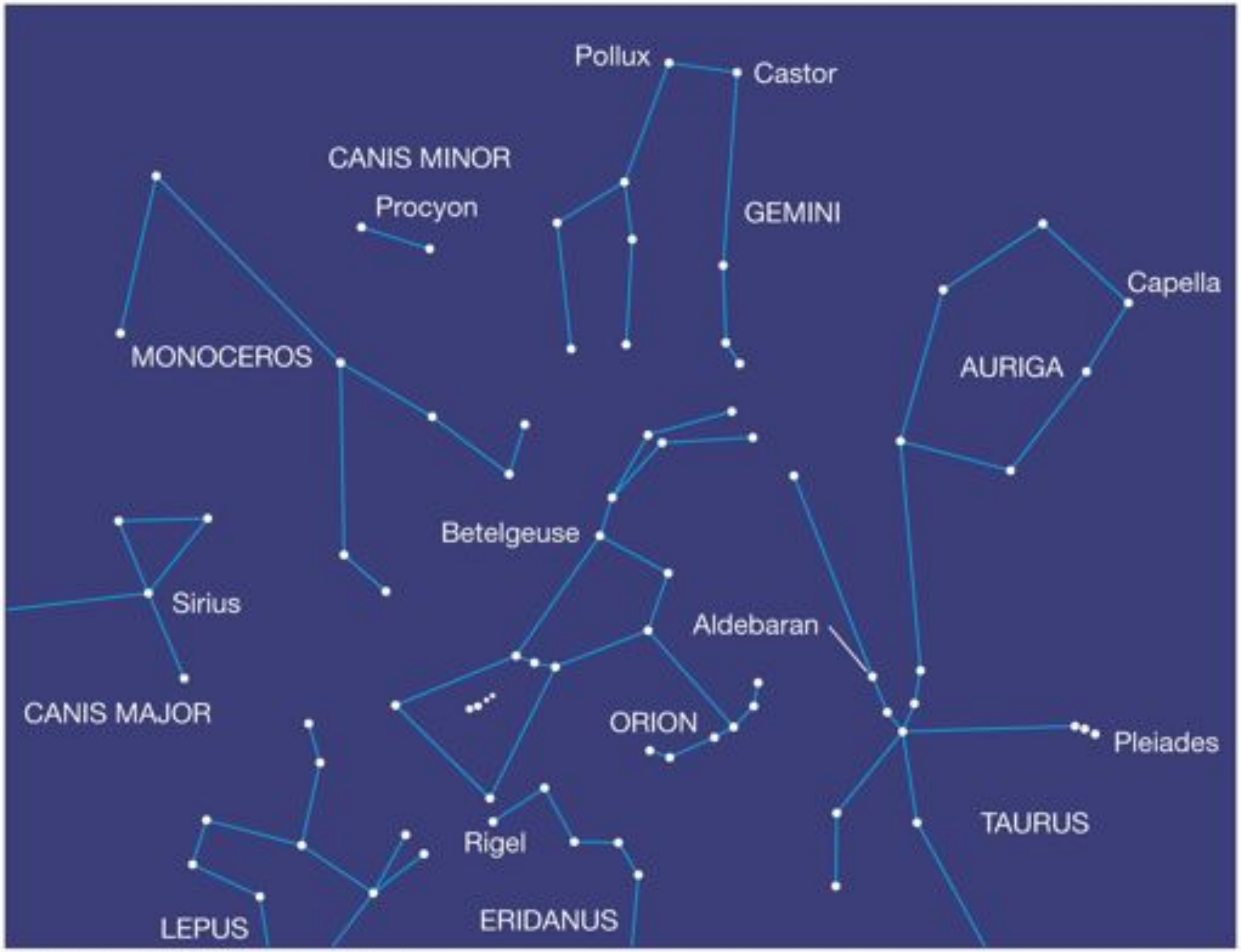
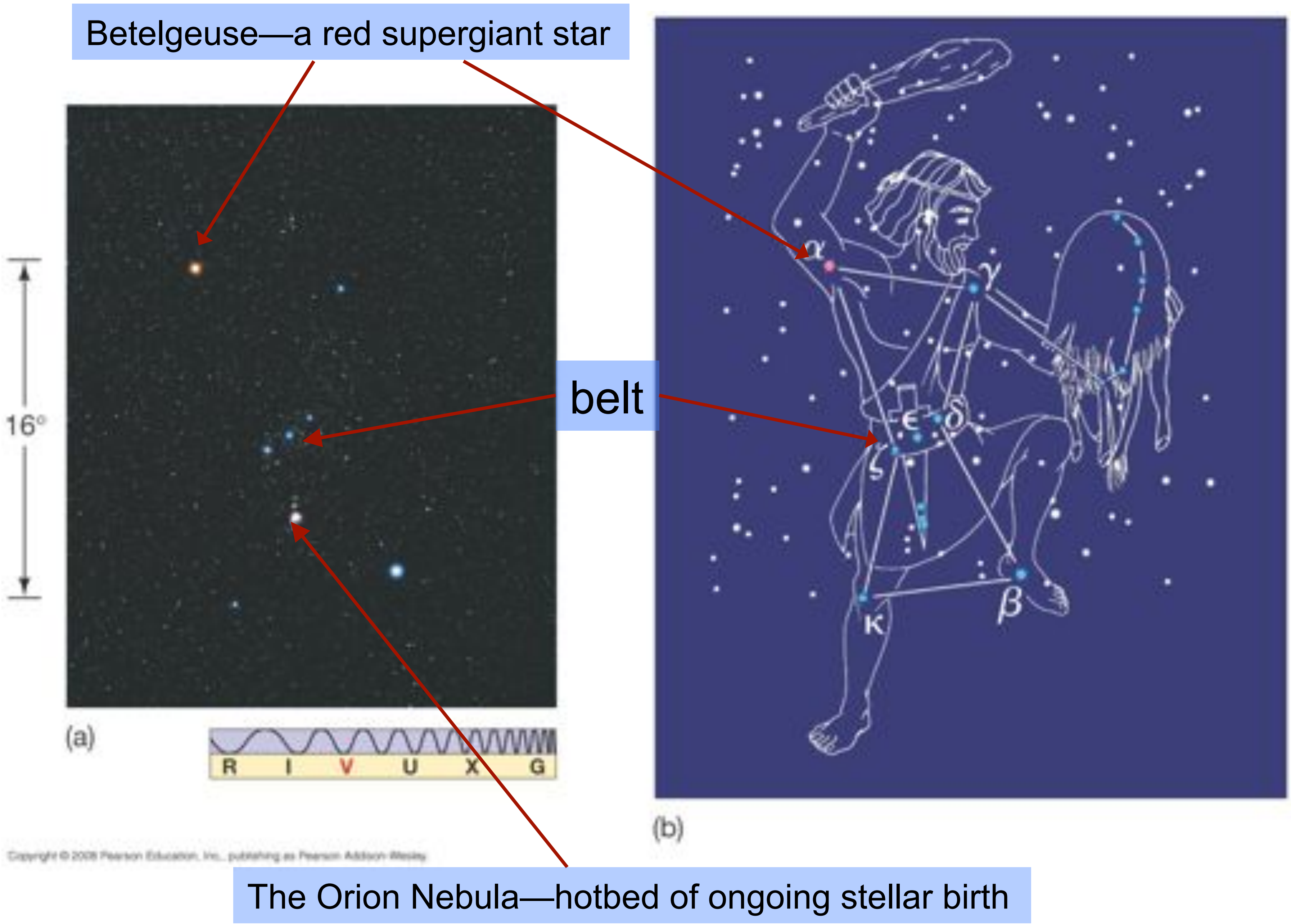
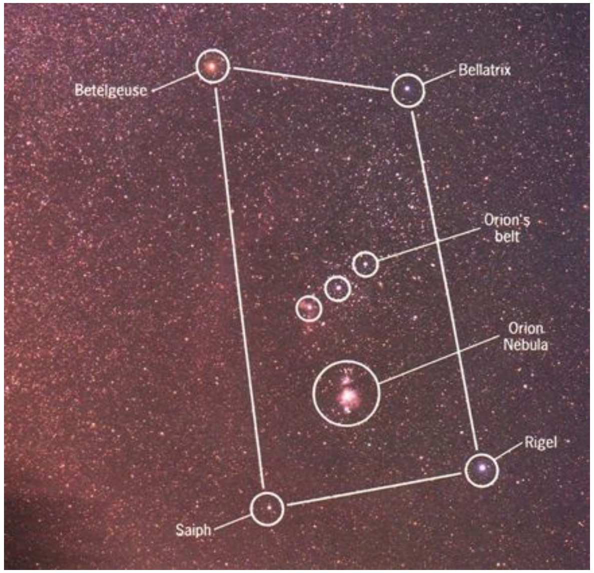


