



Freedman • Geller • Kaufmann

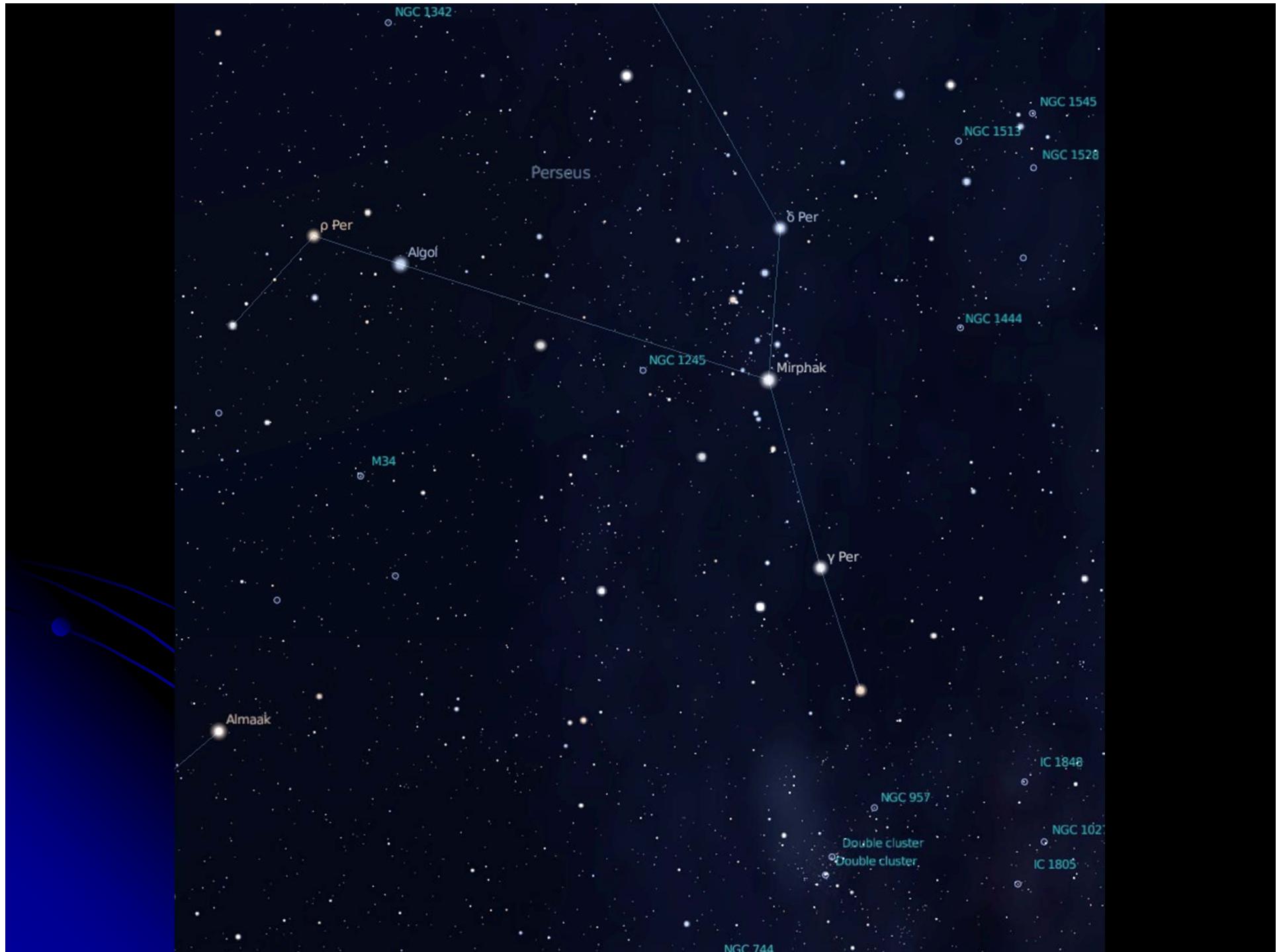
Universe

9th Edition

CHAPTERS 2 & 3

Knowing the Heavens

Jonn Serrie, "The Stargazer's Journey"



Historical Astronomy

As a science, astronomy began as an effort to explain the appearance of the sky.

Ancient cultures quickly realized that the sky does change!

Different stars are visible at different times of night at different times of year

The Moon changes phase and when it is visible in a regular pattern

The position of the Sun changes

The positions of each of the planets change

To ancient cultures, there were four primary questions underlying astronomy:

Could one use the positions of the sun, stars, planets, etc. to tell time?

Could one explain the “workings of the celestial spheres”, as the Greeks put it?

How did the positions of objects and their changes with time relate to a culture’s religion?

Did matters astronomical have any effect on matters here on Earth and on daily or tribal life?

Sundials



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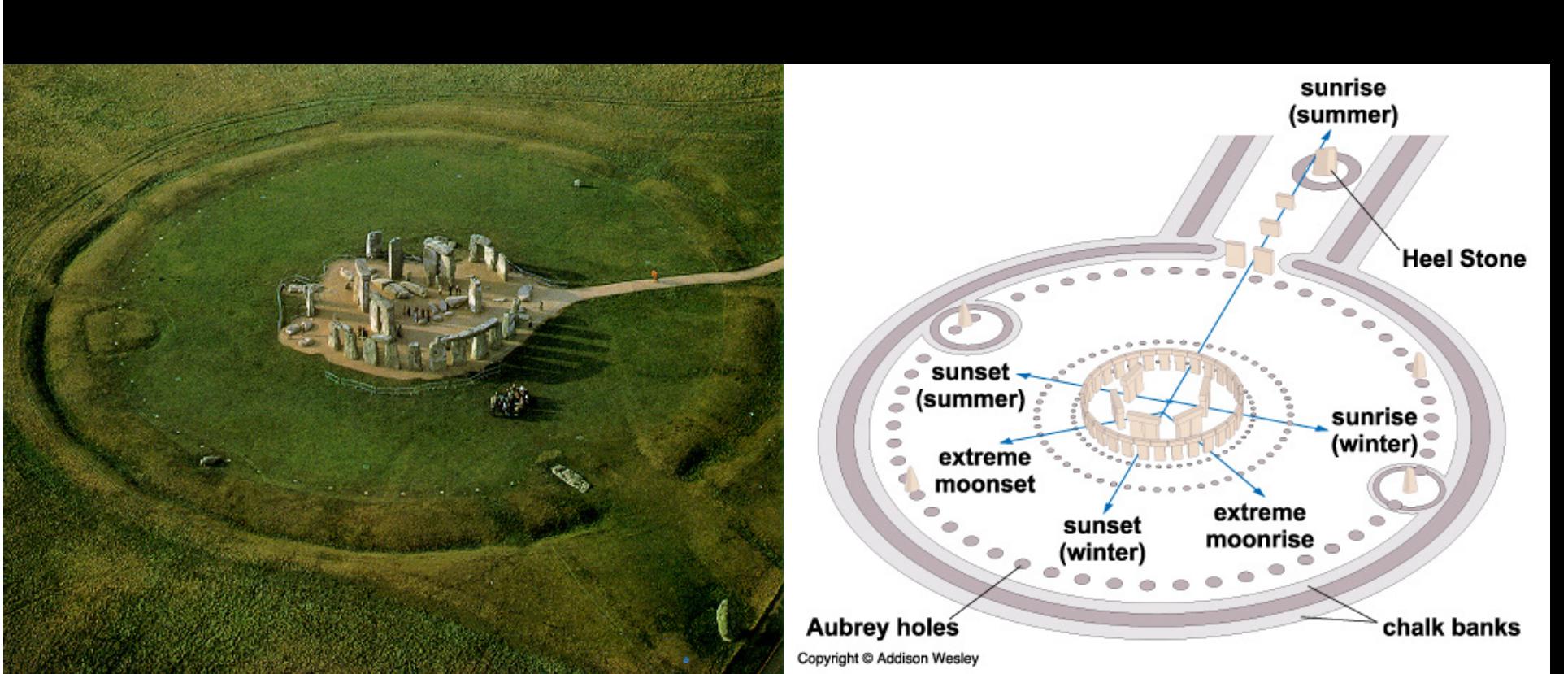
Astronomical Calendars and Observatories in the Americas, c.1000 AD





The Pyramids in Egypt





**Ancient cultures also discovered how to use
the motions of the sky as a calendar.
Stonehenge is a well-known example of this**

The seasons in Africa

Cultures in Africa used the Moon to predict the weather and rainfall. They found that the angle of the crescent moon's "horns" correlated with the time of the year. Since Nigeria has a fairly reliable wet and dry season, this enabled them to predict when to plant and harvest crops.

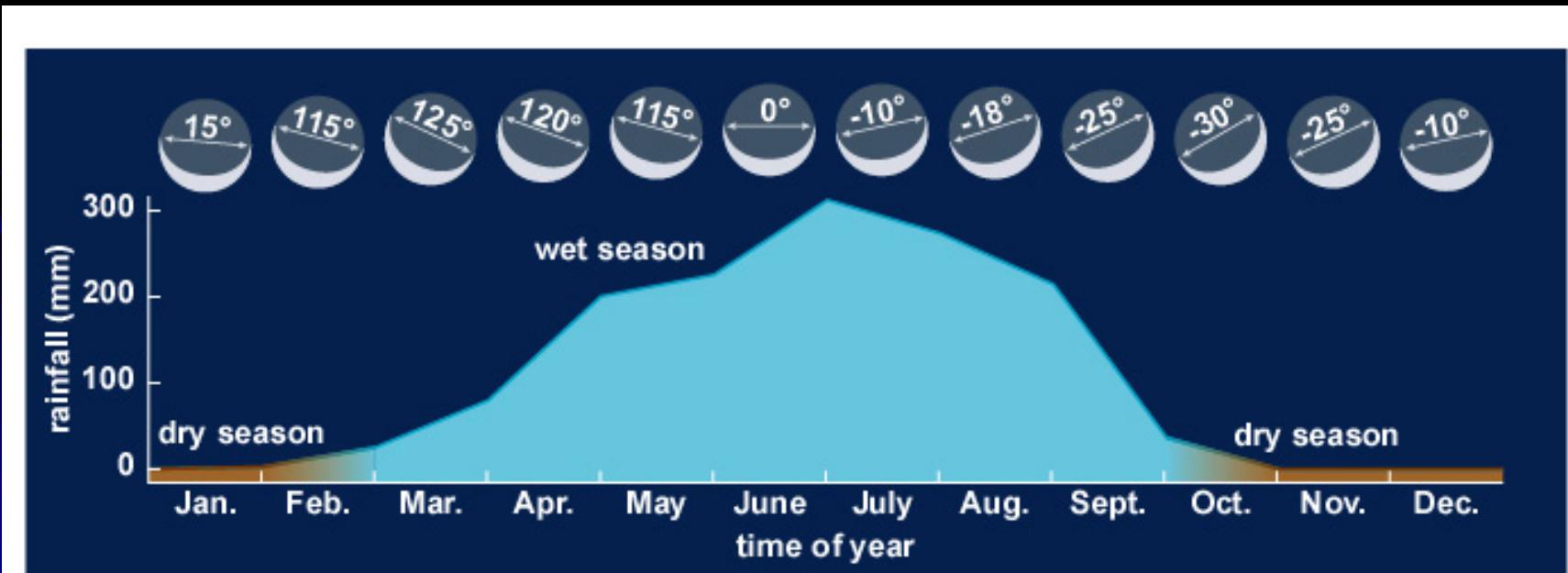


Table 3.1 The Seven Days of the Week and the Astronomical Objects They Honor

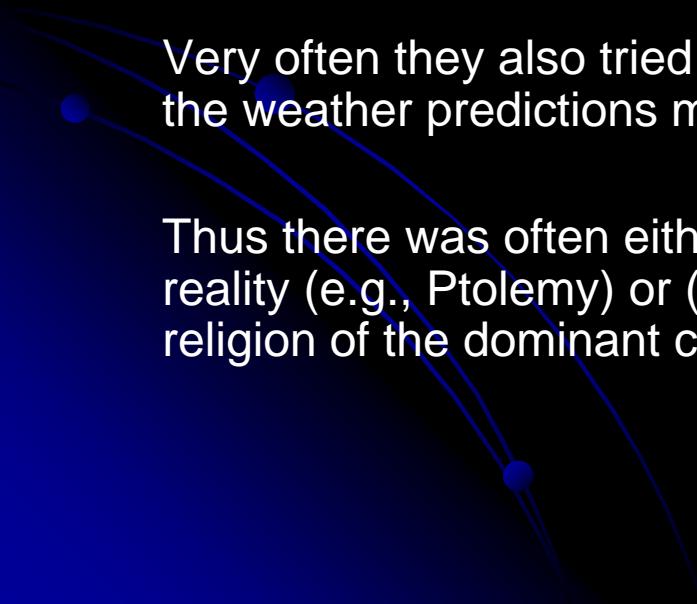
The correspondence between objects and days is easy to see in French and Spanish.

