Astronomy 101
Basic Astronomy

Instructor: Dr. Kevin Krisciunas

Textbook = *The Essential Cosmic Perspective*, 8th ed., by Bennett and coauthors.

Supplementary reading = *A Guide to Wider Horizons*, 2nd edition, by Krisciunas. Three copies are on reserve at the ground floor of the Evans Library annex. The most relevant chapters are available from the course website.

Note the TAMU class website:

people.physics.tamu.edu/krisciunas/astr101_fall20.html

and the website associated with our book:

www.pearsonmylabandmastering.com

The course ID is “krisciunas66672” (09:20 class).

For the 12:00 pm class the course ID for online homework is “krisciunas72984”.

To phone Pearson support: 1-800-677-6337

Over the past 14 years here at Texas A&M almost half of my students have earned an A or B in basic astronomy

What's the nominal grading scale?

80+ to 100 = A, 70+ to 80 = B, 60+ to 70 = C, 50+ to 60 = D, less than 50 = F.

How to maximize your grade in this class:

Read the chapters ahead of time.

Come to class.

If you hear my spin on some topic, then you might more easily recognize the phraseology on a test.

Study online quiz questions at the Mastering Astronomy website.

Why are you here (in this class, or at this university)?
Possible reasons:

1) To garner points and a grade

2) Because you're interested in astronomy

3) Because learning makes life more fulfilling

4) To figure out what you really want to do in life

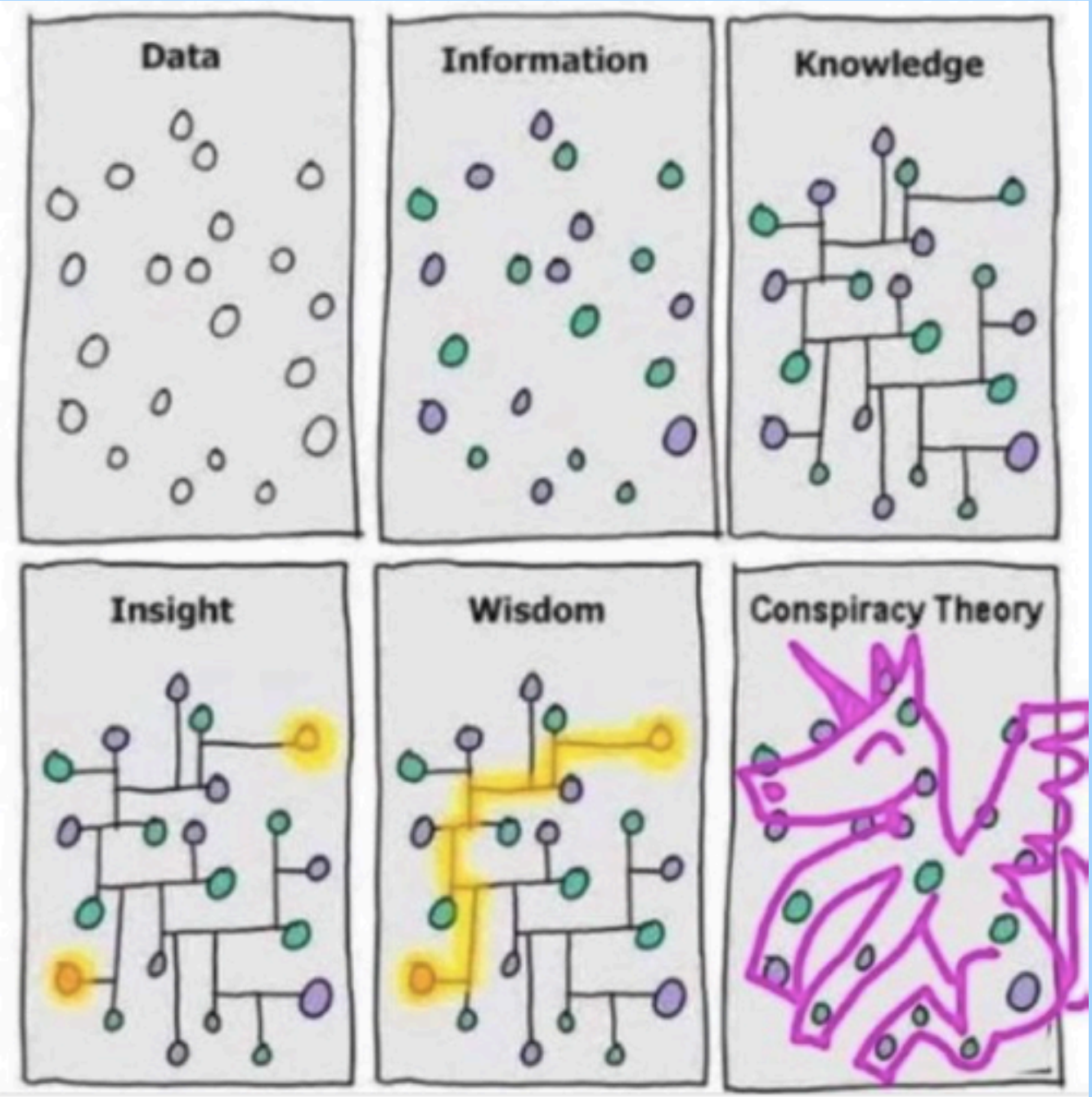
In medieval universities students began with the *trivium*, which consisted of grammar, logic (also known as dialectic), and rhetoric.

The *quadrivium* was considered preparatory work for philosophy and theology. It consisted of arithmetic, astronomy, geometry, and music.

Thus, astronomy has been an integral part of a well-rounded education for centuries.

It helps to see how reason-based discovery of knowledge, starting in the Enlightenment period following the Middle Ages, led Thomas Paine and others to begin the "American Experiment" that overthrew autocracy. The Key was education by the Seven Liberal Arts: the *trivium*: Grammar, Logic, Rhetoric, and the *quadrivium*: Algebra, Geometry, Astronomy, and Music. These lib-arts grew into countless ways to reason and invent. So we live in AC comfort traveling by GPS while listening by cell-phone to music of centuries past (or gravity waves from black holes!) "Liberal" means liberation from superstition, illness, poverty, and slavery that liberal democracies promise. But now we see that for too many people those promises have seemed too long coming and too difficult to keep.

