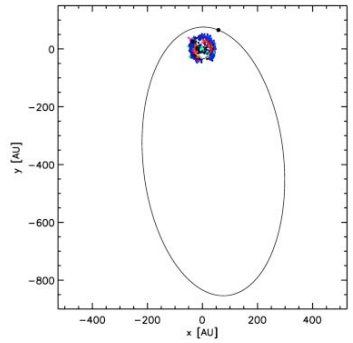
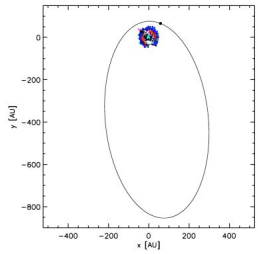
Orbits…the celestial paths of planets



But first, things for you to read on your own

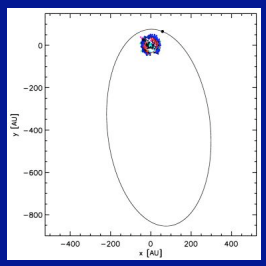
- Difference between *mean solar time* and *apparent solar time*
- Time zones (central standard time, mountain standard time, etc).
- Be sure and read material on eclipses, fill out presentation in class

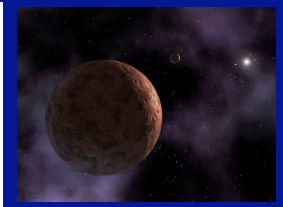
The science of orbits…what are the properties of the paths followed by the planets around the Sun?



What is shown in this egg-shaped figure?

The science of orbits…what are the properties of the paths followed by the planets around the Sun?





What is shown in this egg-shaped figure?

Galileo Galilei

Laws of orbits which are still used today were stated by Johannes Kepler in about 1600

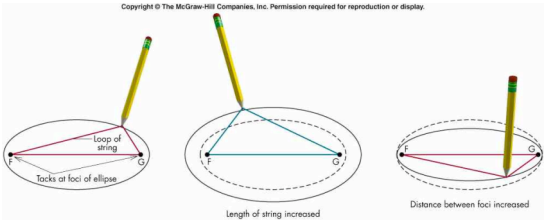
Kepler was a contemporary of Galileo

Properties of orbits were expressed in terms of Kepler's Laws of Planetary motion (3 of 'em)

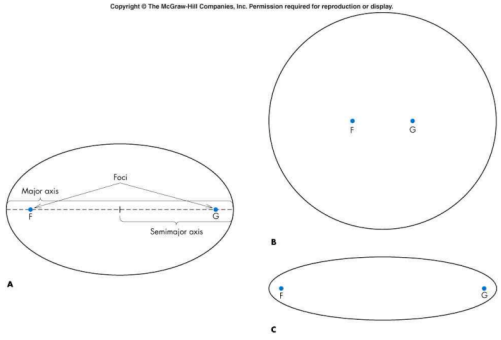
Kepler's 1st Law: orbits are ellipses with the Sun at one focus

Remember your high school math: ellipses are plane figures….agrees with observed fact that orbits lie in a plane

definition (one of) of an ellipse



Kepler's 1st Law of Planetary Motion

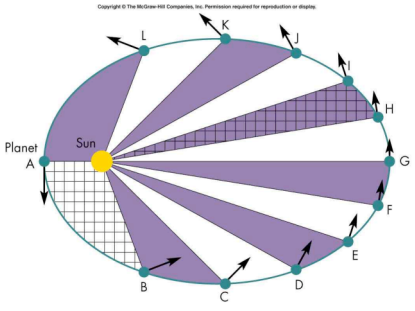


Definitions of particular importance

- Major axis (like the diameter of a circle)
- Semimajor axis (like the radius of a circle)
- Eccentricity (how elliptical or non-circular the ellipse is). Eccentricity can vary from 0 to 0.9999999…..

Kepler's 2nd Law: a line from the Sun to a planet sweeps out equal areas in equal time intervals

Kepler's 2nd Law of Planetary Motion (the equal area law)



Kepler's 3rd Law: the harmonic law. The semimajor axis of an orbit, and the orbital period are not independent. They are related by a simple equation.