In English, the correspondence becomes clear when we look at the names of the objects used by the Teutonic tribes who lived in the region of modern-day Germany.

Object	Teutonic Name	English	French	Spanish
Sun	Sun	Sunday	dimanche	domingo
Moon	Moon	Monday	lundi	lunes
Mars	Tiw	Tuesday	mardi	martes
Mercury	Woden	Wednesday	mercredi	miércoles
Jupiter	Thor	Thursday	jeudi	jueves
Venus	Fria	Friday	vendredi	viernes
Saturn	Saturn	Saturday	samedi	sábado

Chinese Astronomical Observatory and Instruments –c. 1400 AD





Many different cultures developed astronomical models, and indeed scientific modes of thinking.

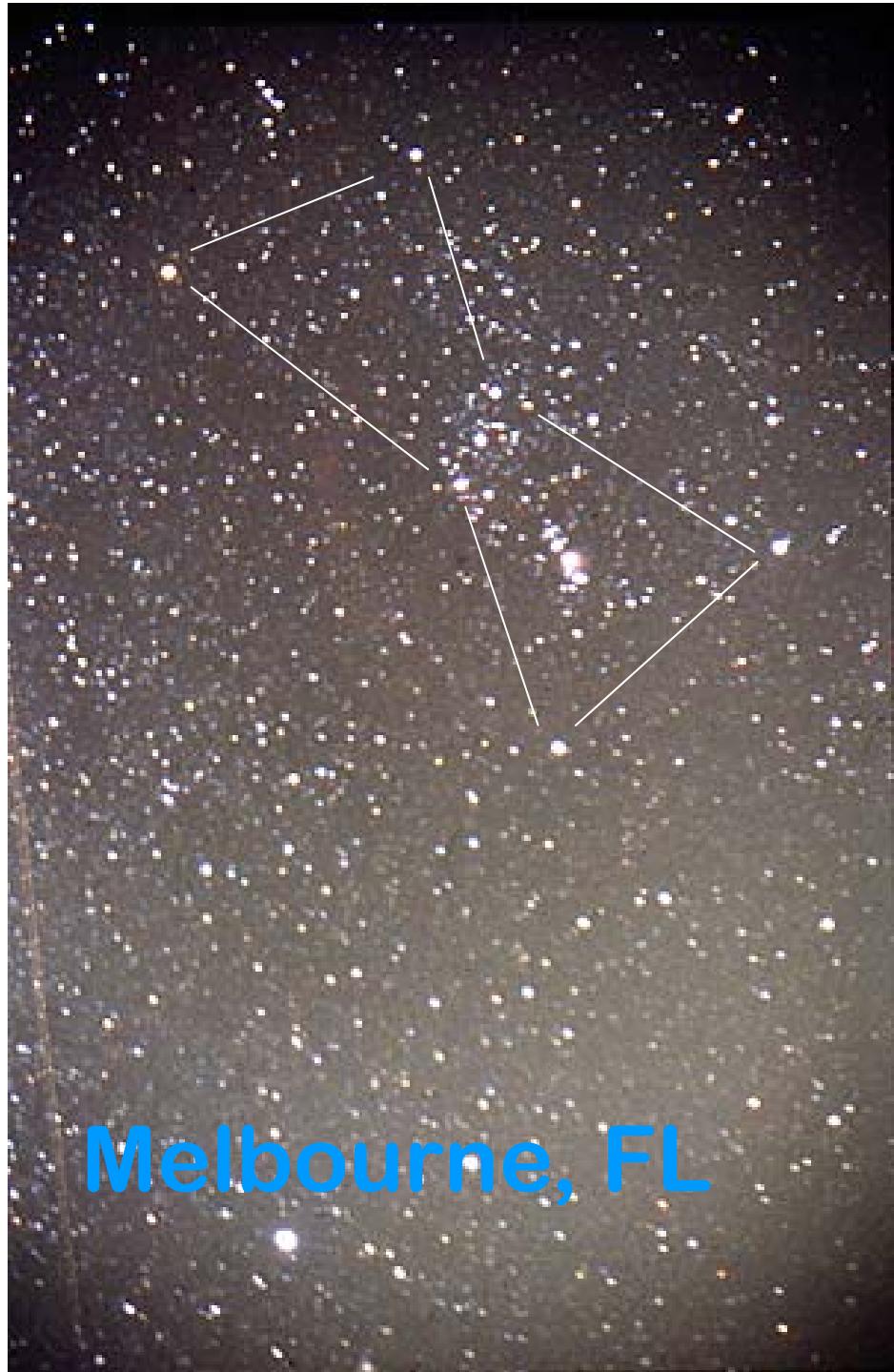
All were an attempt to explain the observations that they made and make predictions that could be verified.

Constructing Stonehenge, the Pyramids of Giza, Chichen Itza, or the calendars of the Aztecs all required sophisticated astronomical knowledge.

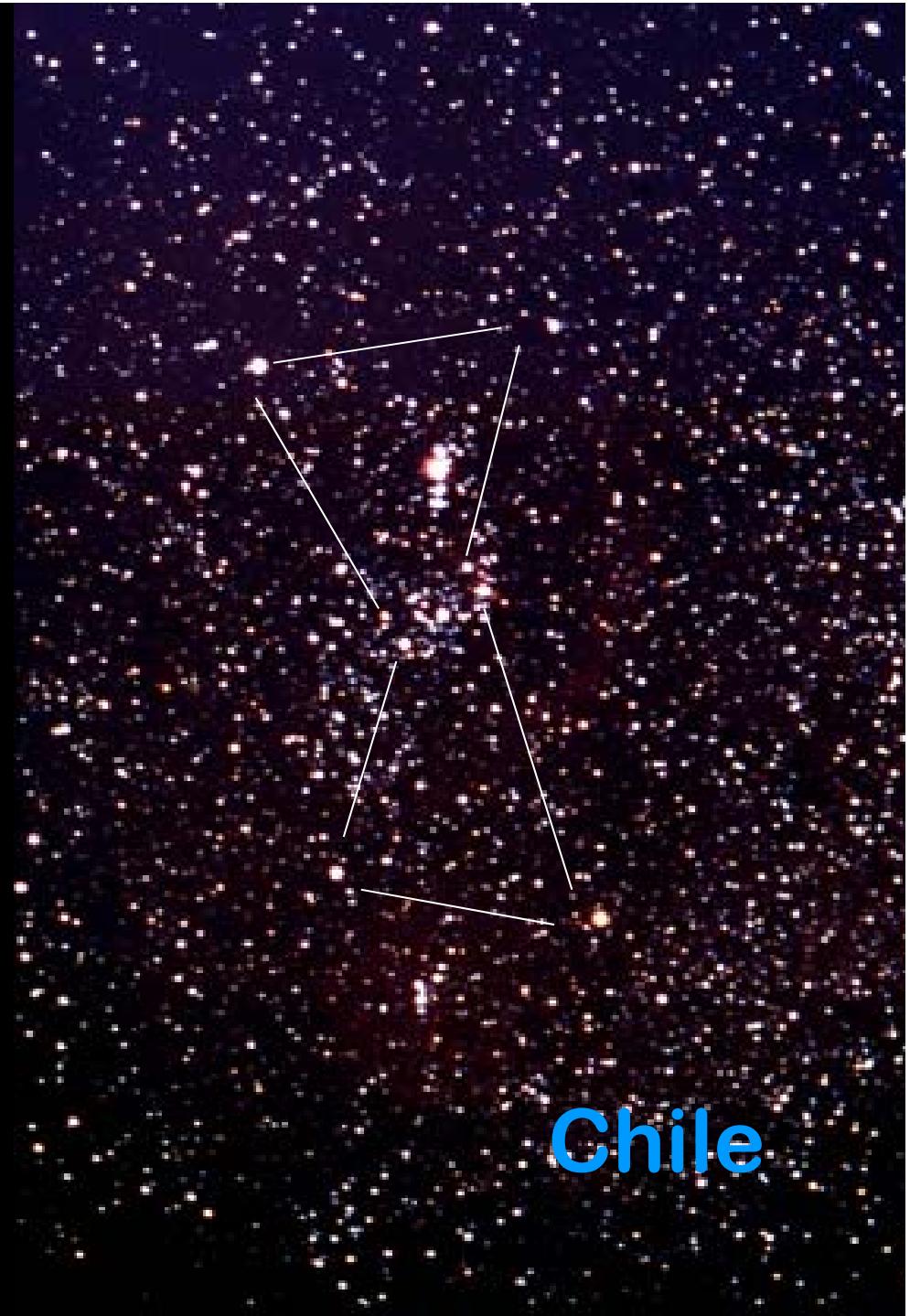
But all ancient cultures were somewhat bound by the ideas of the day (from which they drew their premise).

Very often they also tried to explain the events that happened to them – as in the weather predictions made by Africans based on the Moon.

Thus there was often either (1) little concern as to whether they represented reality (e.g., Ptolemy) or (2) the hypothesis had to be consistent with the religion of the dominant culture at that time/place.

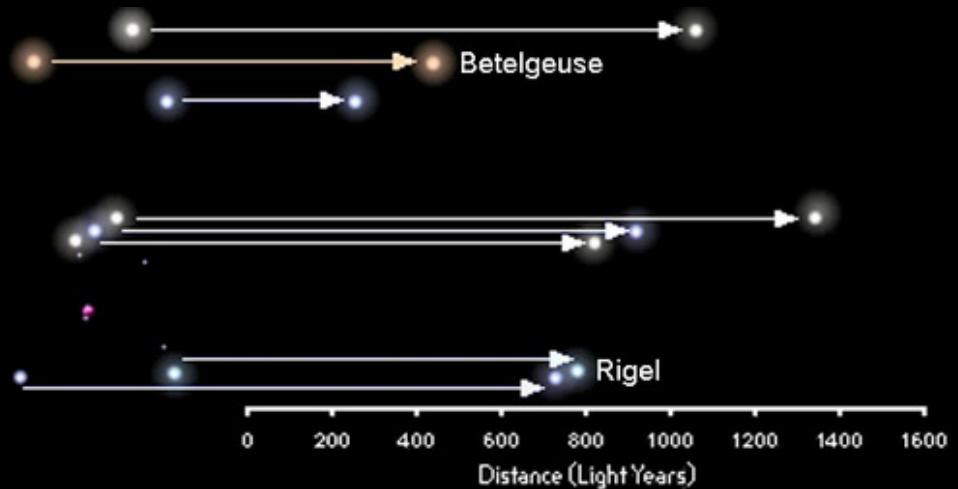
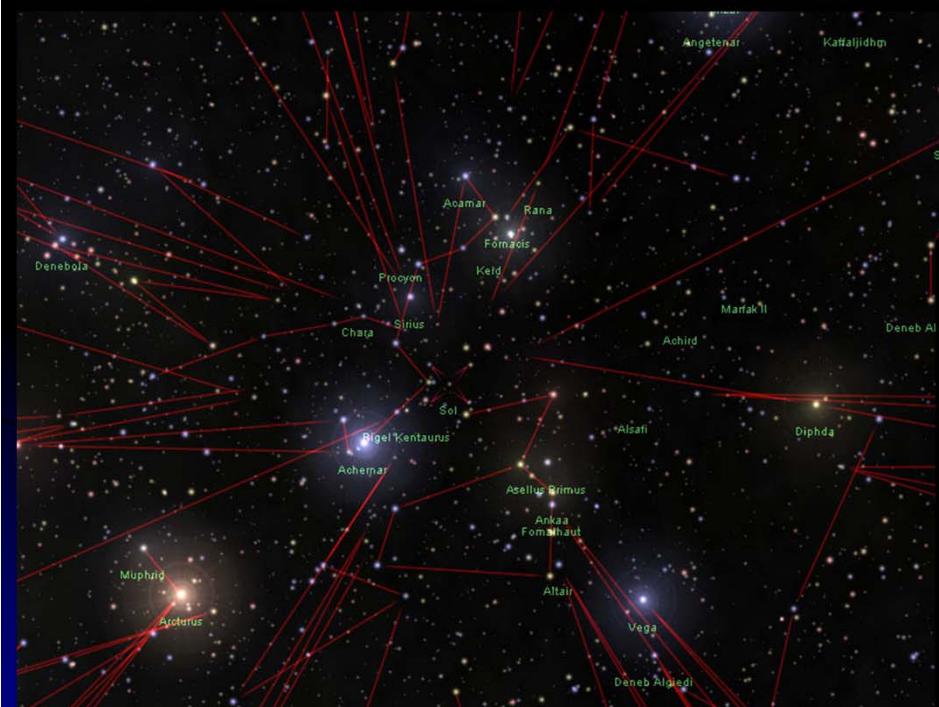