- Bill Harter, Univ. Arkansas Dept. of Physics



Kathy Kaplan

Five themes of basic astronomy:

I. We are a part of the universe and thus can learn about our origins by studying the universe.

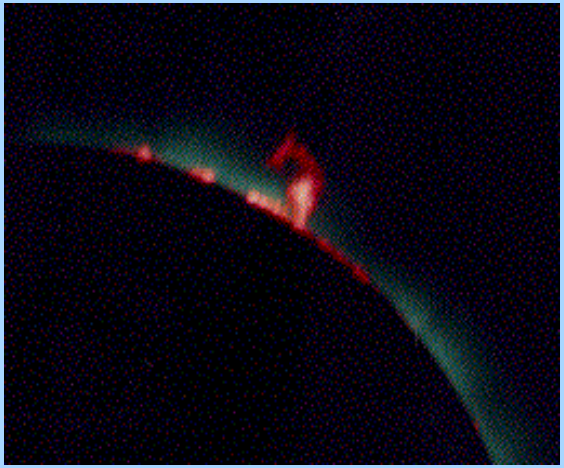
II. The universe is comprehensible through scientific principles that anyone can understand.

III. Science is not a body of facts but rather a **process** through which we seek to understand the world around us.

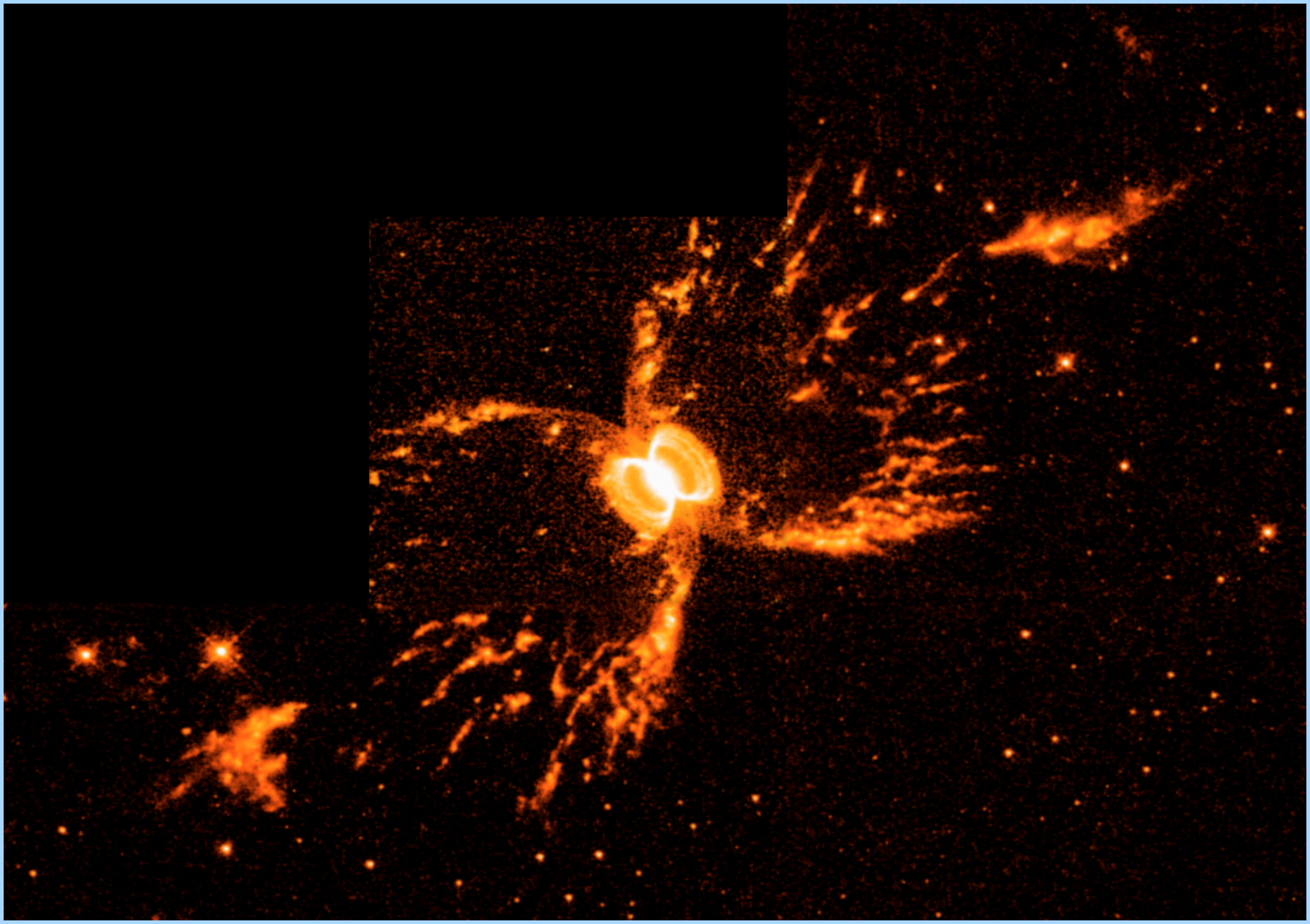
IV. A course in astronomy is the beginning of a lifelong learning experience.