Figure 1.8



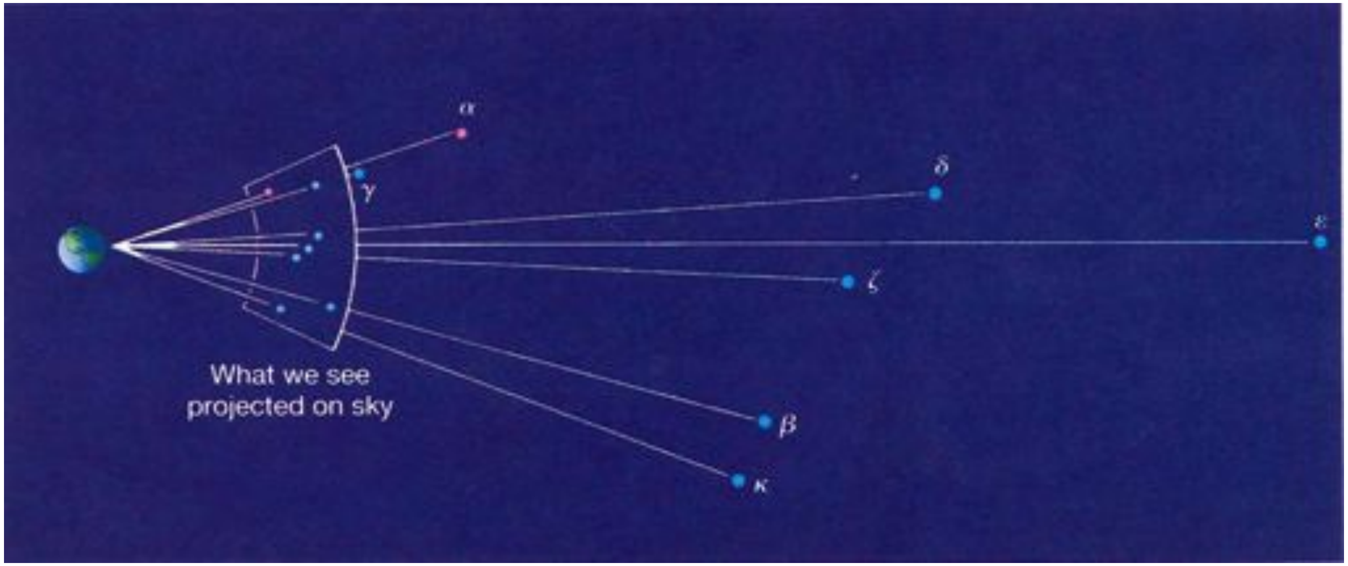
Betelgeuse—a red supergiant star
16°
belt
(a)
R I V U X G
α
γ
ε
δ
ζ
κ
β
(b)
The Orion Nebula—hotbed of ongoing stellar birth