Melbourne, FL



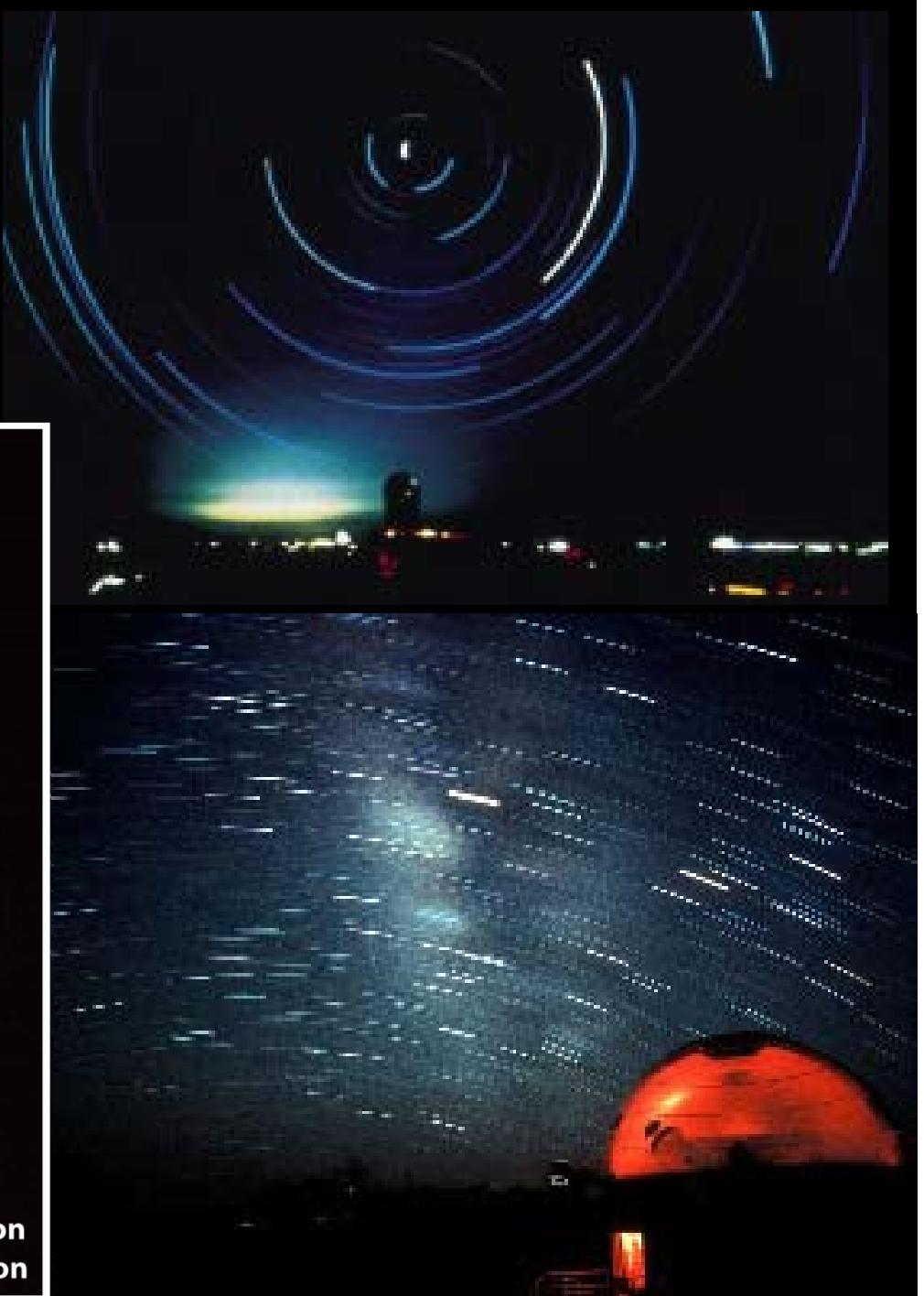
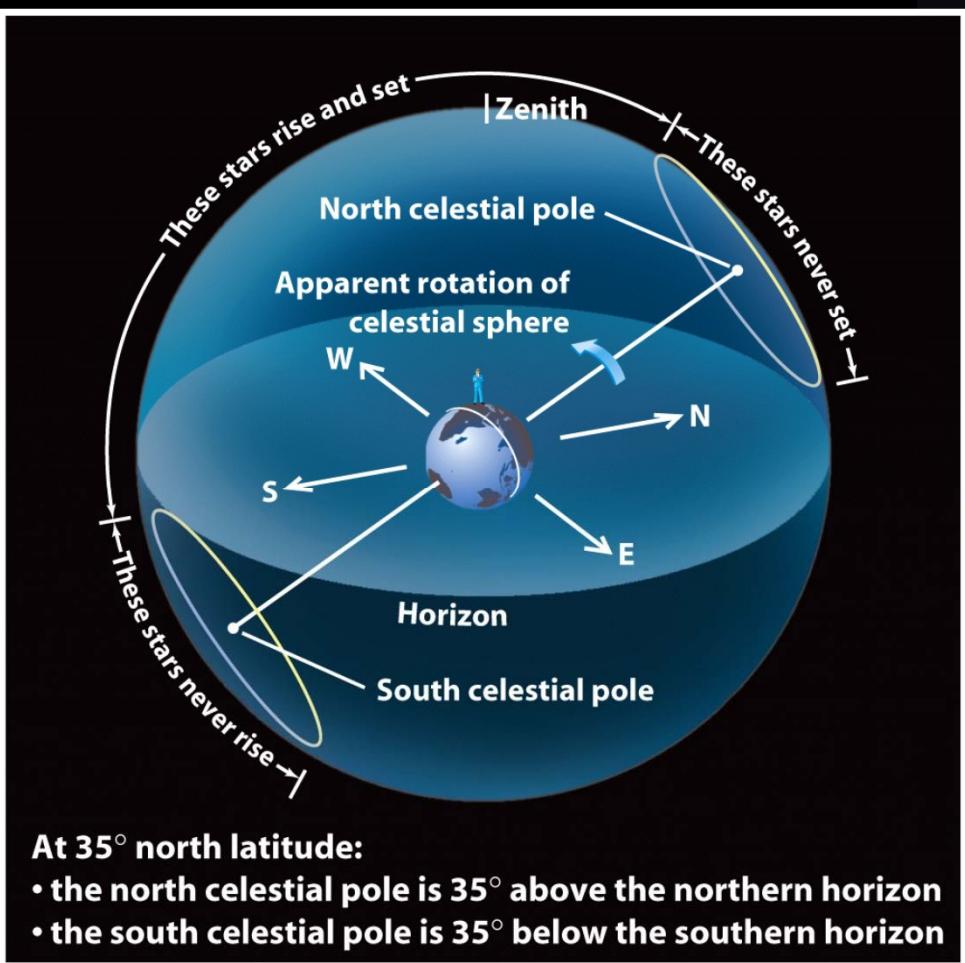
Chile

Perspective in Astronomy

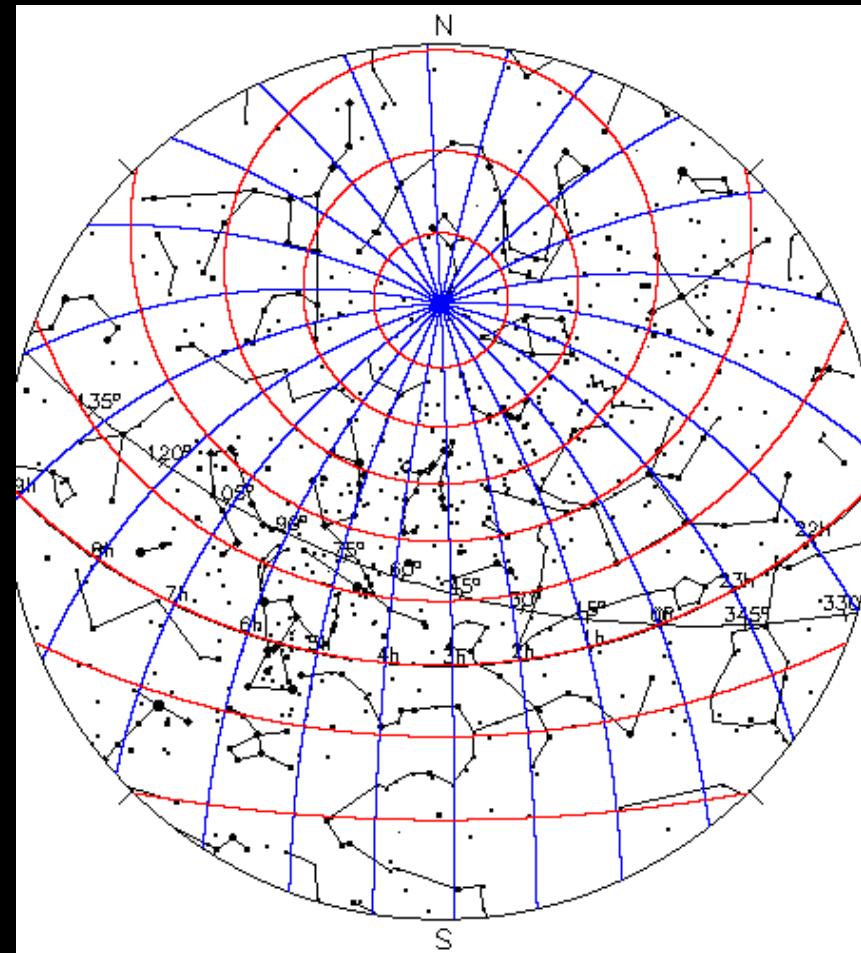
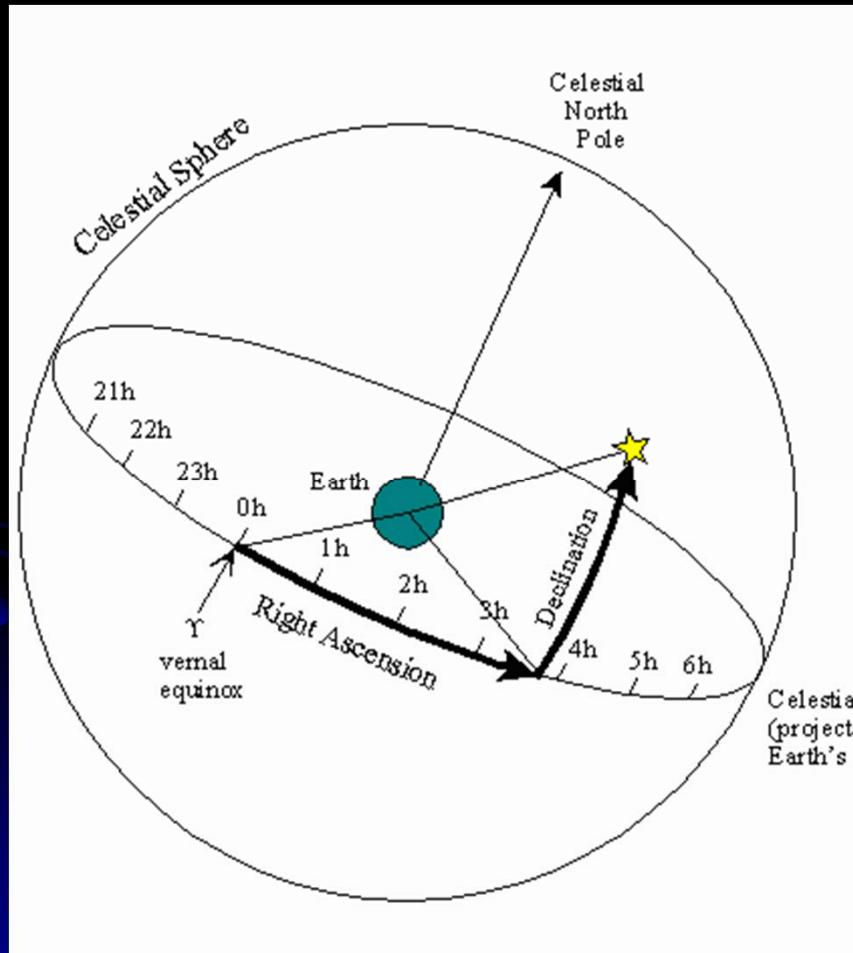