V. Astronomy affects each of us personally with the new perspectives it offers.

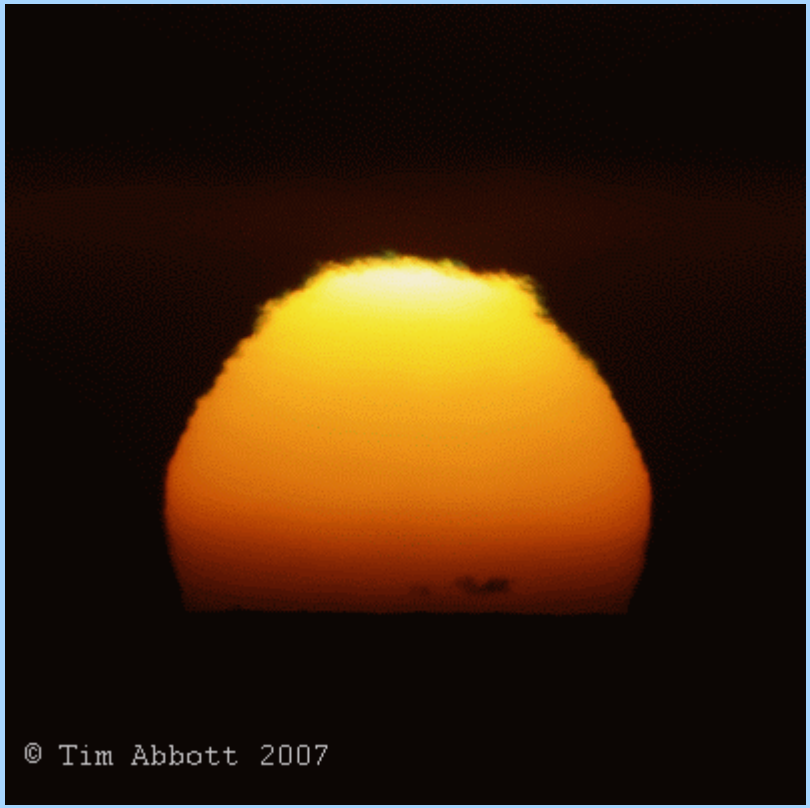
Apollo 8 photo 12/24/68



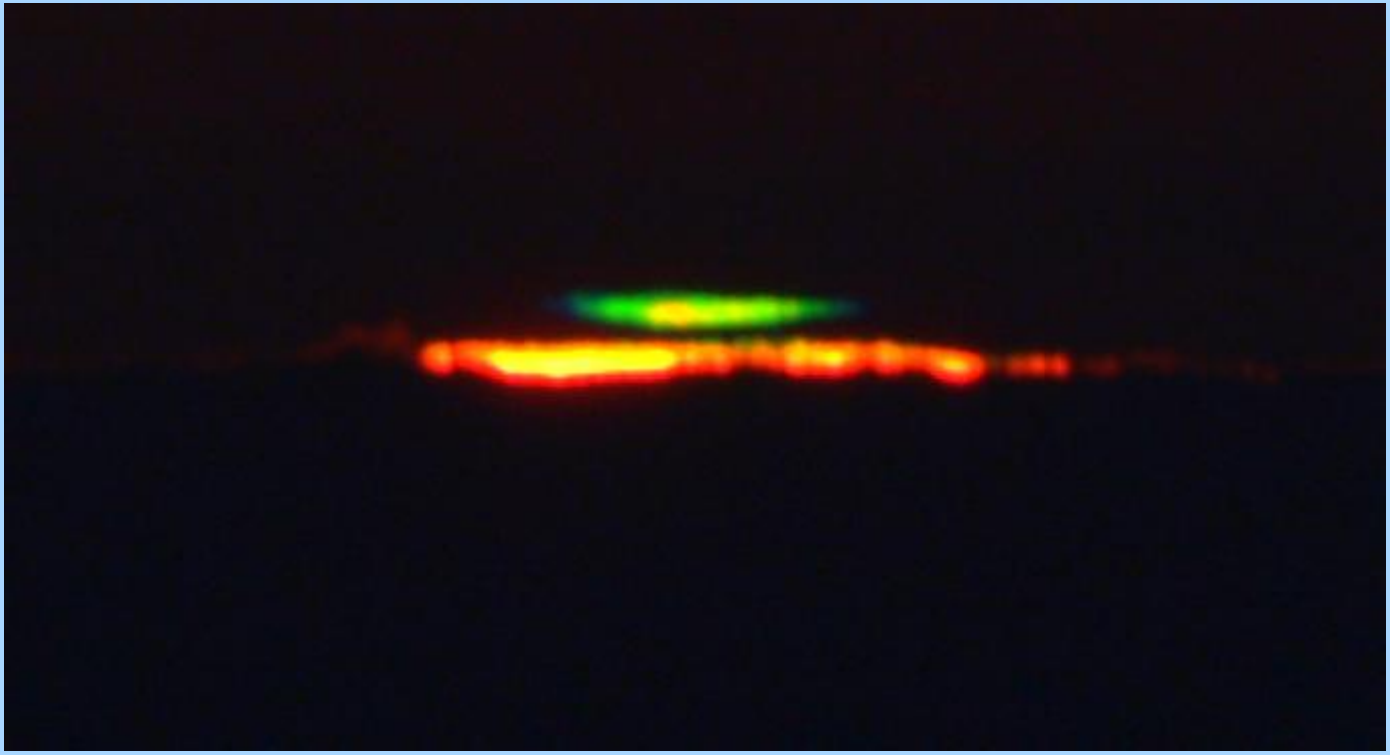
solar eclipse 7/11/91 (KK)



The Southern Crab Nebula (He 2-104), HST image.



Sunset at Cerro Tololo Observatory, Chile (T. Abbott).



An excellent website for interesting astronomical images is the Astronomy Picture of the Day:

http://antwrp.gsfc.nasa.gov/apod/

Aug. 12 Perseids (Fred Bruenjes)

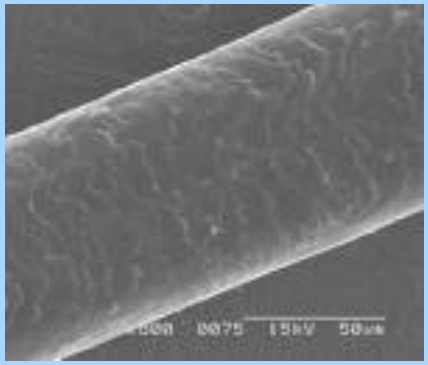
Night sky over the Grand Tetons (Wally Pacholka)