Constellations: These are just apparent groupings of stars in the sky; they are (usually) not physically associated, and could be at *very* different distances (see Orion example).



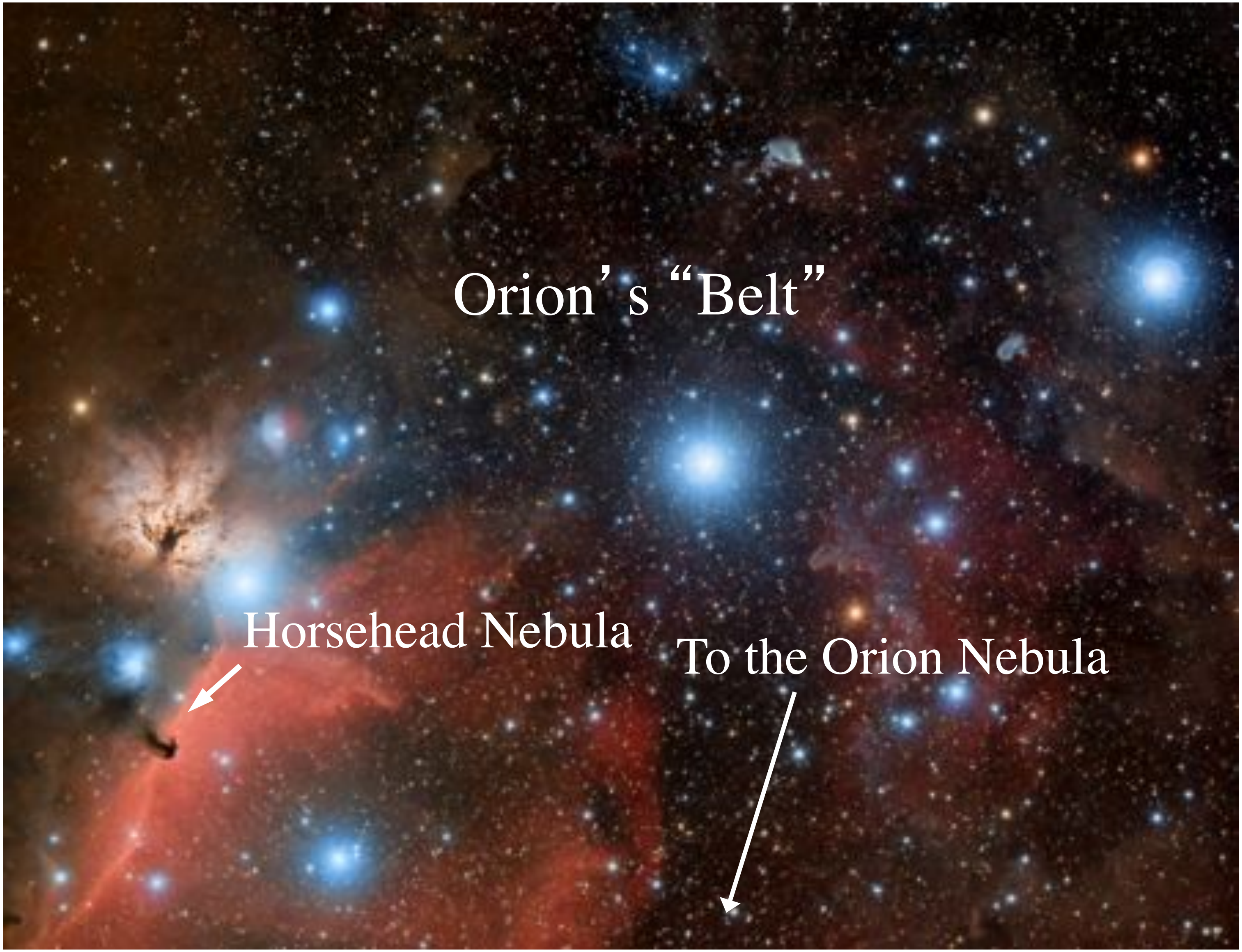
This is the constellation Orion as it appears in the sky

This shows how the stars in Orion are really distributed in space



Orion close-up:

Stars forming in dark *dust clouds* (see the "Horsehead Nebula"); bright stars *ionize* local gas that becomes emission nebulae (*HII regions*).