www.spacetelescope.org

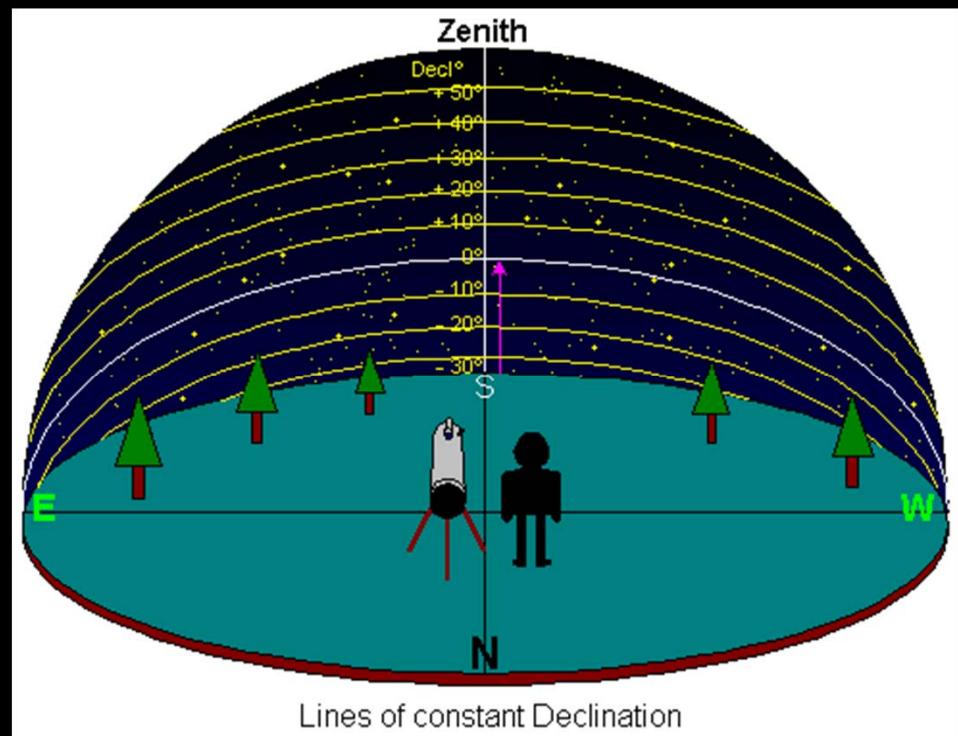
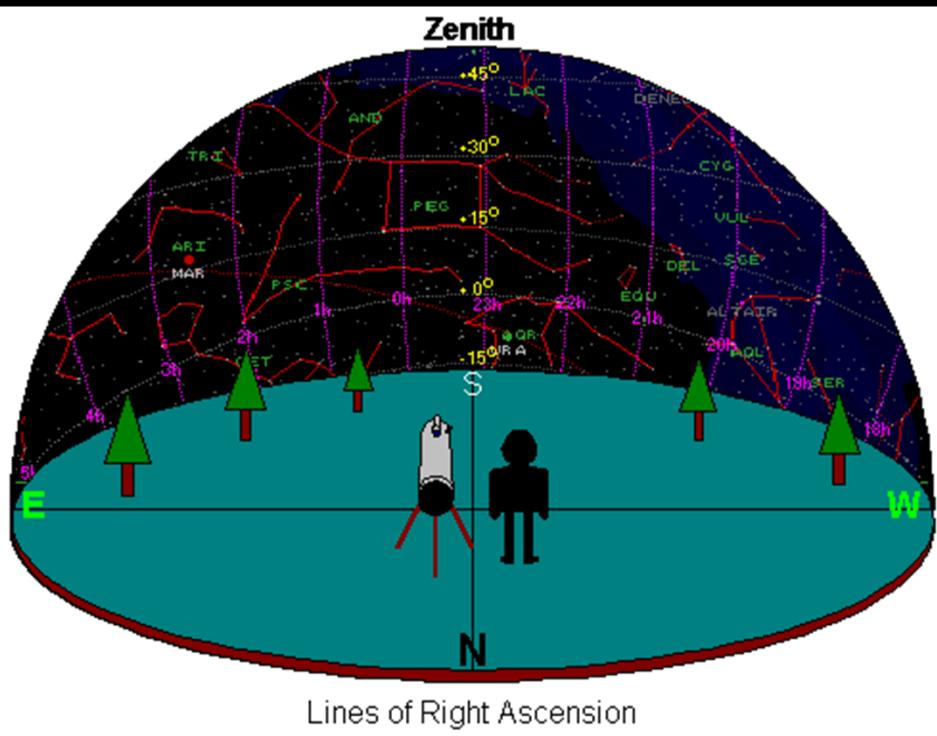
CELESTIAL SPHERE



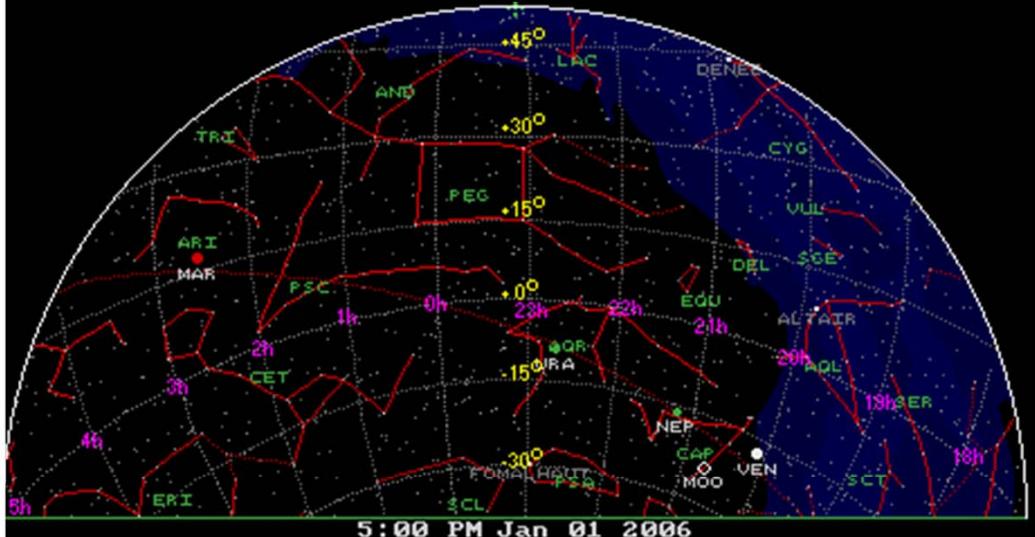
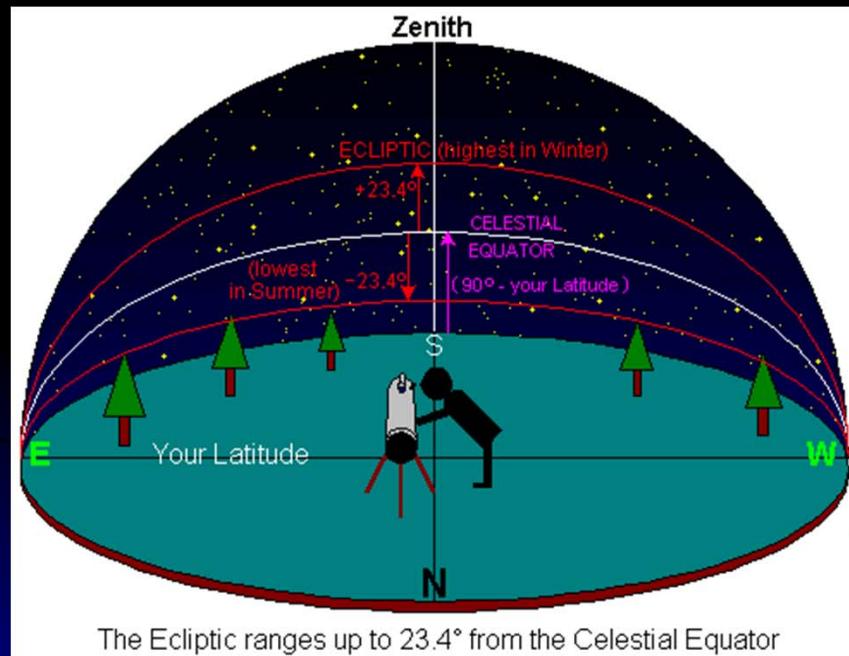
Right Ascension & Declination



RA vs. Dec as we observe it



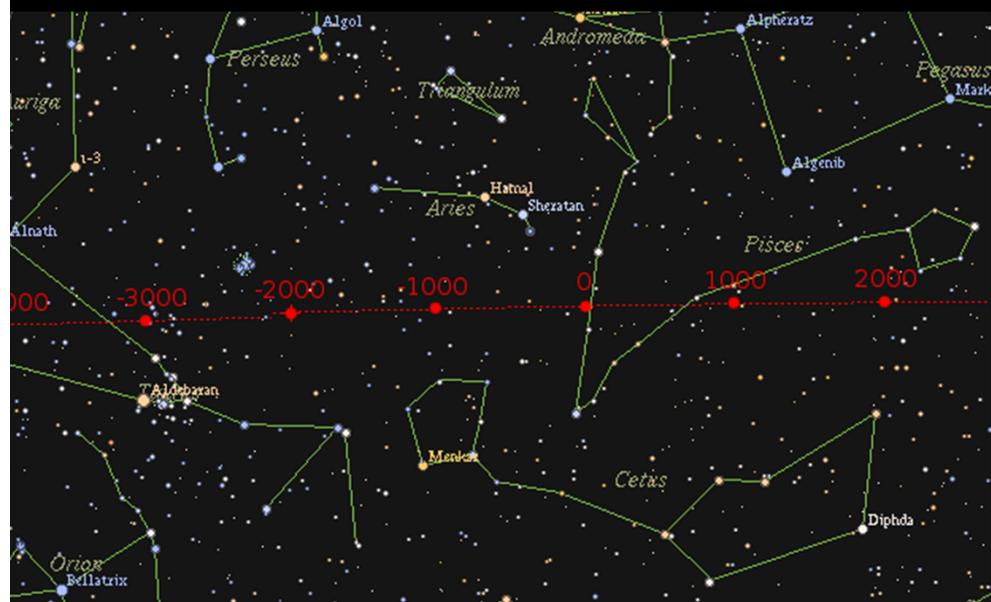
The Ecliptic



Ecliptic Plane = Plane of Earth's orbit

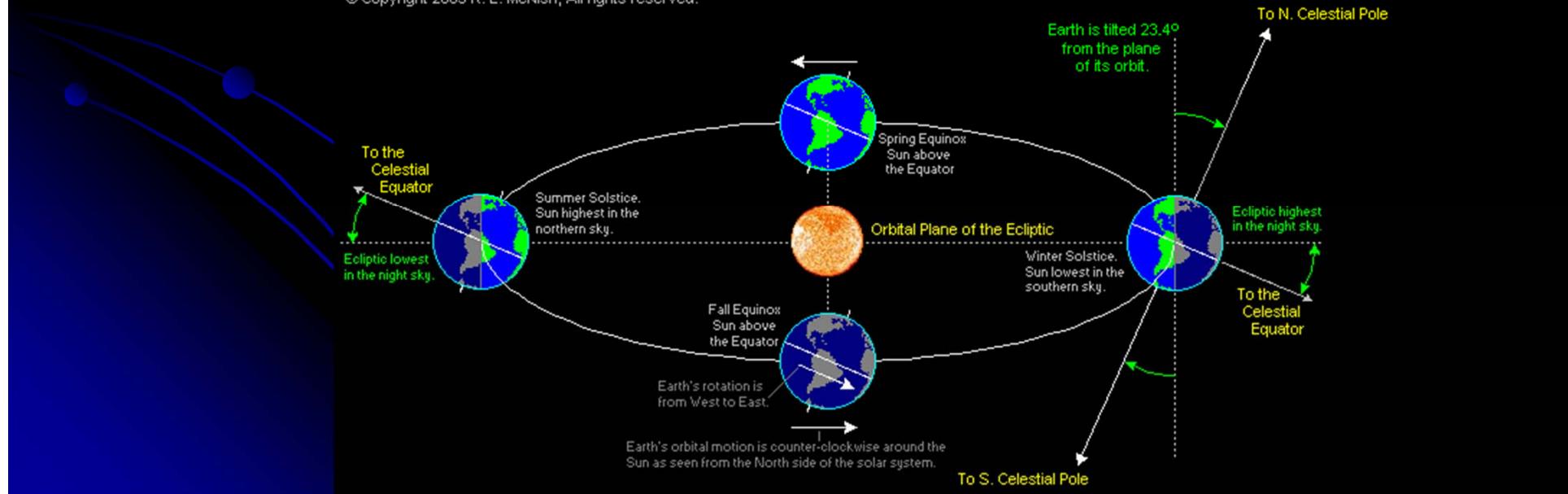
Also where the planets can be found.