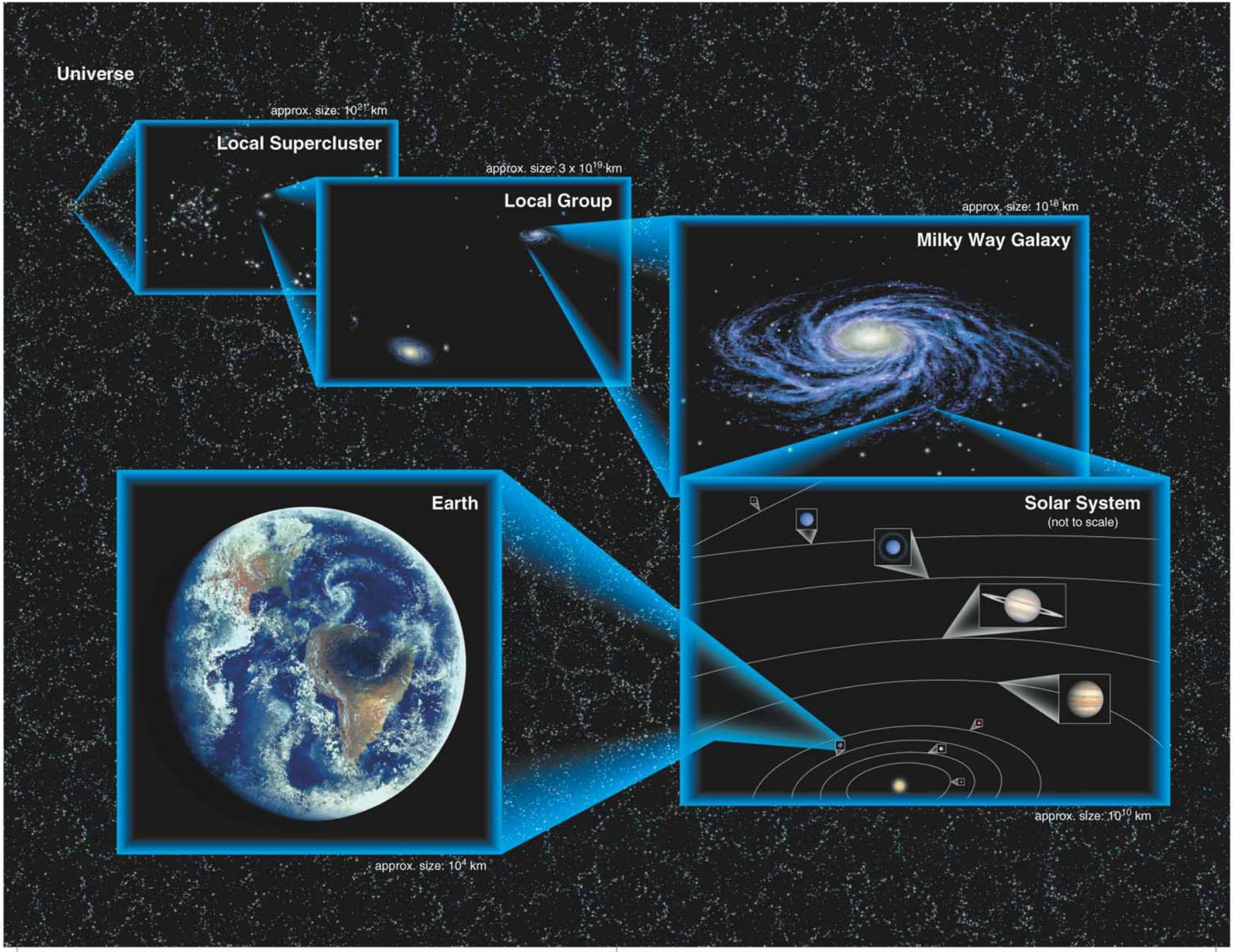
Scientists use the “meters-kilograms-seconds” (MKS) system of units or the “centimeters-grams-seconds (CGS) system of units.

100 centimeters (cm) = 1 meter
1000 millimeters (mm) = 1 meter
1 micron (μm) = one millionth (10^{-6}) of a meter
1 kilometer = 1000 meters
1 kilogram = 1000 grams ~ 2.2 pounds
1 liter = 1000 milliliters = 1000 cubic centimeters

A Sense of Scale

proton	10^{-15} m
hydrogen atom	10^{-10} m
thickness of human hair	18 to 180 microns (10^{-6} m)
human	2 m
medium sized town	10 km (10^{4} m)




Universe
approx. size: 10^{21} km
Local Supercluster
approx. size: 3×10^{19} km
Local Group
approx. size: 10^{18} km
Milky Way Galaxy
Earth
approx. size: 10^{4} km
Solar System
(not to scale)
approx. size: 10^{10} km

Earth diameter	1.28×10^4 km ~ 10^7 m
distance from Earth to Sun	1.5×10^{11} m
distances to nearest stars	10^{17} m
size of Milky Way galaxy	~10^{21} m
Local Group of galaxies	5×10^{23} m
radius of observable universe	1.4×10^{26} m

Sometimes we like to use different units:

1 mile = 1.609347 kilometers

mean Earth-Sun distance = 1 Astronomical Unit

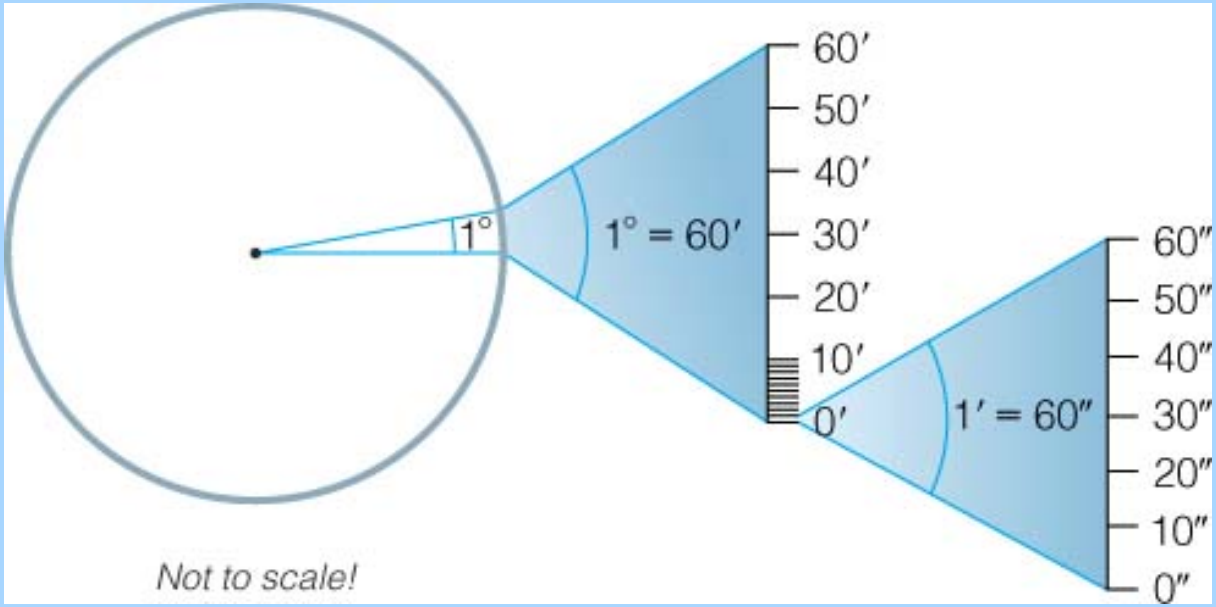
1 light-year = distance that light travels in one year (roughly 6 trillion miles)