Next topic:

Angular measure
(and why we need distances)

Angular measure [See box p. 11]

The only thing we see directly are ***angular sizes and separations****. We need* ***distances*** *in order to make any sense of these angular appearances. We also need sufficient* ***angular resolution****.*

→ **Units for angles**: Degrees, minutes of arc, seconds of arc (arcsec)

The "*arcsecond* barrier" is imposed by Earth's atmosphere.
This effect, called "*scintillation*," is due to the turbulence in the Earth's atmosphere, which makes stars appear to "twinkle."

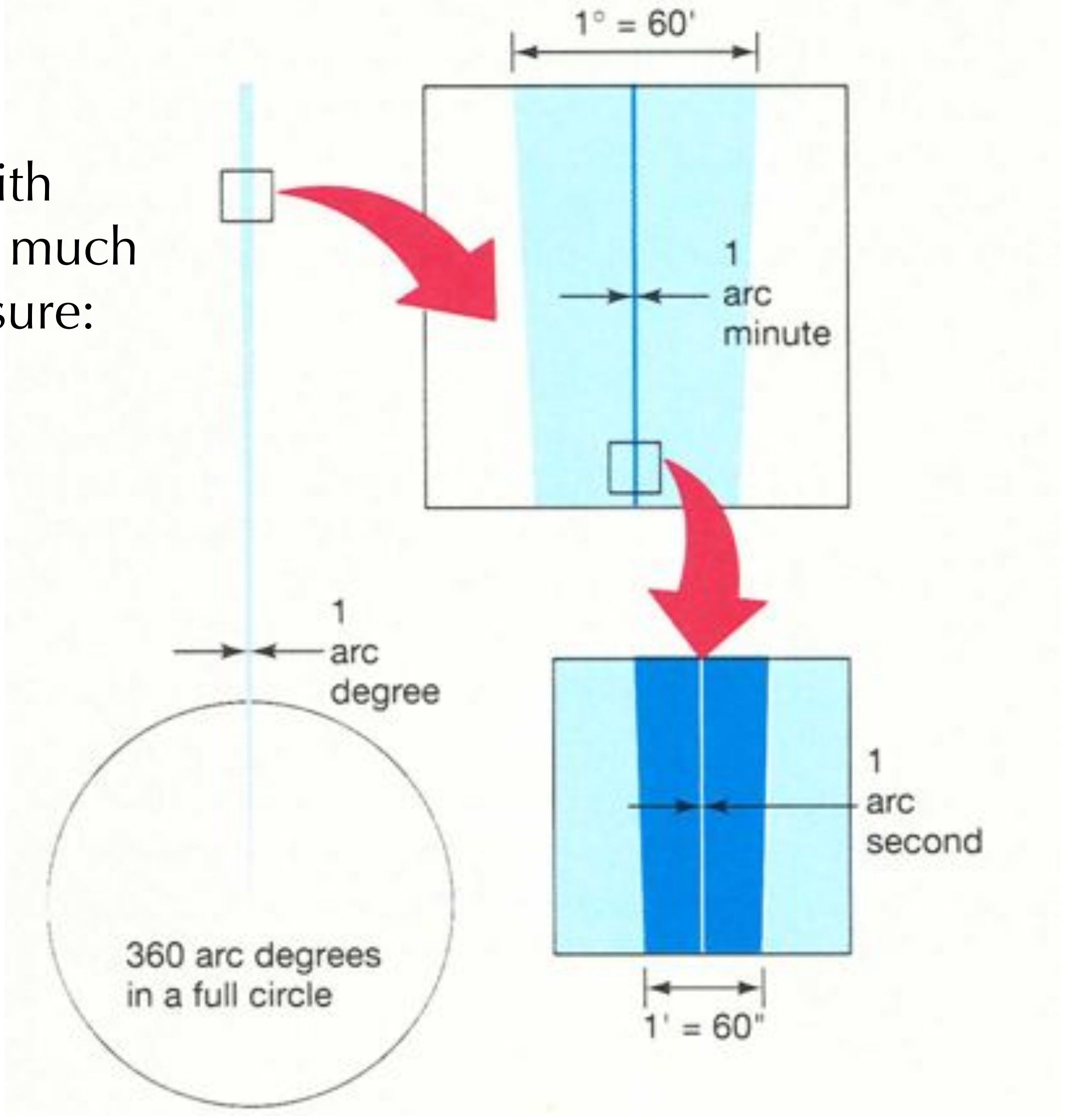
→ *The term for the smallest angular size at which you can distinguish objects is called "****angular resolution****," a phrase you will encounter frequently!* **Get used to it now!**