Precession



Earth's Orbital Motion

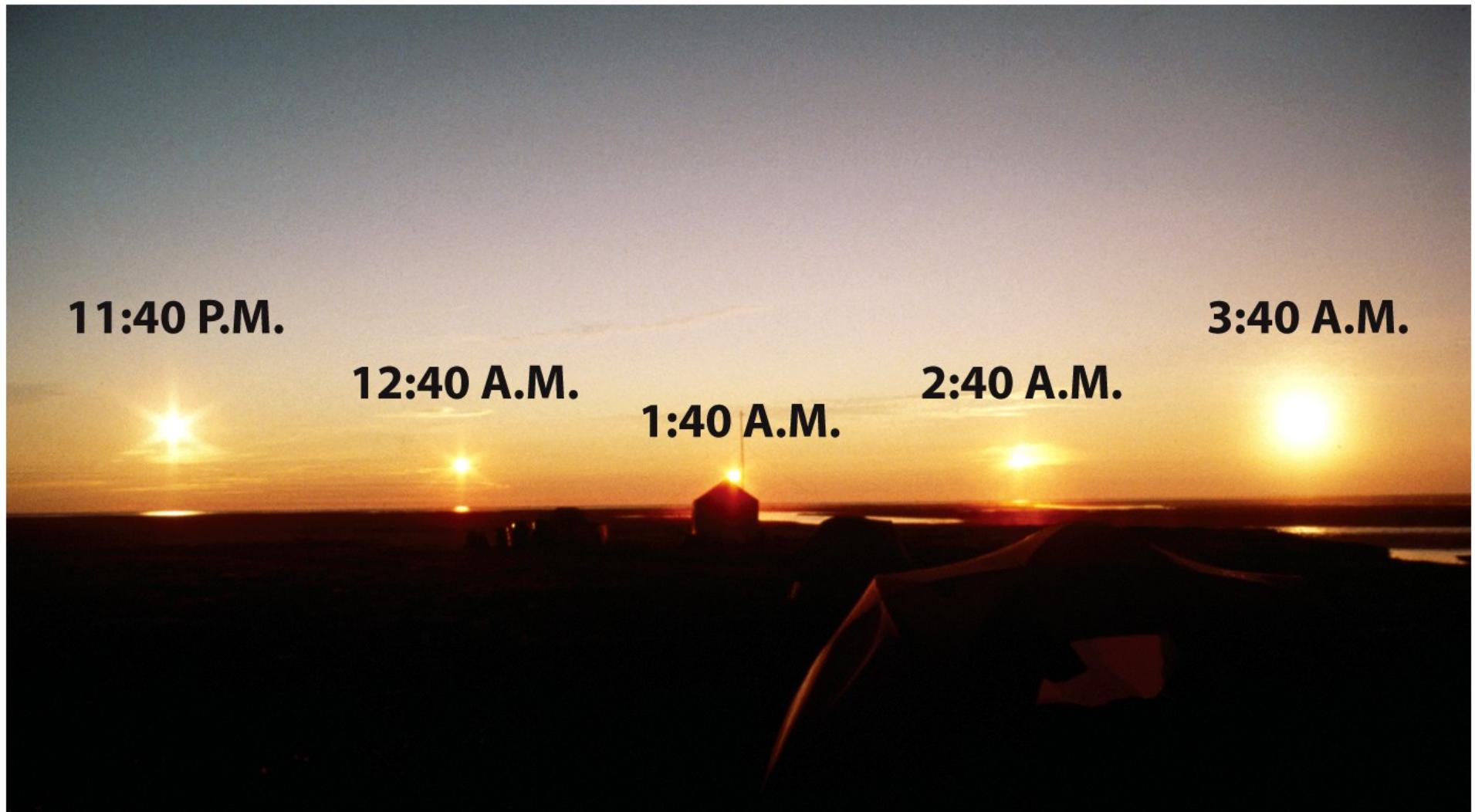
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Cerro Tololo (Chile)



Where was this picture taken?



11:40 P.M.

12:40 A.M.

1:40 A.M.

2:40 A.M.

3:40 A.M.



At the north pole

Where was this picture taken?

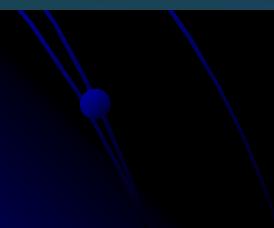


Photo ©LeRoy Zimmerman

Night Trails of Africa

Photo ©LeRoy Zimmerman

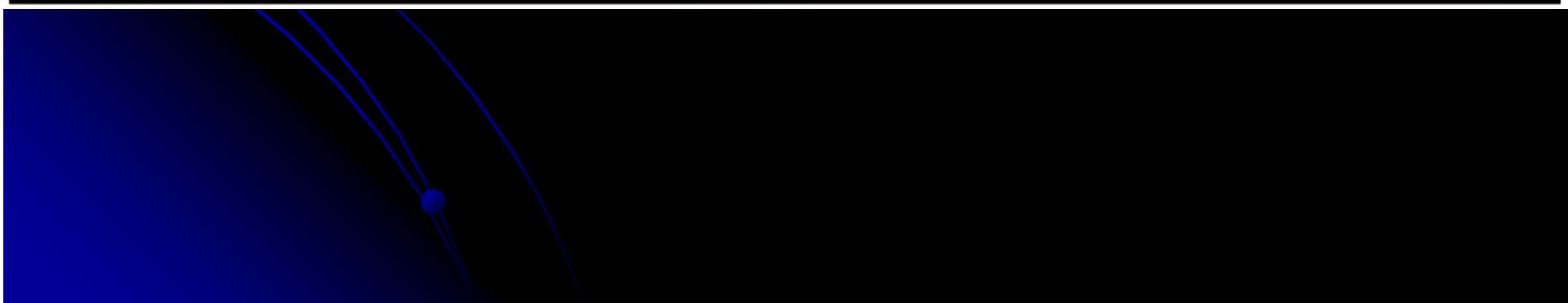
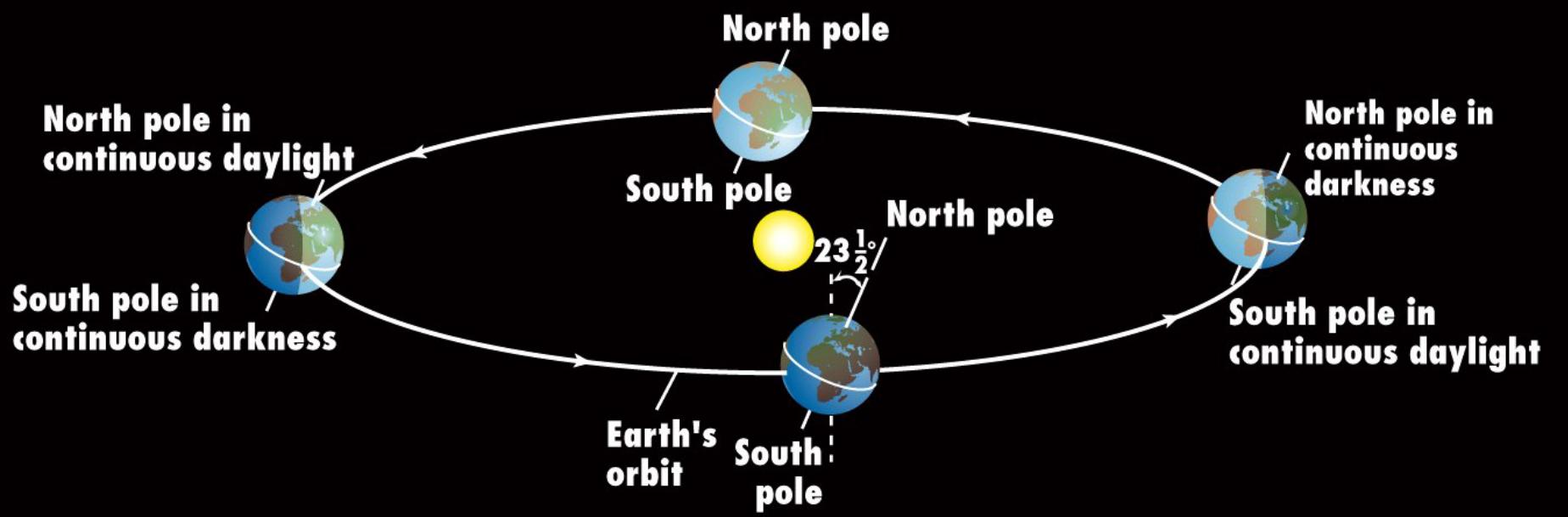
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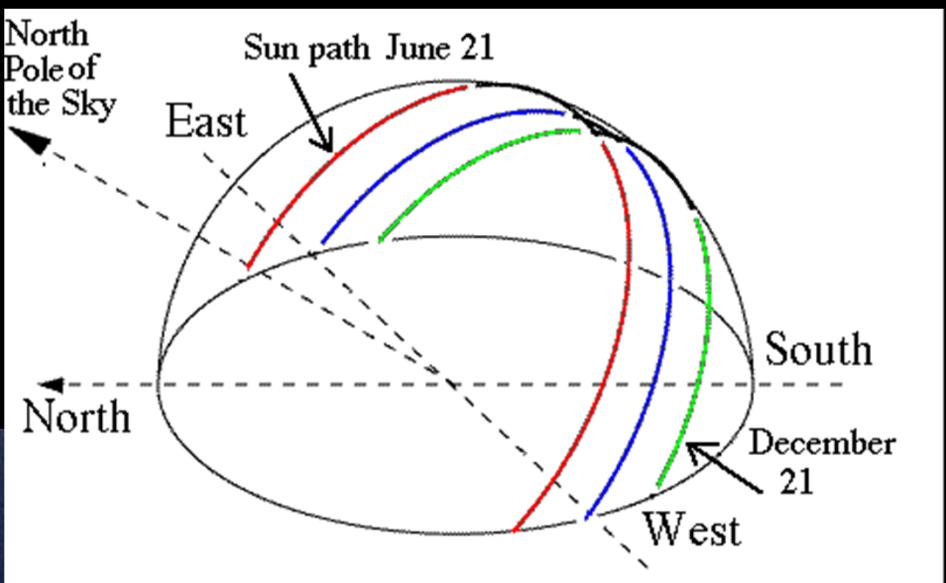
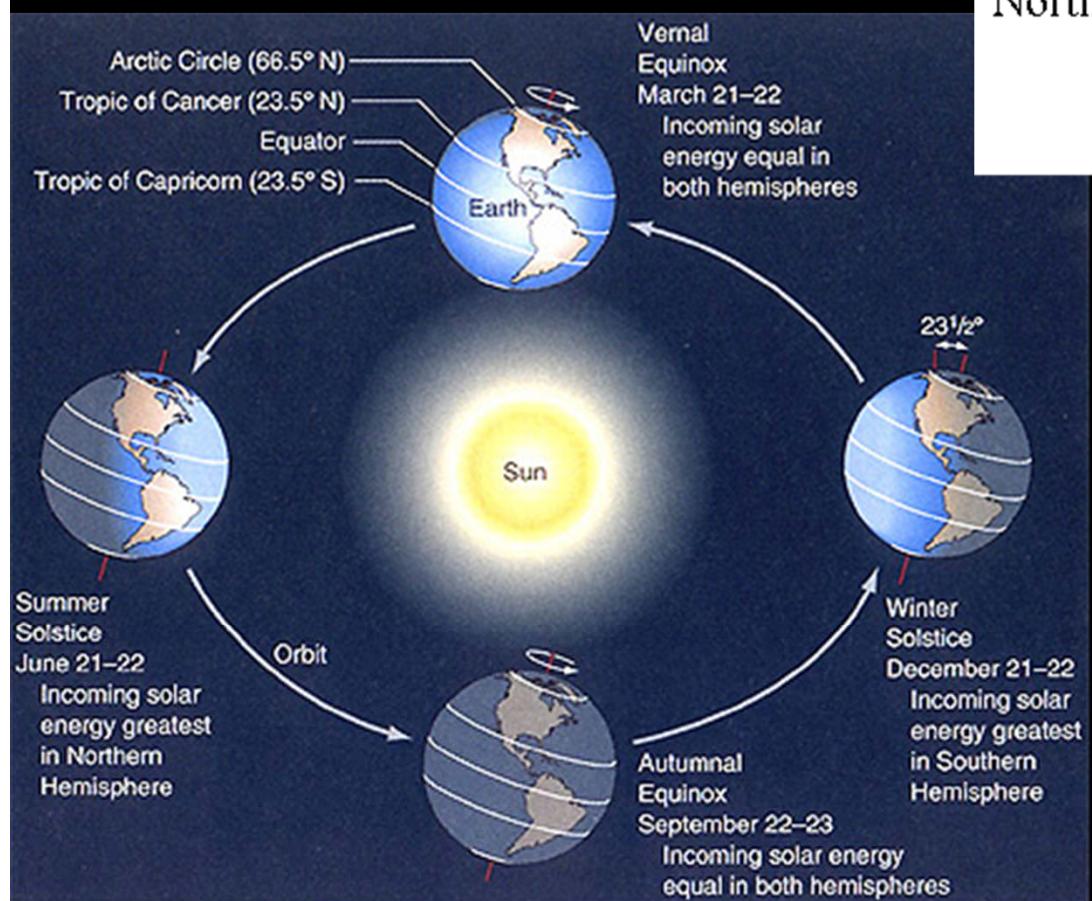


