Consider the Sun's motion with respect to the stars:
The Sun follows a path against the background stars, the ecliptic, taking 1 year to complete a cycle. This motion is from W to E relative to the stars.

Why is it warm in summer & cold in winter?
-Sun is closer in summer/farther in winter
-Longer days in summer/shorter in winter
-Sun is higher in summer/lower in winter

The angle of the Sun is the main factor: When the Sun passes high overhead, its energy is concentrated directly on the surface of the Earth. When it is low in the sky, its energy is spread over the Earth's surface The more direct heating with the "high Sun" produces the warmer temps.

The angle of the Sun, the amount of daylight, the ecliptic, the Sun's changing position over the course of a year, etc. are all caused by a 23° tilt in the Earth's rotation axis relative to our orbit.

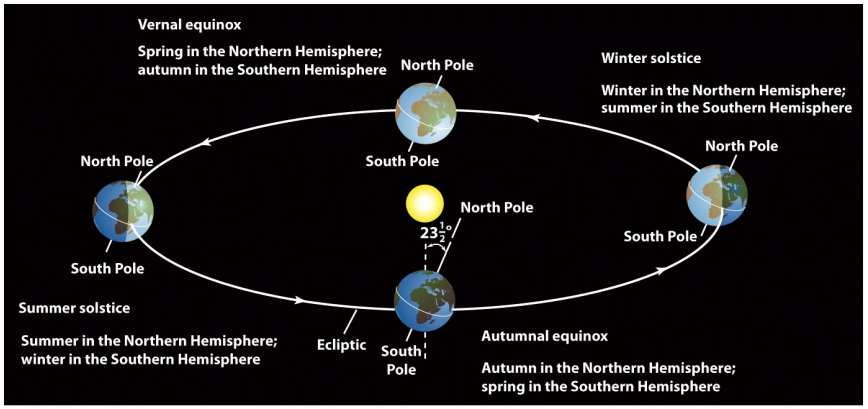
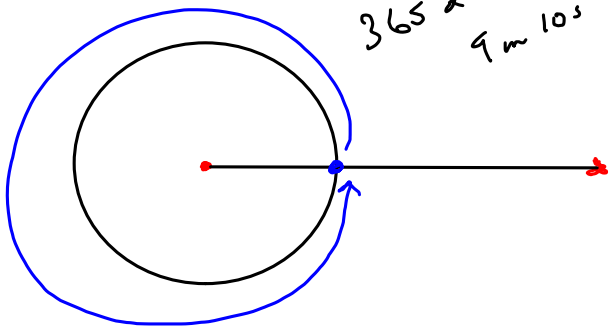


Figure 1-15
Discovering the Universe, Eighth Edition

Precession

The ecliptic gradually shifts over time, moving the positions o the equinoxes & solstices (relative to the stars). It also gives us two different "years:"

sidereal year - the time for the Sun to complete one cycle around our sky relative to the stars (or for Earth to orbit once relative to the the stars).



tropical year - the time for the Sun to cycle from 1 equinox (or solstice) back to that same equinox (or solstice).

365 d, 5h, 48m, 45s (20m 25s shorter)

We follow the tropical year.

The cause of this difference is precession - the Earth's rotation axis "wobbles" like a spinning top with a period of 25,771 years. This changes the location of the ecliptic and of the N & S celestial poles.

The Moon's Motion

Daily: rise in the E & set in W (like everything else).

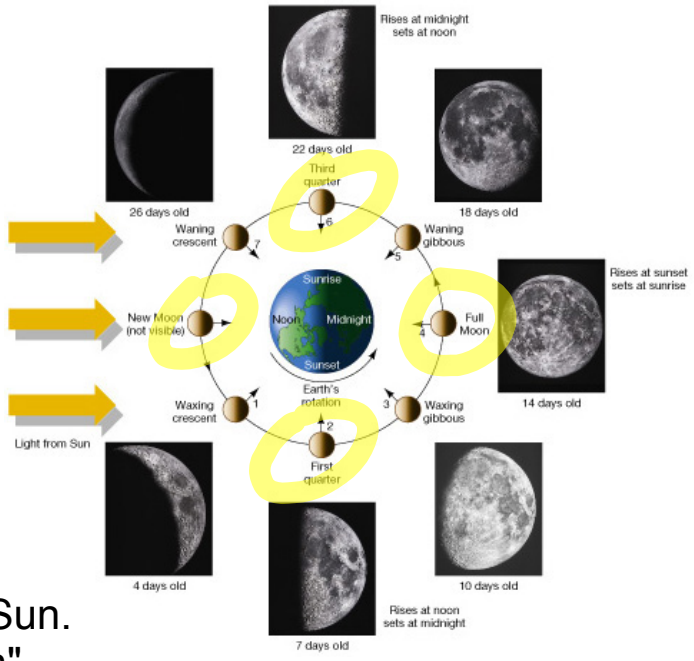
Longer-term:
Like the Sun, the Moon moves W to E against the background stars, moving about 1/2° per hour. It takes abou one month to complete a cycle ("moonth")

sidereal period - the time for the Moon to make one cycle around the sky measured relative to the stars. About 27.3 days

synodic period - the time for the Moon to make one cycle around the sky measured relative to the Sun. It's also the length of the cycle of phases of the Moon. About 29.5 days

