Chapter Outlines

NOTE: This is intended to help students 'organize' their understanding of each topic. It is <u>not</u> a comprehensive study guide for quizzes or midterms, i.e. <u>study your text!</u>

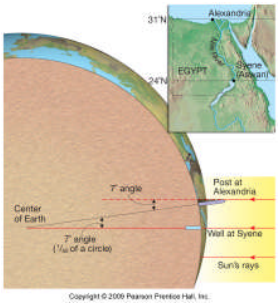
Stonehenge

Origins of Modern Astronomy

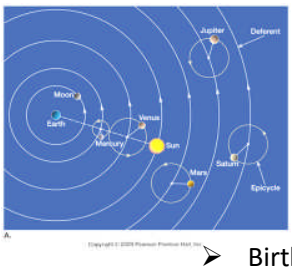
- Ancient Astronomy
  - Pre-history humans were attentive observers of the stars
  - Seasonal locations of the Sun and stars could be used to plan hunting or seeding
  - Ancient structures such as Stonehenge in England were likely used as huge calendars *(among other possible uses)* for this purpose

Hipparchus

- Greek astronomy
  - The Greeks used philosophical arguments along with observational data to explain natural phenomena
  - General views:
    - Stars were spots of light attached to a transparent, hollow sphere
    - This celestial sphere turns daily around Earth
    - There were 7 bodies that 'wandered' across the sky. These included the Sun, Moon, and 5 planets
  - Anaxagoras, 450± BC,
    - Establish that the moon shines due to light reflected from the sun, and…
    - The Moon is a sphere

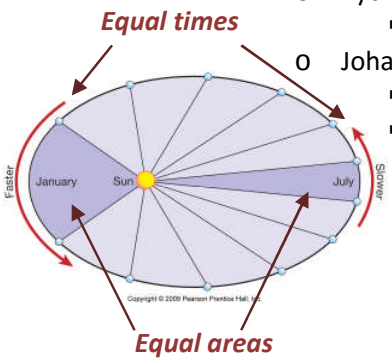


  - Aristotle, 340± BC,
    - Concluded Earth is spherical by viewing the curved shadow it cast on the moon
  - Aristarchus, 250± BC
    - First to profess a Sun-centered *(heliocentric)* universe. He made calculations of distances to the moon and Sun *(there were some mistakes in his calculations)*
  - Eratosthenes, 200± BC
    - Established the size of Earth using angles of the sun's rays in deep water wells at different latitudes



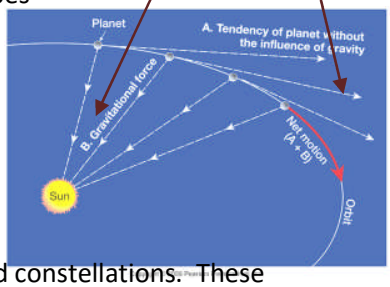
  - Hipparchus, 150± BC
    - Greatest Greek astronomer, is known for his star catalogue of nearly 850 stars
  - Ptolemy, 90-168± AD
    - Credited with the Ptolemaic system of A.D. 141, in which Earth was the center. He explained the retrograde motion of planets by including epicycles *(small circles)* in their orbits.

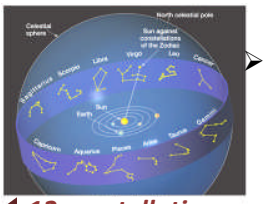
- Birth of Modern Astronomy in the 1500's and 1600's
  - Nicolaus Copernicus, 1473-1543
    - Constructed a Sun centered solar system, but with circular rather than elliptical orbits *(Venus' phases was a clue)*
  - Tycho Brahe, 1546-1601
    - Recorded very precise measurements that were useful to others
  - Johannes Kepler, 1571-1630
    - Discovered the elliptical orbits of the planets
    - Presented the 3 laws of planetary motion
      - Planets travel in an ellipse with the Sun as one focus
      - Equal areas are 'swept' by planets during equal periods of time
      - Orbital periods *(one revolution around Sun)* are proportional to the distance from the Sun. p^2 *(in years)*= d^3 *(in AU's)*