Since we all live on this planet, it is useful to know that the Earth is 8000 miles in diameter. The mean distance from the Earth to the Sun (the Astronomical Unit) is 93 million miles (150 million km).

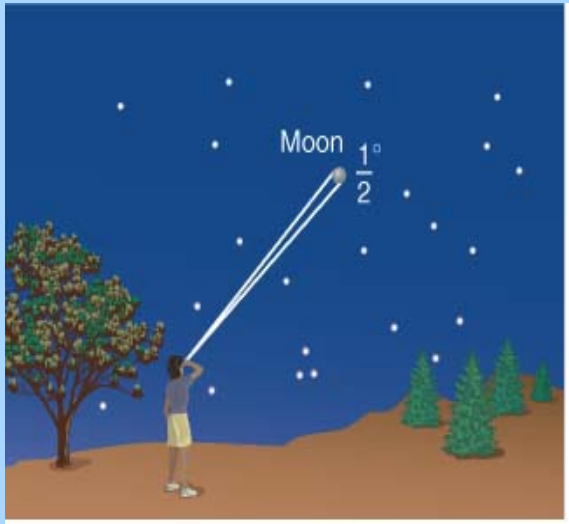
It takes light 8.3 minutes to travel from the Sun to the Earth.

The distance light travels in one year is the unit called *the light-year*. The most distant quasars are billions of light-years away. We are observing them as they appeared billions of years ago.

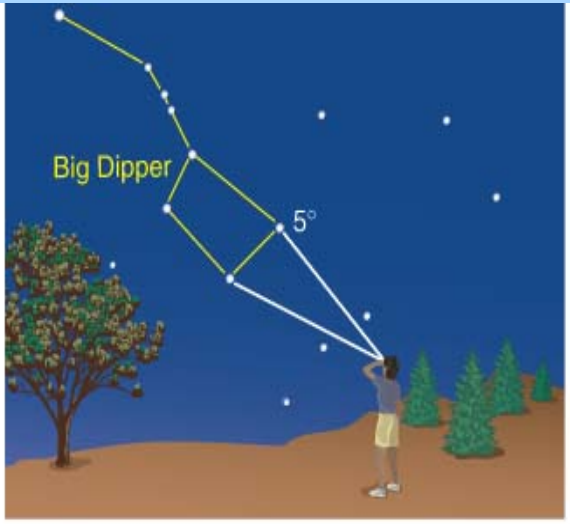
Astronomers also use angular units. One circle contains 360 degrees. A right angle has 90 degrees.



one degree = 60 arcminutes
one arcminute = 60 arcseconds
so one degree = 3600 arcseconds



a The angular size of the Moon is about 1/2° (which is also the angular size of the Sun).



b The angular distance between the two "pointer stars" of the Big Dipper (which point to the North Star, Polaris; see Figure 2.13a) is about 5°.

c You can estimate angular sizes or distances with your outstretched hand.

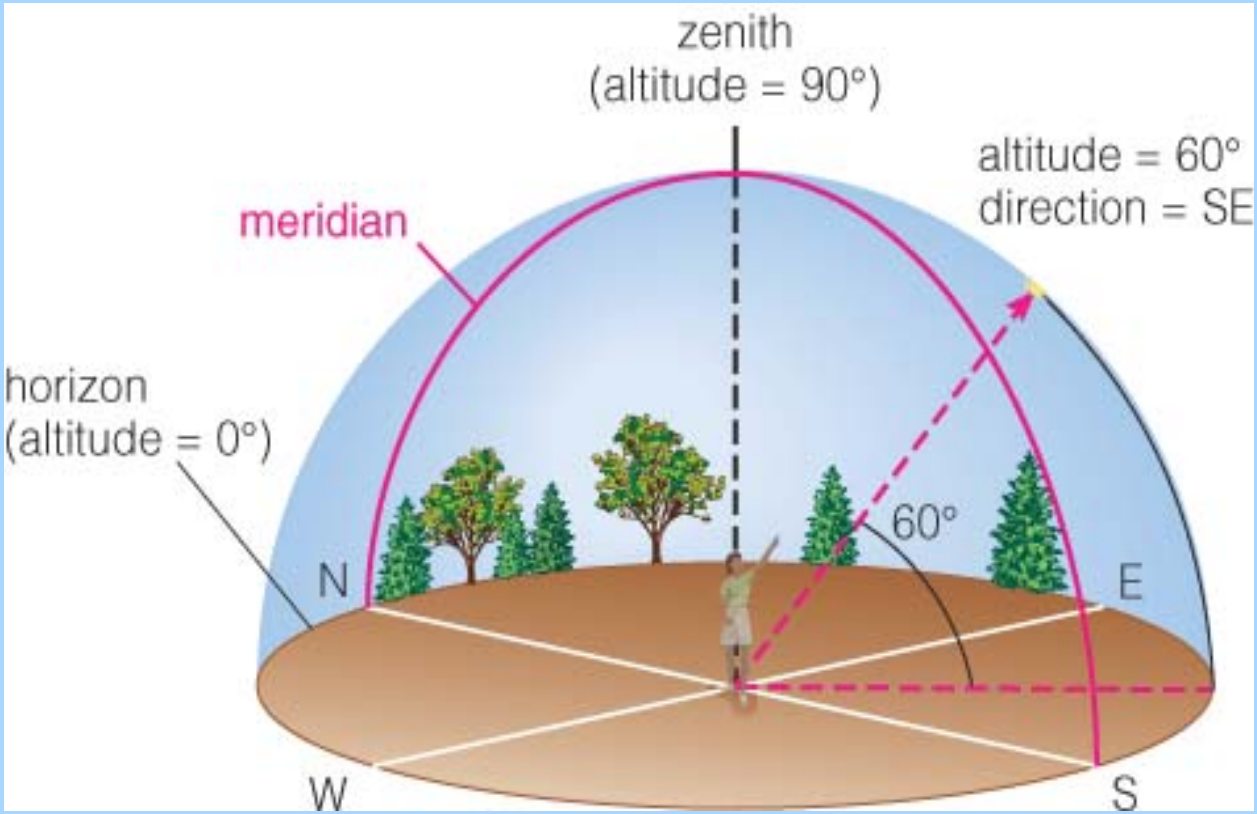
The Moon subtends an angle of just over ½ degree. The Sun is just slightly smaller in angular size, on average. If they line up in the daytime sky, you see a total solar eclipse.