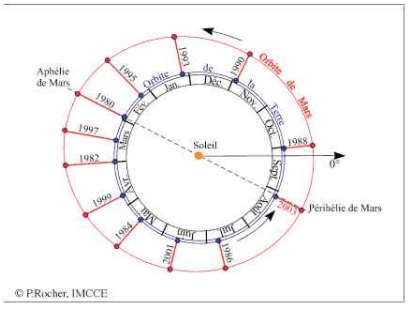
$A^3=P^2$

Planetary data (I love tables with data)

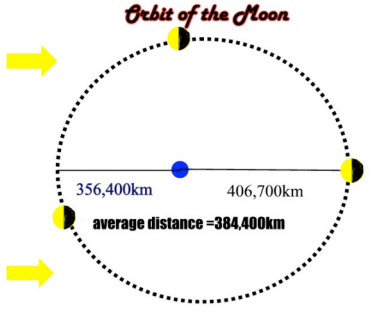
Orbital Data for the Planets

Planet	Semimajor Axis (AU)	Orbital Period (yr)	Orbital Speed (km/s)	Orbital Eccentricity (e)	Inclination of Orbit to Ecliptic (°)	Rotation Period (days)	Inclination of Equator to Orbit (°)
Mercury	0.3871	0.2408	47.9	0.206	7.00	58.65	0
Venus	0.7233	0.6152	35.0	0.007	3.39	-243.01*	177.3
Earth	1.000	1	29.8	0.017	0.00	0.997	23.4
Mars	1.5273	1.8809	24.1	0.093	1.85	1.026	25.2
Jupiter	5.2028	11.862	13.1	0.048	1.31	0.410	3.1
Saturn	9.5388	29.458	9.6	0.056	2.49	0.426	26.7
Uranus	19.1914	84.01	6.8	0.046	0.77	-0.746*	97.9
Neptune	30.0611	164.79	5.4	0.010	1.77	0.718	29.6
Pluto	39.5294	248.54	4.7	0.248	17.15	-6.387*	122.5

Applications of Kepler's Laws: variations in the opposition of Mars

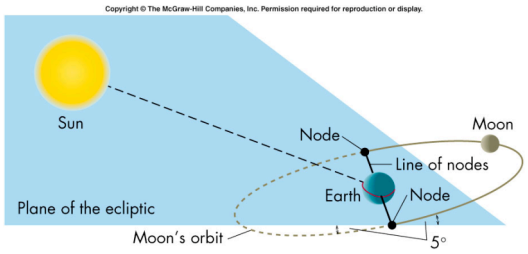


Another application of Kepler's 1st Law: the orbit of the Earth's Moon.

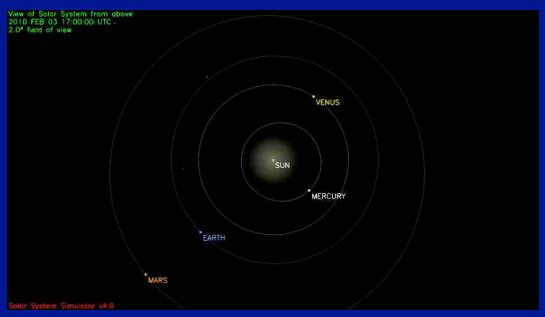


Explains difference between total and annular solar eclipses

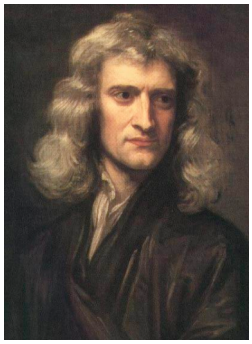
Another important fact in eclipses: Moon's orbit inclined by 5 degrees with respect to ecliptic



Gravity and Orbits…how and why the planets move the way they do

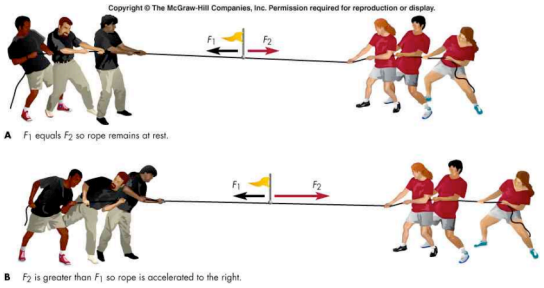


Isaac Newton…beginning of modern physics

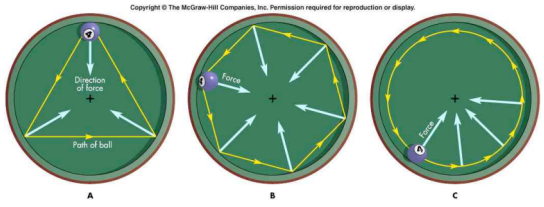


Newton's laws of motions: the foundation of physics and the start for our understanding of orbits

The net force is what moves things



Centripetal acceleration and central force



The gravitational force from spherical object