- Galileo Galilei, 1564-1642
  - Made many important discoveries using improved telescopes
- Sir Isaac Newton, 1642-1727
  - Formulated and tested the law of universal gravitation
  - Developed the laws of motion
  - Explained elliptical orbits

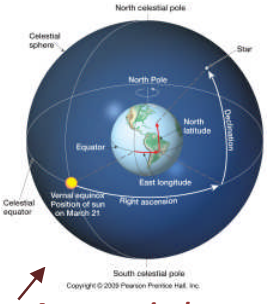
Orbits are the balance of gravity & inertia





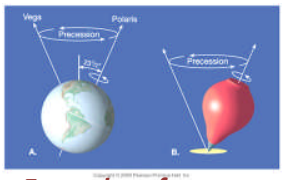
12 constellations of the zodiac

- Basics of charting the sky
  - Constellations
    - The sky is loosely divided into approximately 88 units called constellations. These were mostly named by humans long ago. These are recognized by patterns of stars that often represent mythical characters
    - The brightest stars in a constellation are identified in order of their brightness by the letters of the Greek alphabet—alpha, beta, and so on
  - 'Location' system for locating stars is called the equatorial system
    - Stars appear to be fixed on an imaginary spherical shell *(the celestial sphere)* that surrounds Earth, and are mapped using a 'latitude-longitude' system similar to that used on Earth's surface
    - Angle up from Earth's equator (celestial equator) is 'declination'
    - Right ascension—the angular distance measured eastward along the celestial equator from the position of the vernal equinox
    - Plane of the ecliptic is defined by Earth's orbit, it is essentially the same plane on which all the planets revolve



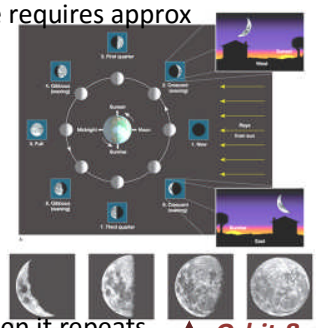
Astronomical coordinate system

Motions of Earth
- Rotation – The revolution about its axis every 24 hours. Non-astronomers use the 24 hour 'solar day', while astronomers us the 23 hour, 56 minute, 4 second 'sidereal day'
- Revolution – Earth's path around the Sun every year (365.25 days)
- Precession – the very slow "wobble" of Earth's axis. One complete wobble requires approx 26,000 years.

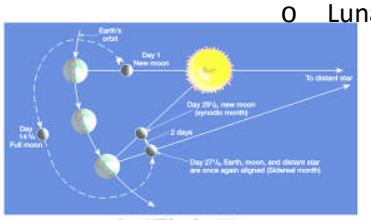


Examples of 'precession'

- Motions of the Earth-Moon System
  - Phases of the Moon – when viewed from above the North Pole, the Moon revolves about Earth counterclockwise. Phases are a result of seeing only a portion of the lit surface from Earth
  - Lunar motions
    - Synodic month…relative positions of the Sun, Earth, and Moon. It progresses from New Moon, first, second, and third quarters, then it repeats every 29 ½ days. Moon has a 'sidereal month' that is only 27 1/3 days.
    - Sidereal month – True period of the Moon's revolution around Earth, takes 27 1/3 days
    - Moon's rotational period is the same as its orbital period. This causes the same side of the Moon to always be facing Earth



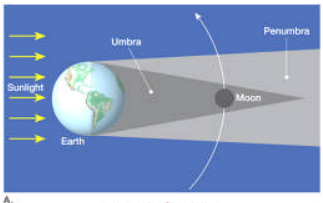
Orbit & phases of the moon



Synodic & Sidereal months

- Eclipses
  - The Moon's orbit is inclined about 5° to the plane of the ecliptic, so lunar or solar eclipses can only occur when the Moon crosses the plane of the ecliptic *(when the Sun, Earth, and Moon are on the same plane)*
  - Solar eclipse – viewable only at limited areas on Earth
    - Moon moves in a line directly between Earth and the Sun, this can occur only during the new-Moon phase
  - Lunar eclipse – viewable at any location on Earth
    - Moon moves within the shadow of Earth, occurs only during the full-Moon phase

Solar eclipse



Lunar eclipse