As a holdover from the ancient Babylonians and Egyptians, minutes and seconds are designated in base 60. For example, the latitude of this classroom is 30 degrees, 37' 14.8”. In decimal degrees the value would be

30 + 37/60 + 14.8/3600 = 30.62078 degrees.

Similarly, 41.70083 degrees is the same as

41 deg + 0.70083 X 60 '/deg = 41 deg 42.05' =
41 deg 42' + 0.05 X 60”/' = 41 deg 42' 03”



We can designate a direction in the sky from the "altitude" (or elevation angle) above the horizon, plus the "direction" (or azimuth angle) around the horizon.

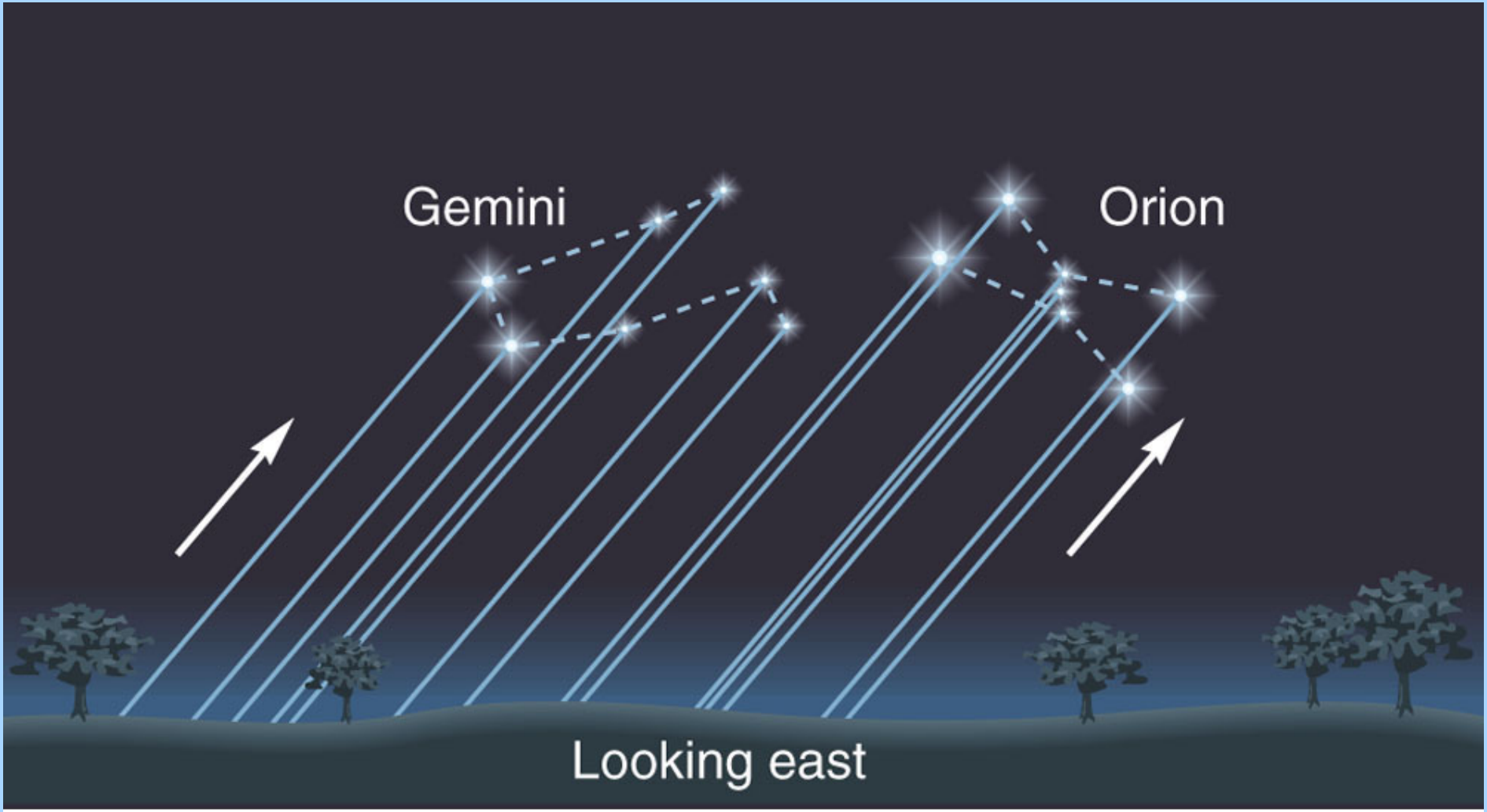
The problem with using the “horizon system” of celestial coordinates is that the Earth's turns on its axis once a day.