At the equator

SEASONS

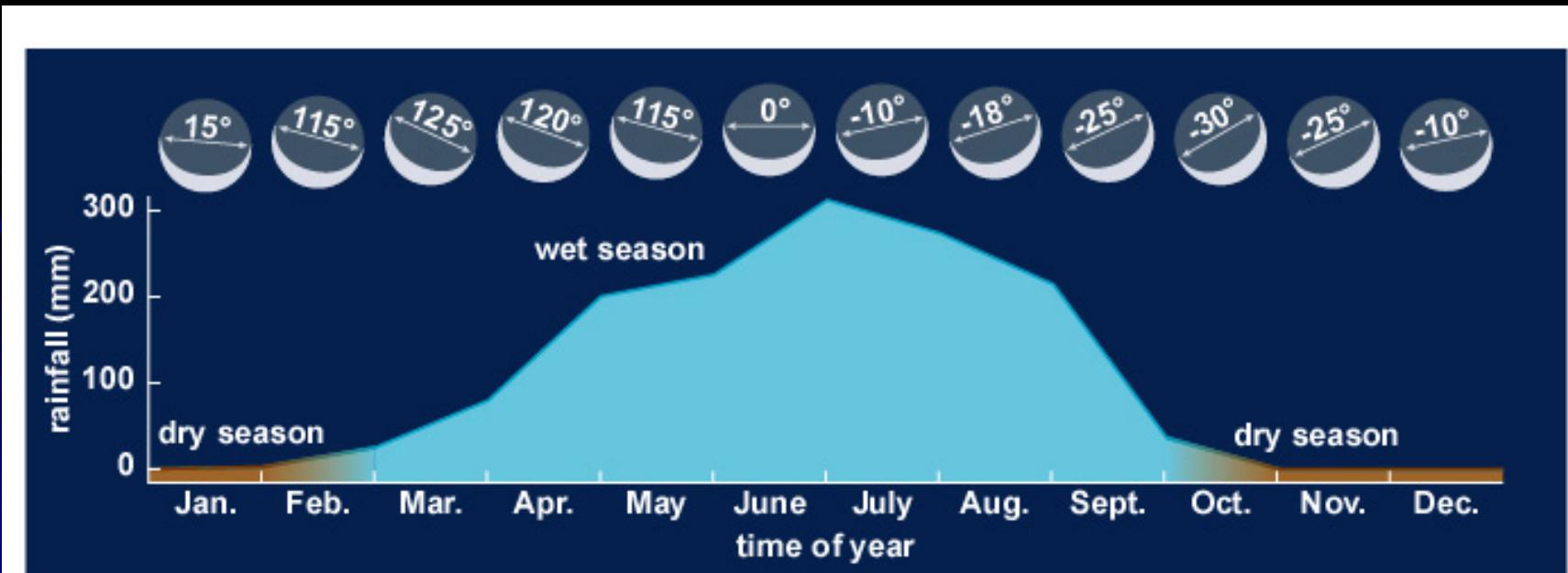


Seasons



The seasons in Africa

Cultures in Africa used the Moon to predict the weather and rainfall. They found that the angle of the crescent moon's "horns" correlated with the time of the year. Since Nigeria has a fairly reliable wet and dry season, this enabled them to predict when to plant and harvest crops.



Astrology vs. Astronomy

Basic tenet of astrology is that human events are influenced by the apparent positions of the Sun, Moon and planets among the stars in the sky.

To ancient cultures, this was natural, because they could see the weather being dependent on the Sun, and the Moon determining the tides.

The idea of astrology in ancient times was to attempt to learn how the positions of the Sun, Moon and planets influenced our lives.

So they kept records on the positions of planets as well as human events, trying to correlate the two.

Usually astronomers and astrologers were the same in the ancient world, but astronomers realized the shakiness of astrology. For example, Kepler cast horoscopes even as he was discovering the laws of planetary motion! But he still described astrology as a “dreadful superstition” and the “foolish stepdaughter of astronomy”. He needed the money – this was not uncommon!

With the scientific method, one can actually *test* astrology by evaluating many horoscopes and comparing their accuracy to what would be expected by chance. Many scientific tests of astrology have been conducted and it has failed time and time again.

**The Sun is high
in the midday
summer sky...**

**... so a shaft of
sunlight is
concentrated onto
a small area, which
heats the ground
effectively and
makes the days
warm.**



(a) The Sun in summer

**The Sun is low in the
midday winter sky...**

**... so the same shaft of
sunlight is spread out
over a larger area and
less heating of the
ground takes place.**



(b) The Sun in winter

One day of Earth's Orbit
is a little less than 1°
($360^\circ / 365\frac{1}{4}$ days)

The extra amount the Earth
has to rotate in one day to still
see the Sun directly overhead
at local Noon.

To the Sun's centre

The Earth's Orbit

To a star at "infinity"

Local Noon
Day 1

Day 2

Day 3

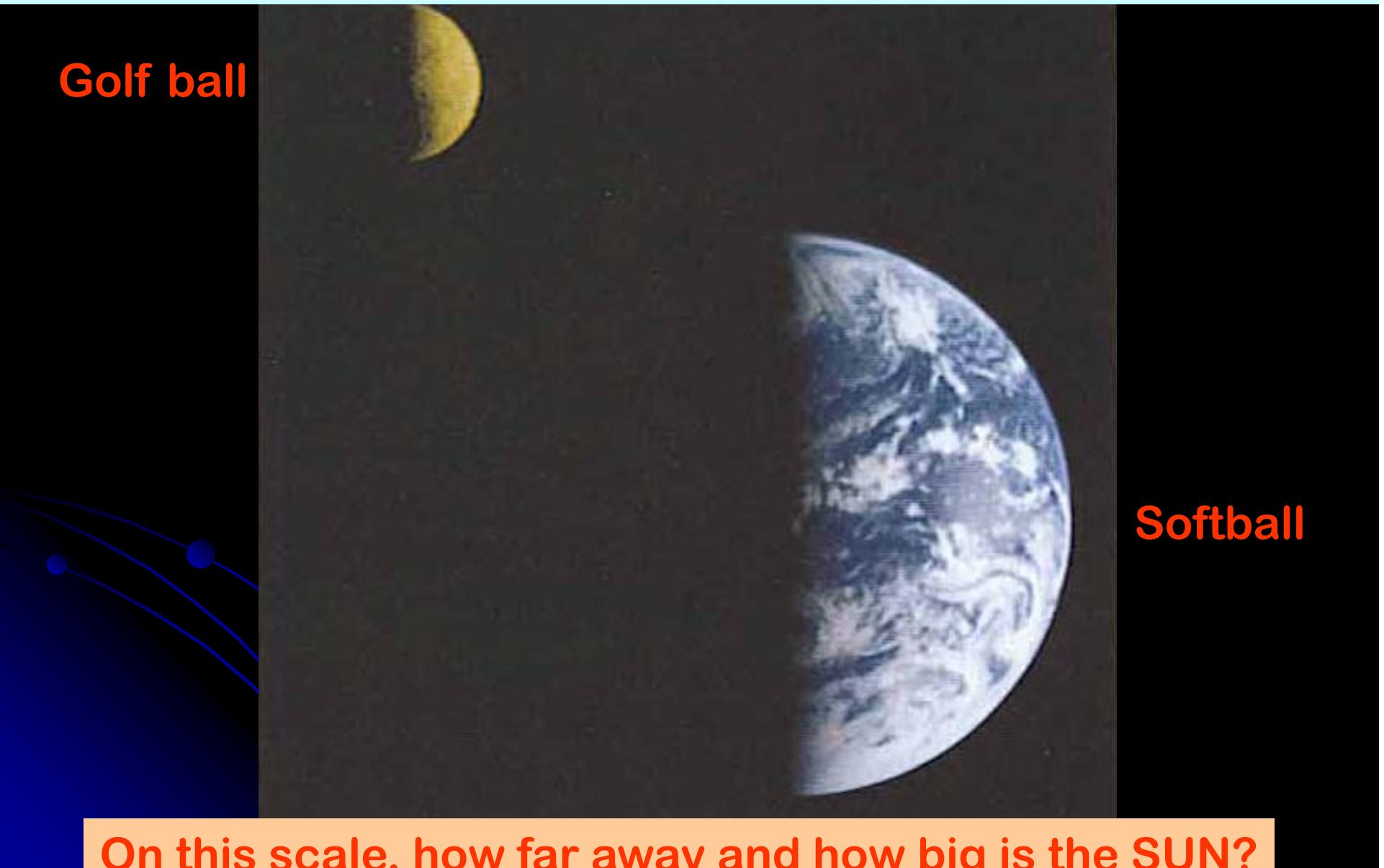
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Relative Sizes of the Earth & Moon

Golf ball

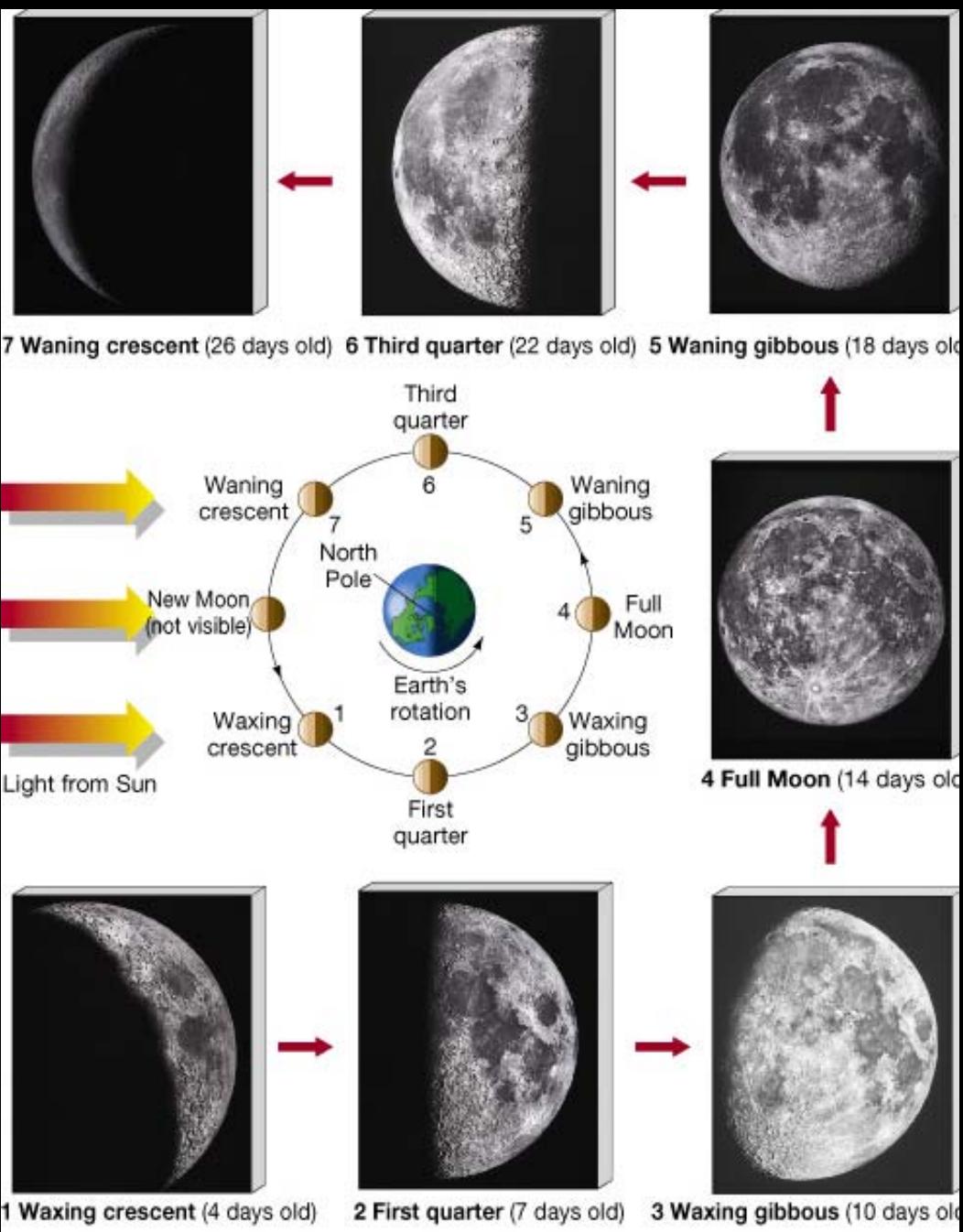
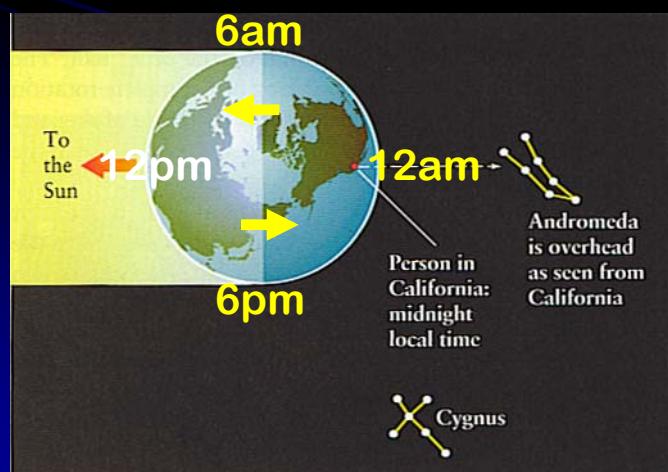
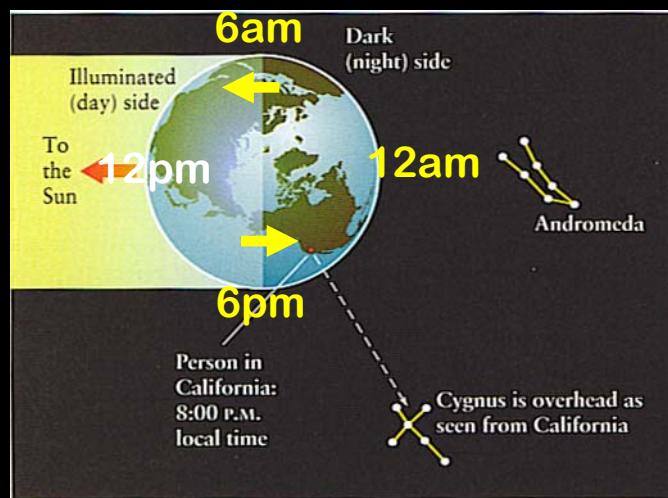