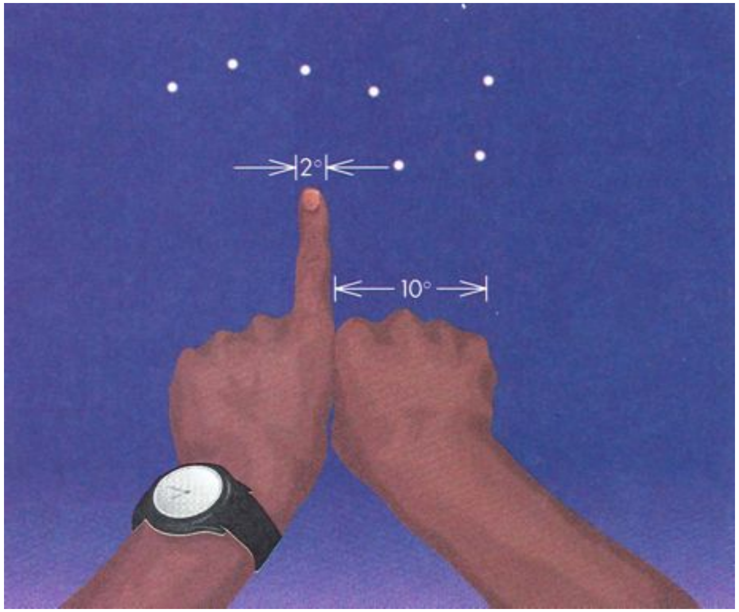
You can remember what **resolution** means by keeping in mind that poor resolution is like being very nearsighted—everything looks blurry
→ "*you can't resolve it*"

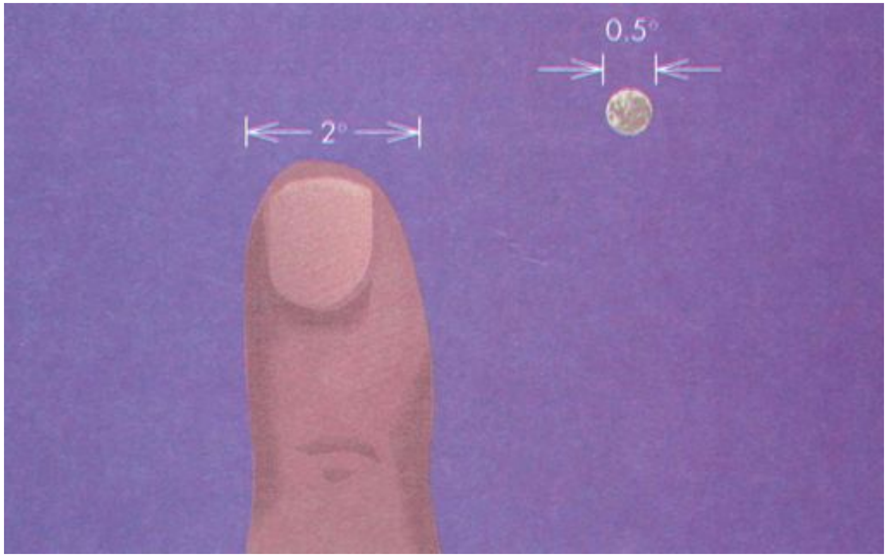
Lack of resolution is dangerous, in astronomy and in life! Famous old cartoon series based on dangers of poor resolution: "Mr. Magoo."

Angular measure--illustration from your textbook.

You are probably familiar with degrees. Now get used to a much smaller unit of angular measure: the *arcsecond*.

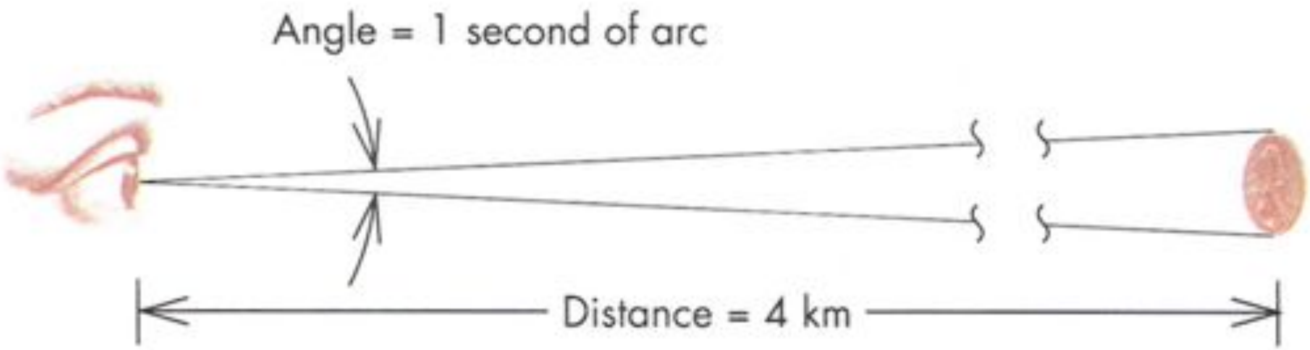






One Second of Arc

A penny at a distance of 4 km (2.5 miles) has an angular diameter of 1 second of arc.