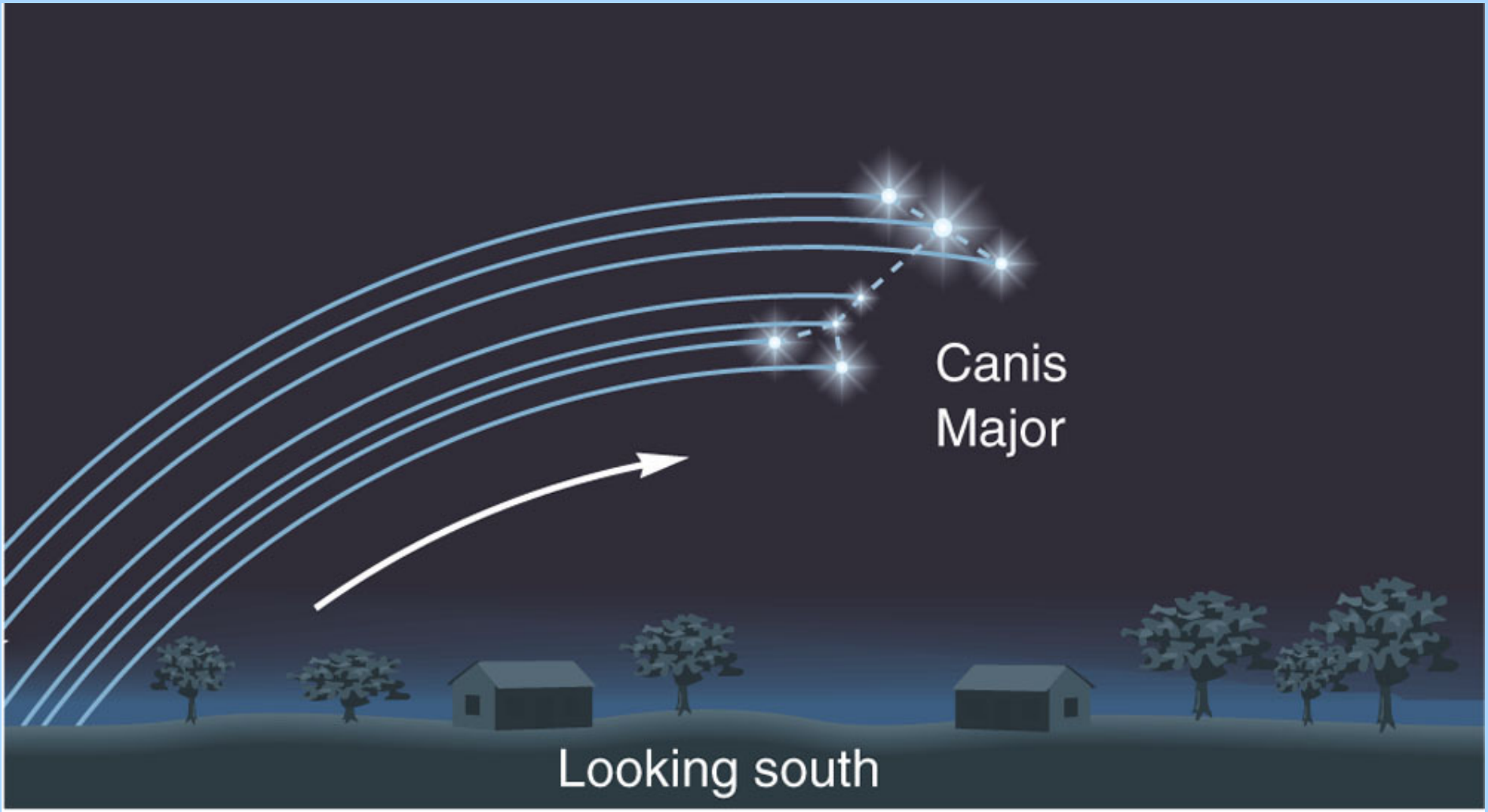
The Sun rises and sets each day.

The Moon rises and sets each day.

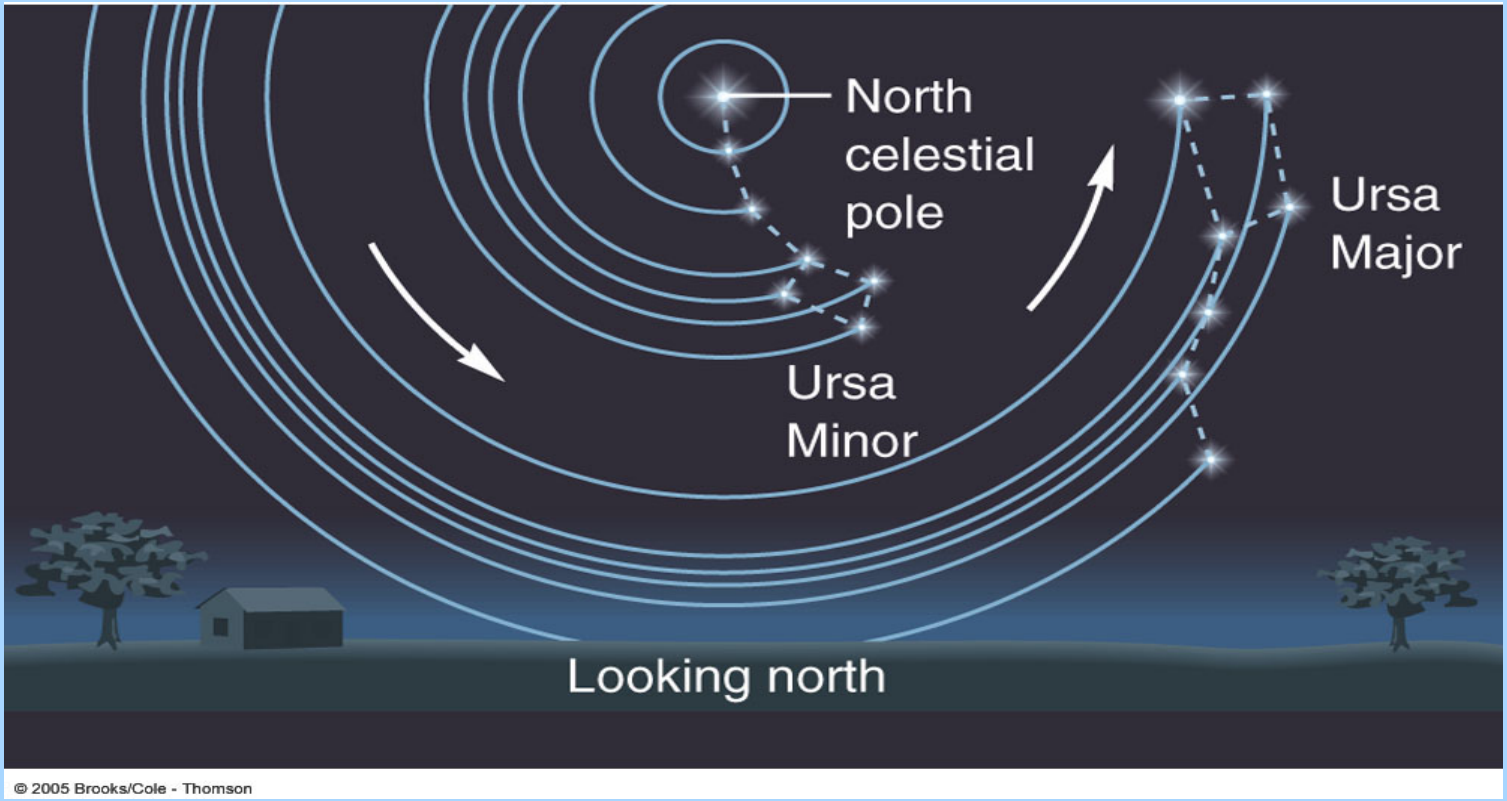
The stars also rise and set. Their principal apparent motion is simply due to the rotation of the Earth.