Softball

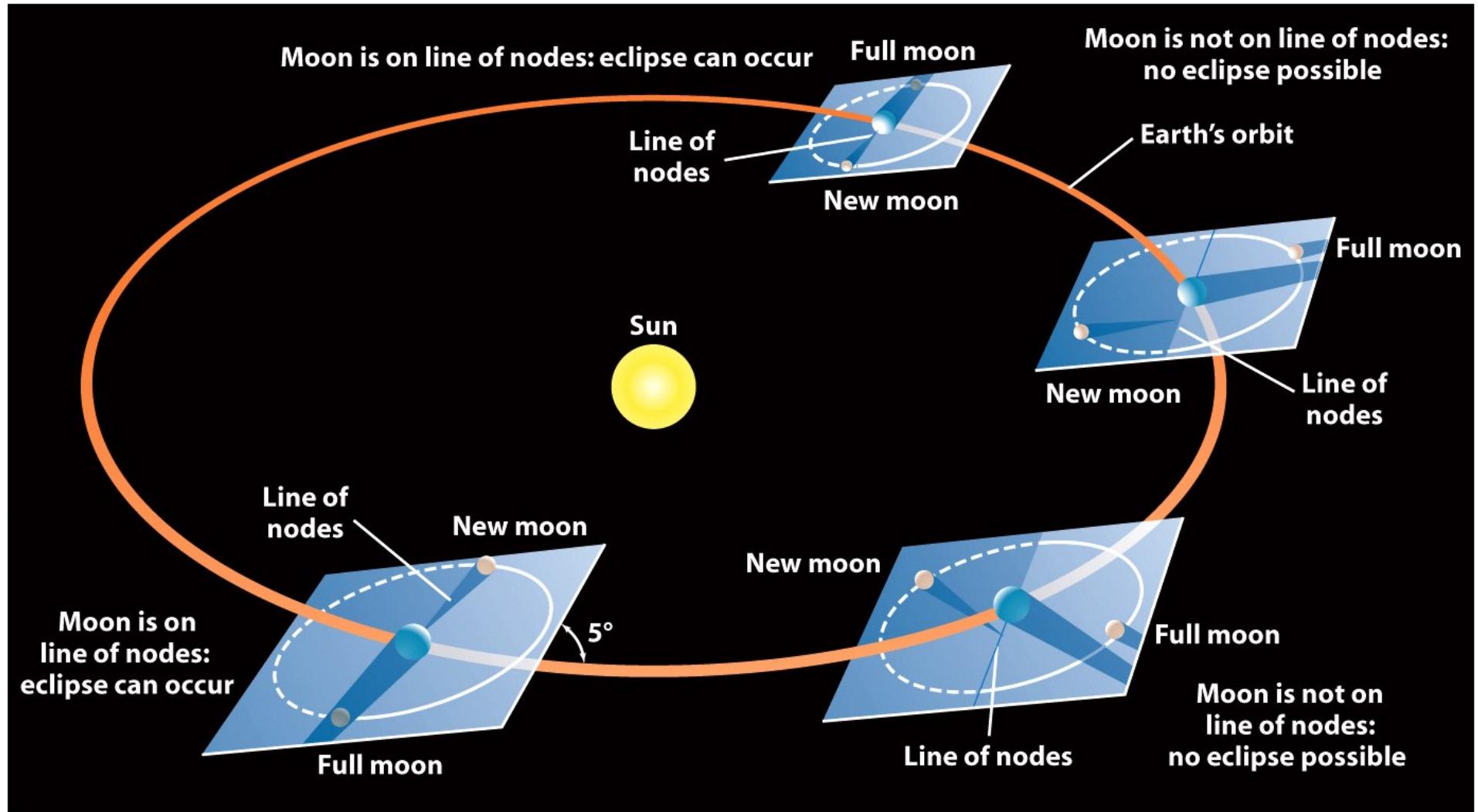
On this scale, how far away and how big is the SUN?

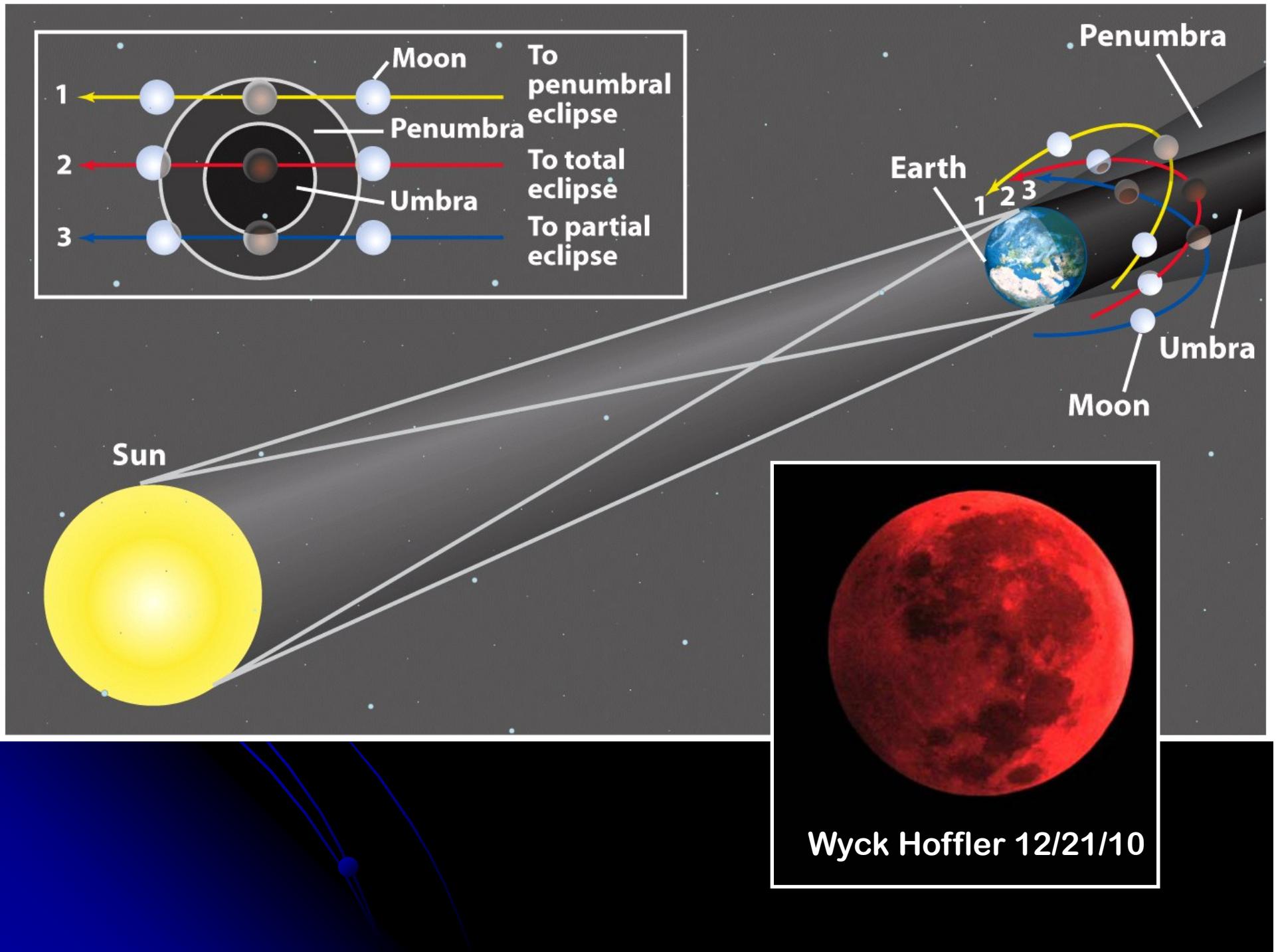
Lunar Phases

Rising/Setting Times



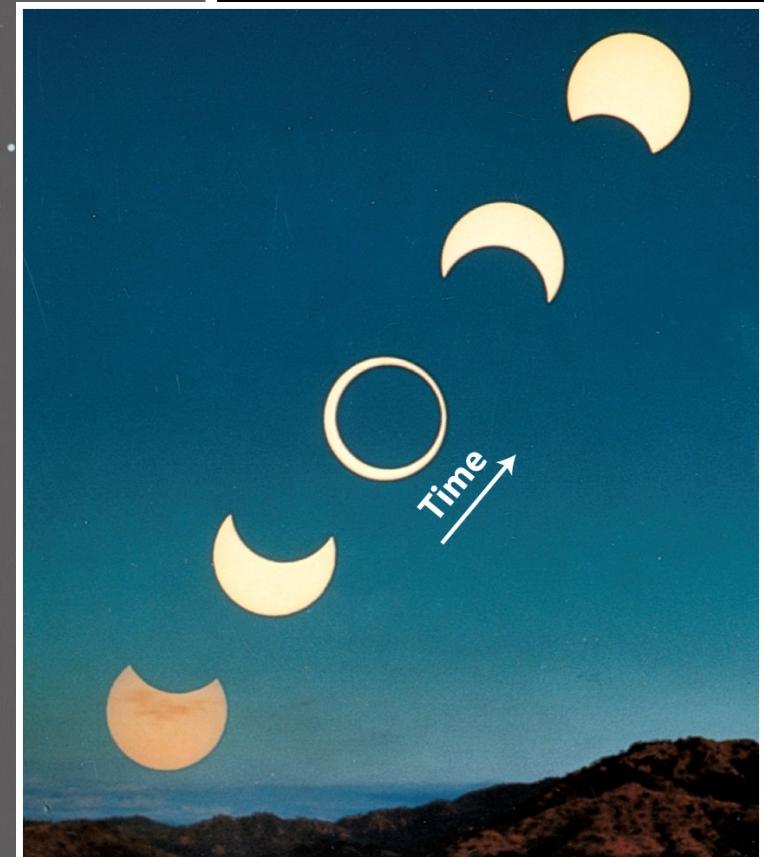
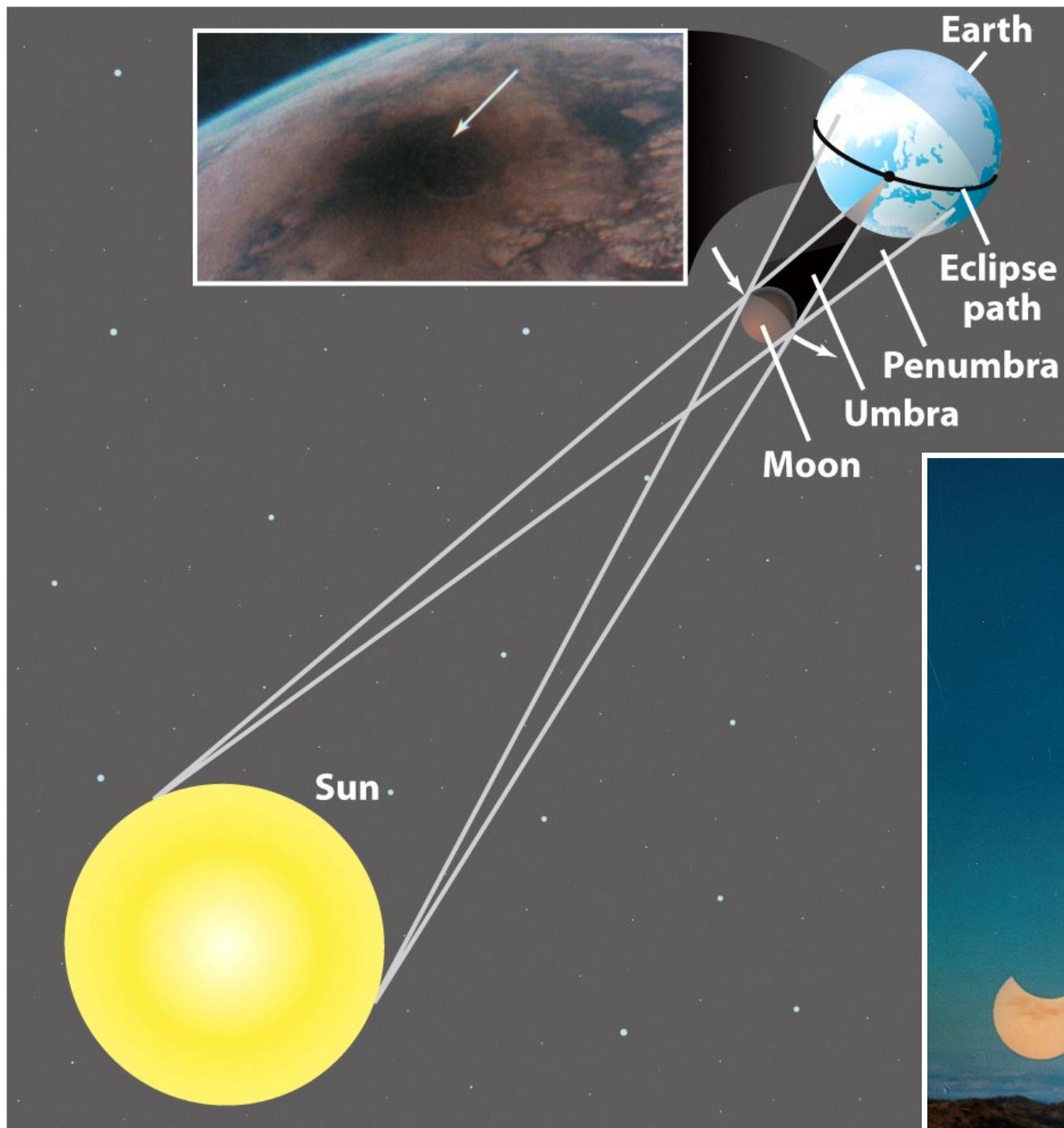
LUNAR ECLIPSES