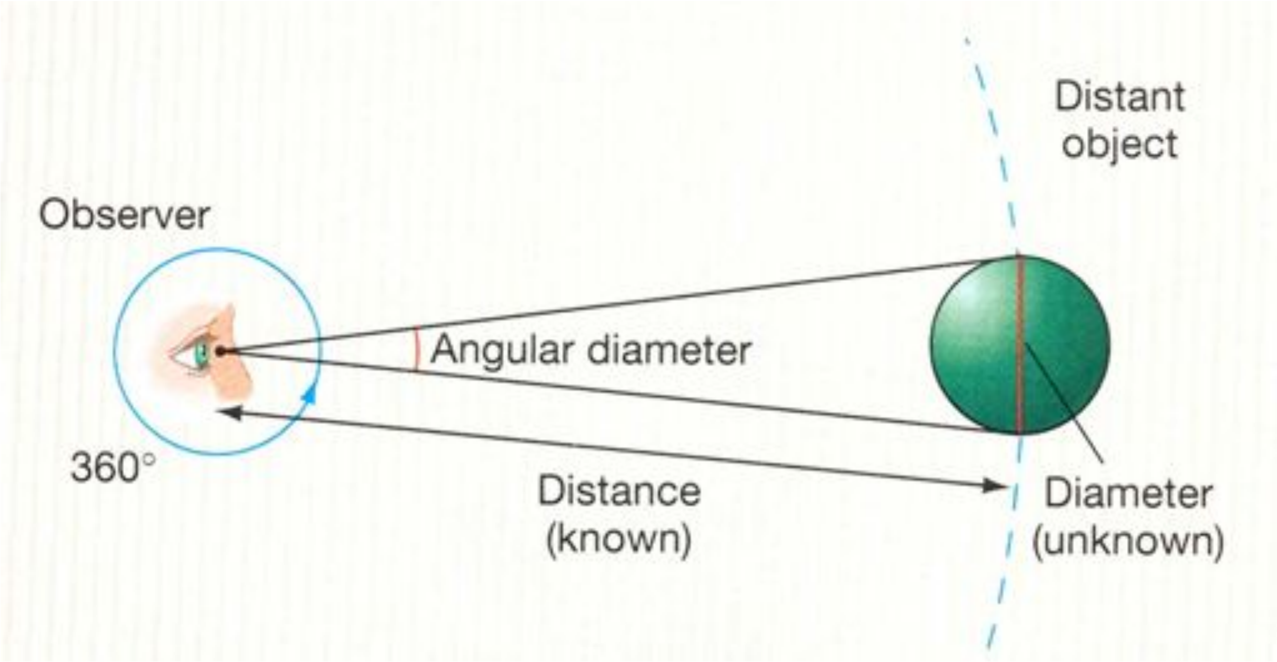
Angular and *linear* diameter of an object

From the angular diameter, you could get the size of the object (linear diameter), IF you knew its distance.

Think about this until it seems obvious.

Formula: ***linear* diameter = distance** x ***angular* diameter** (in "radians")

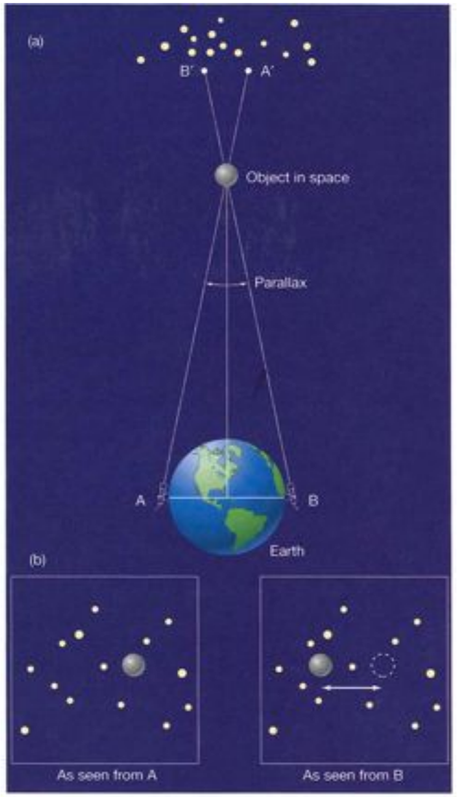
But if you can't "*resolve*" the object, then you can't use this method at all (e.g. we only see stars as points of light, even with largest telescopes).



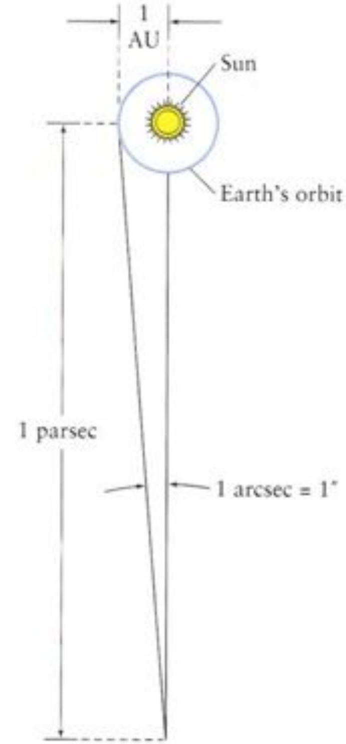
Next topic:

Distances and the structure of the universe

Distances from **Parallax** Angle (sec. 1.6 in text)



▲ **FIGURE 1.31 Parallax** (a) This imaginary triangle extends from Earth to a nearby object in space (such as a planet). The group of stars at the top represents a background field of very distant stars. (b) Hypothetical photographs of the same star field showing the nearby object's apparent displacement, or shift, relative to the distant, undisplaced stars.



A Parsec The parsec, a unit of length commonly used by astronomers, is equal to 3.26 light-years. The parsec is defined as the distance at which 1 AU perpendicular to the observer's line of sight subtends an angle of 1 arcsec.

Left: Parallax using diameter of Earth. Understand why baseline is too small for stellar distances.