The Moon's Phases:

new moon
When the Moon is in line with the Sun (as seen from Earth) (not visible)
-rise @ sunrise
-set @ sunset
-highest @ noon



1st quarter
When the Moon has moved 90° E of the Sun. We see a "half-moon" shape.
-rise @ noon
- highest @ sunset
- set @ midnight

full moon
When the Moon is opposite the Sun in our sky. We see all the illuminated half of the Moon.
-rise @ sunset -highest @ midnight -set @ sunrise

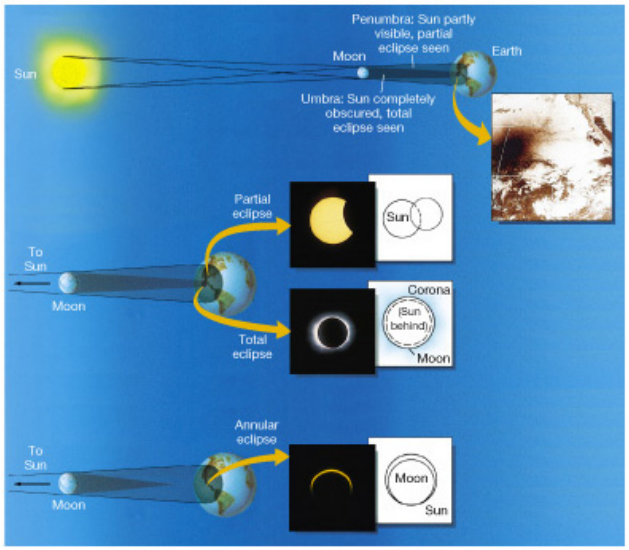
3rd quarter
When the Moon is 3/4 of the way around its orbit. We'll see a "half-moon" shape (but the other half from 1st quarter).
-rise @ midnight - highest @ sunrise -set @ noon

Eclipses

The Moon's path is not *exactly* lined up with the ecliptic; it's tilted about 5° to the ecliptic. If we happen to have new moon or full moon when the Moon is "crossing" the ecliptic, then the Sun, Earth & Moon are *directly* in line with each other. Then we will have an eclipse.

Solar Eclipse

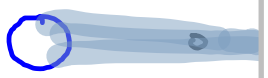
When the Moon passes directly between the Sun & Earth and its shadow falls on Earth.



Happens @ new moon

Lunar Eclipse

Occurs when the Moon is directly opposite the Sun (at full moon)



Planetary Motion

"direct"

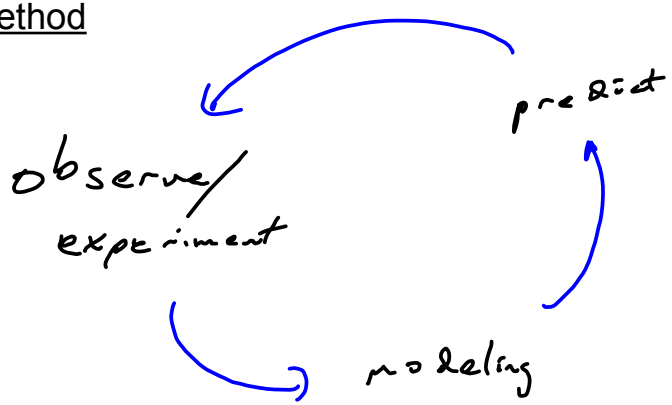
5 planets are visible to the naked eye: Mercury, Venus, Mar Jupiter & Saturn. Over long periods of time, they (and Neptune & Uranus) move W to E relative to the background stars, like the Sun & Moon. But, unlike the Sun & Moon, the all move E to W against the stars for a period of time. We call this "backwards" movement retrograde motion.

For Mars, Jupiter & Saturn, retrograde motion happens around the time of opposition, when the planet is opposite the Sun in our sky. Mercury & Venus are never very far fron the Sun in our sky; retrograde motion for them occurs as they move from the evening sky (E of the Sun) to the morning sky (W of the Sun).
Planets also appear brightest around the time of their retrograde motion.

"Science"

We want to develop a scientific explanation for these motions
What is "science?" It's an approach to gaining understandin
that's based on the *scientific method*.

Scientific Method



observe - we see something happen in nature. If we create a circumstance to observe: experiment.

model - develop an explanation of how/why for the observation or experiment.

-use geometry, math, "cause & effect"

-Models must be testable - they must make predictions that can be checked by observation or experiment.

(This idea being testable also means that observations/experiments can be *repeated* by other observers.)

-Models may be disproved by making wrong predictions and not standing up under testing.

-Models *cannot be proved* - only verified; the goal is not "right vs. wrong," but "accurate vs. inaccurate."