Thus, the elevation angle and the azimuth angle of a celestial object as viewed from the Earth are constantly changing.



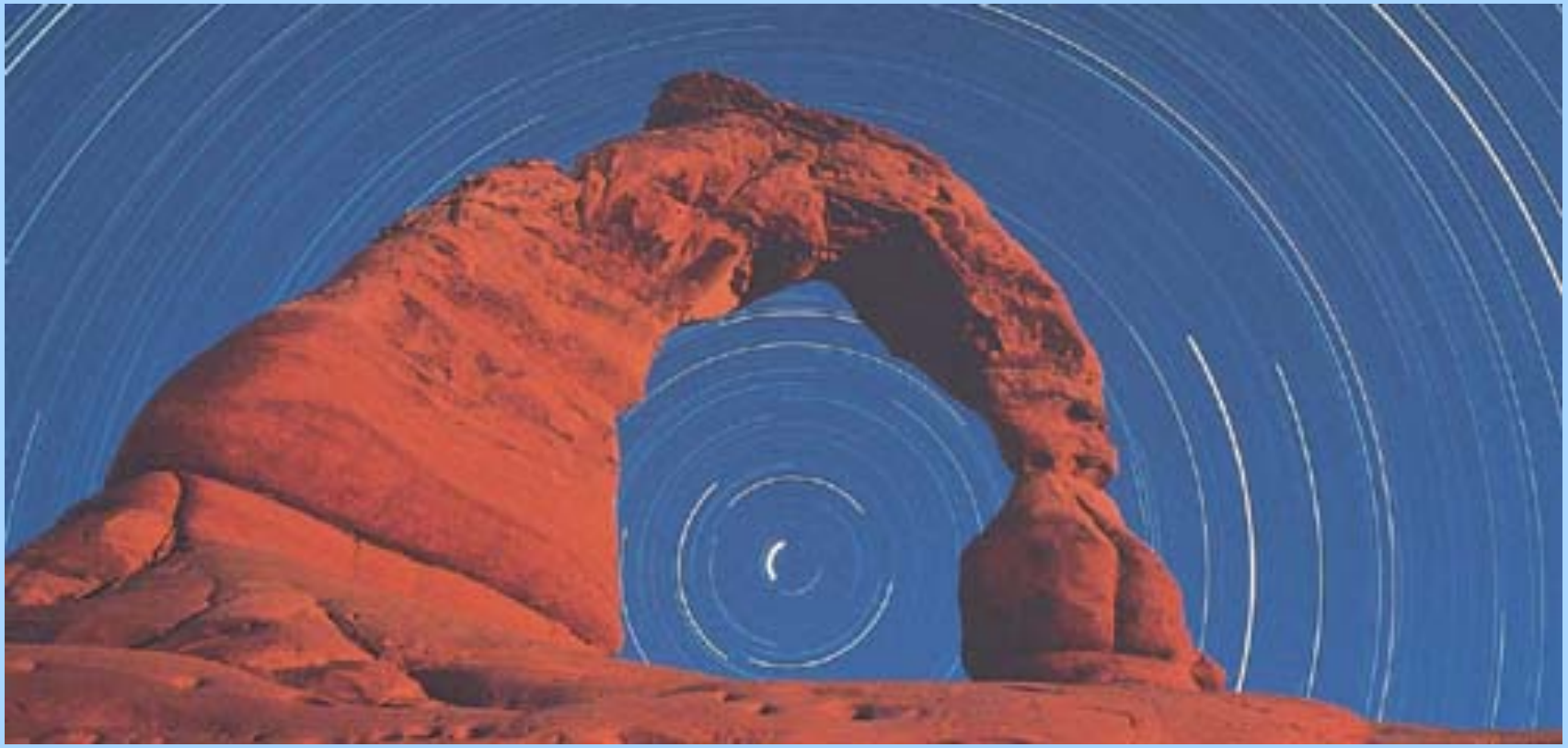


At mid-northern or mid-southern latitudes some stars are always above your local horizon. They are called **circumpolar stars**.



For observers in mid-northern latitudes, the northern sky is like a large clock face.

Knowing the day of the year, it is possible to use the orientation of the Big Dipper or some other circumpolar constellation to determine your clock time. With your eyeballs, a protractor, and some relatively simple calculations, one can determine the clock time to within 10 minutes.



The star Polaris is very close to the direction of the North Celestial Pole, so it makes a very small circle in the northern sky.

Multiple choice question examples:

What is the diameter of the Earth?

A. 8000 km
B. 8000 miles
C. 25,000 km
D. 25,000 miles

Say we build a highway that stretches all the way around the Earth's equator. You get in a car and travel 500 miles per day along this road. How long will it take you to complete one lap around the planet?

A. 16 days
B. 32 days
C. 50 days
D. 100 days

What is the brightest star in the night sky?

a. Sirius
b. Polaris
c. Betelgeuse
d. the star of Bethlehem

(Never mind the Sun….) Approximately how far away are the nearest stars?

a. several light-years away
b. several hundred light-years away
c. several thousand light-years away
d. several million light-years away

The elevation angle of Polaris above the north point on the horizon gives you a good estimate of your

a. longitude
b. latitude
c. altitude
d. declination