Right: Parallax using 1AU baseline defines the unit of distance called a "parsec" (distance of object whose **par**allax is one **sec**ond of arc, i.e. one arcsec). This is abbreviated pc, as in "That star is 6.3 pc away."

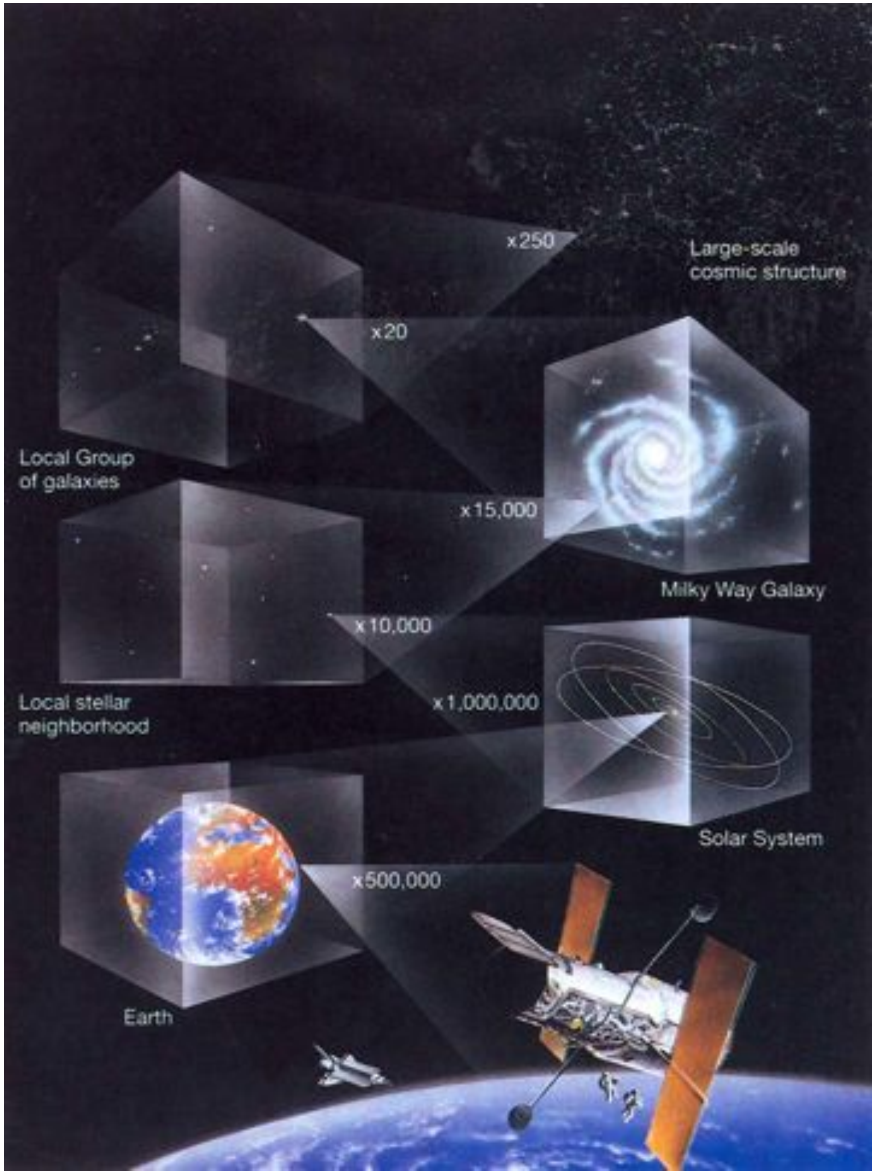
What we learn from distances and sizes in the universe

The measurement of distances to stars by parallax angle is the first in a long list of methods to learn about the scale of the universe at larger and larger distances.

Figure to right (from text) shows what we learn about the structure of the universe just from distances.

*There is an **amazing** range of sizes and distances of a bewildering variety of objects in the universe.*

(I recommend staring at this for a while. Familiarity with the objects we study in this course will help later.)



A few important distances and sizes

We'll return to parallax in more detail later in the course: for now you should just get the basic idea, and that it is related to the unit of distance called "***parsec***."

→ **Nearest stars** are about 1 pc (a few light years) away. This is also the average distance between neighboring stars in most galaxies. ***It is a number that you should remember.***