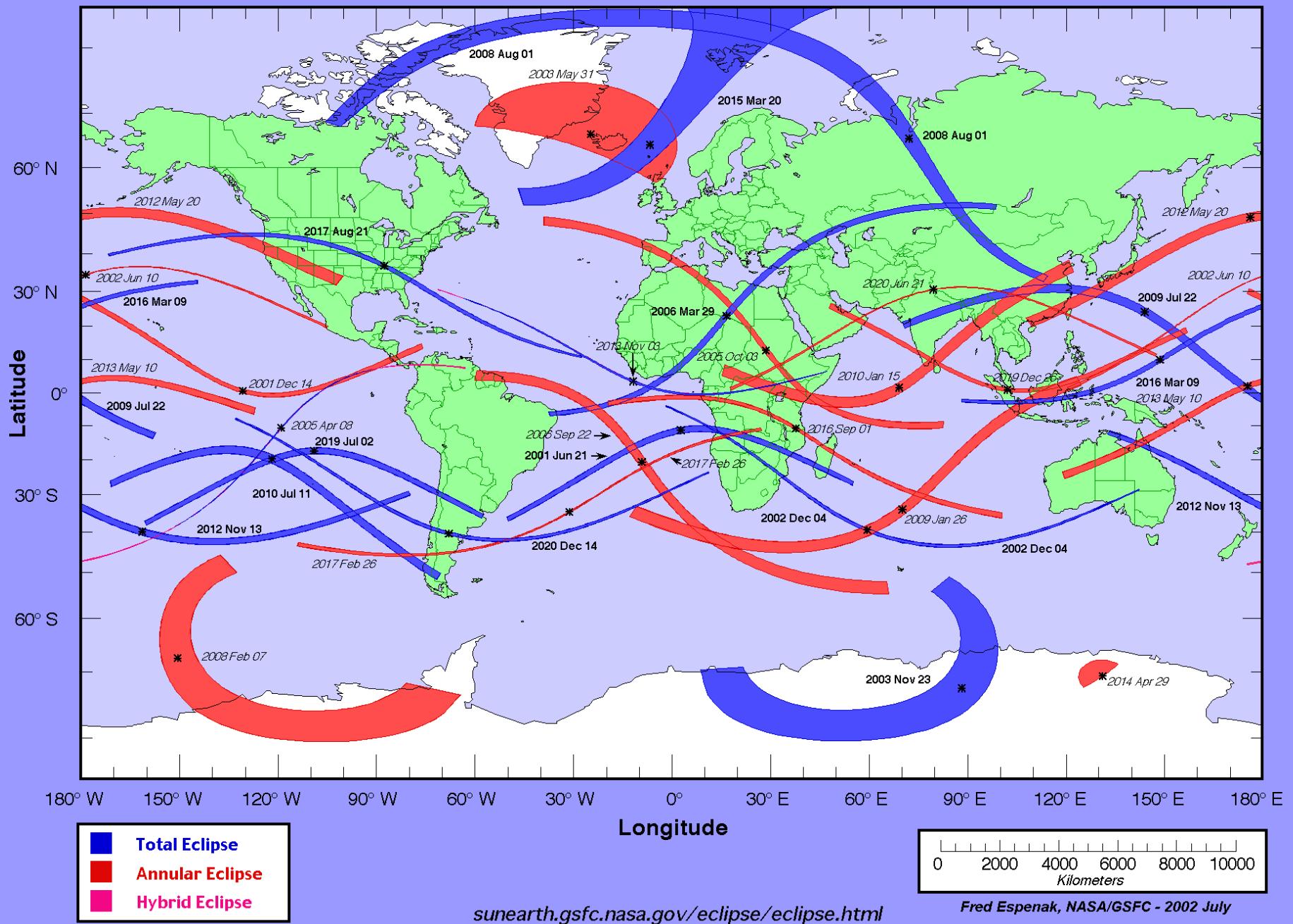


SOLAR ECLIPSES

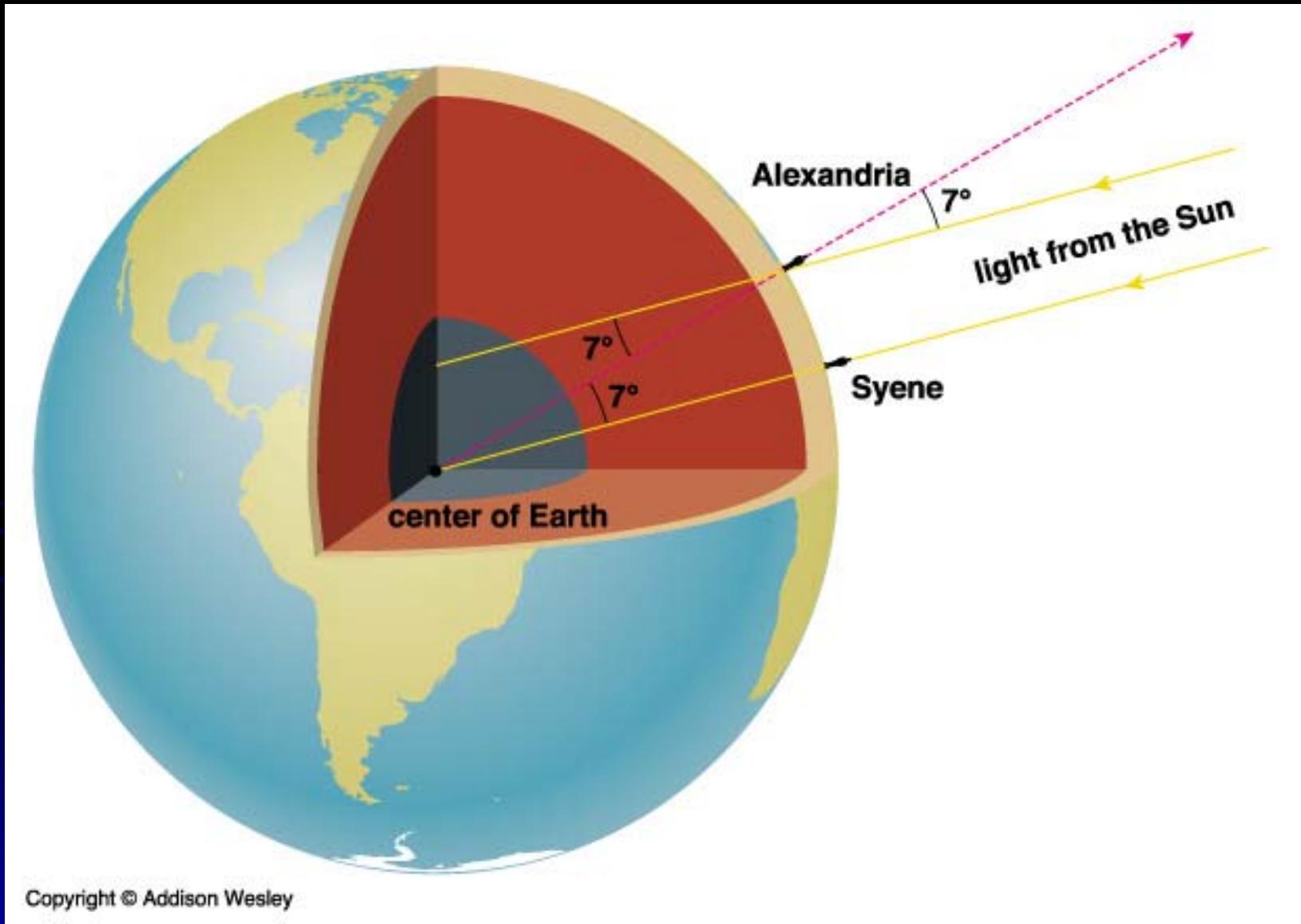
Why have so few seen one?



Total and Annular Solar Eclipse Paths: 2001 – 2020

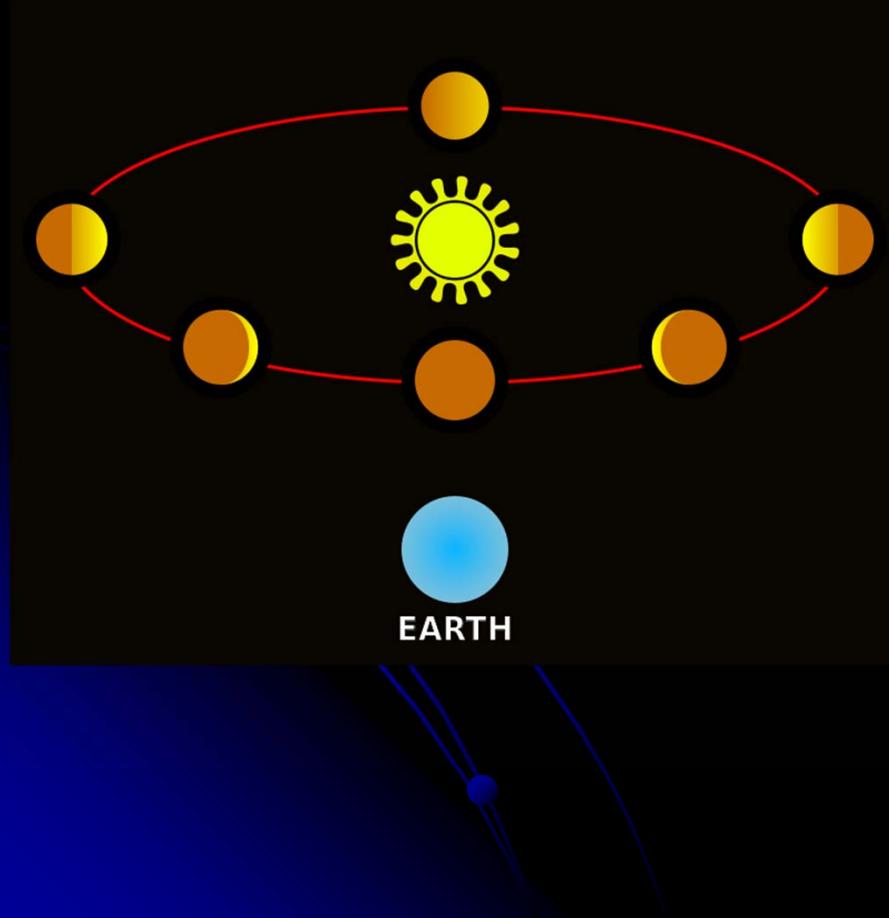


Erastosthenes (c. 276-196 BC) measures the size of the Earth



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Phases & Perspective



Venus has phases!