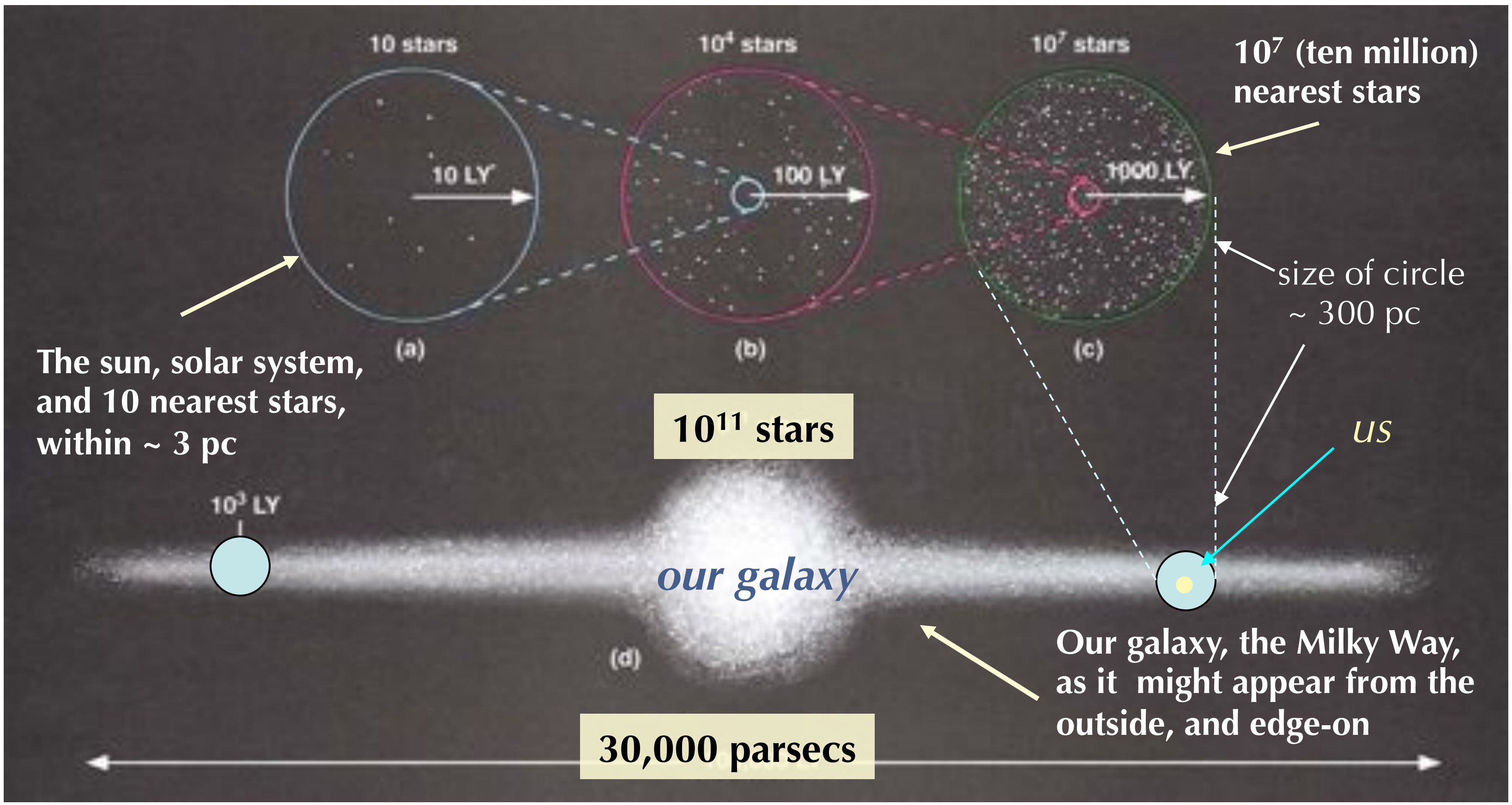
→ **Size of our Galaxy** and many others: ~30,000 pc,

→ **Distances between galaxies:** From millions (Mpc) to billions of pc (1000 Mpc—make sure you are comfortable with what this means--see preceding figure again).

→ **Distances in the solar system** (sec. 2.6). Average distance from Earth to Sun defined as "***astronomical unit***" (1AU) (~ 10^{-3} pc), size of our solar system ~ 100 AU.

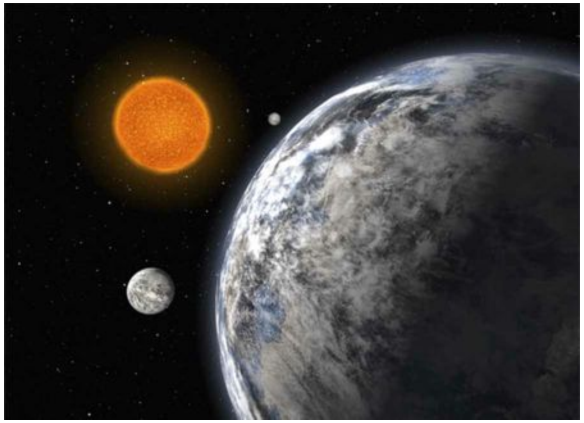
As we move out from the solar system to see the nearest stars, the scale of distances expands enormously--100AU is *tiny* compared to the average distances between stars, and nearly infinitesimal compared to the sizes of galaxies or larger structures in the universe.

Study this illustration until you can explain these distances to someone else.



Try this "problem" to review previous material

These are the objects shown on the first slide.
Can you now say, very roughly, how large they are?
How far away they are?



Summary and next time:

- So far: Preliminaries; large and small numbers (scientific notation); units; sizes and distances in the universe; constellations.
  Relation between angular sizes and physical sizes.
  Angular resolution
  Parallax angle and distances to stars
  Examples of distances and sizes

- Monday: First, some history.
  Heliocentric versus Geocentric views of the universe (sec. 2.2-2.4)
  Kepler's laws (sec. 2.5): How they allow us to calculate either the size of an object's orbit (its "semimajor axis") from its period (how long it takes to orbit once).

- Wed: Sizes in the solar system (sec. 2.6)
  The more fundamental "laws": *Newton's laws* (secs. 2.7, 2.8)

- ***For next class***, you should have finished reading the textbook through Kepler's laws and Newton's laws (end of Chapter 2).