Astronomy

- If you wish to make an apple pie from scratch, you must first create the Universe. -Carl Sagan

Astronomy

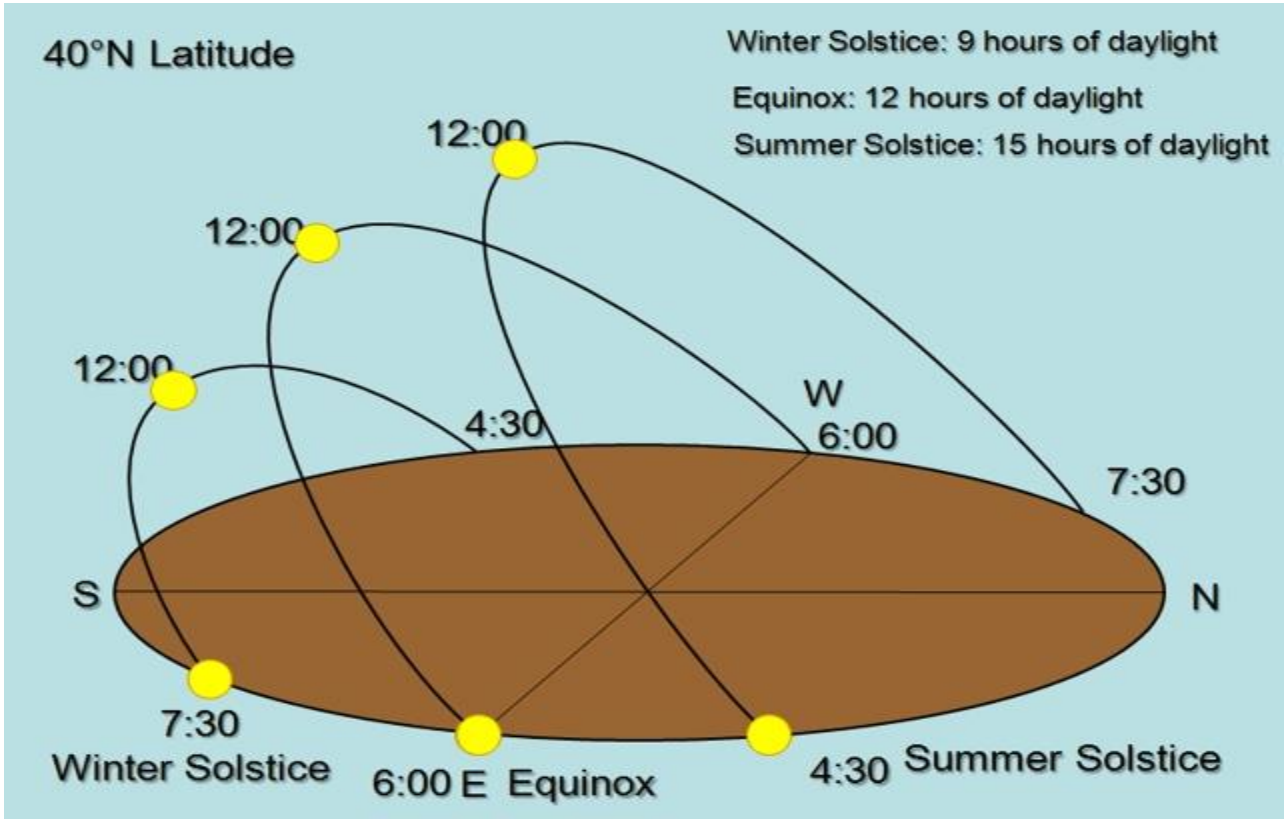
- How to get to Mars
- Astronomy is the study of the Universe and all the objects in space. This includes planets, moons, comets, asteroids, stars and galaxies.
- What are the reasons for day and night?
- The Earth's rotation. How do we know the Earth rotates?
- Foucault's Pendulum
- Coriolis Effect

Rotation

- Sunrise and Sunset
- Daylight Hours- The total hours and minutes between sunrise and sunset.
- Solar Noon- The time of day when the Sun reaches it's zenith (high point). It occurs halfway between sunrise and sunset.

Seasonal changes in Solar Noon

- Why does this happen?



Rotation and Revolution

- Suppose you are sitting on the Sun looking at the Earth. Describe what the Earth is doing…
- Earth's Rotation- The earth spins once (360 degrees) on it's axis every 24 hours.
- Earth's Revolution- The Earth travels once around the Sun (360 degrees) every 365 days. 1 year=1 orbit.

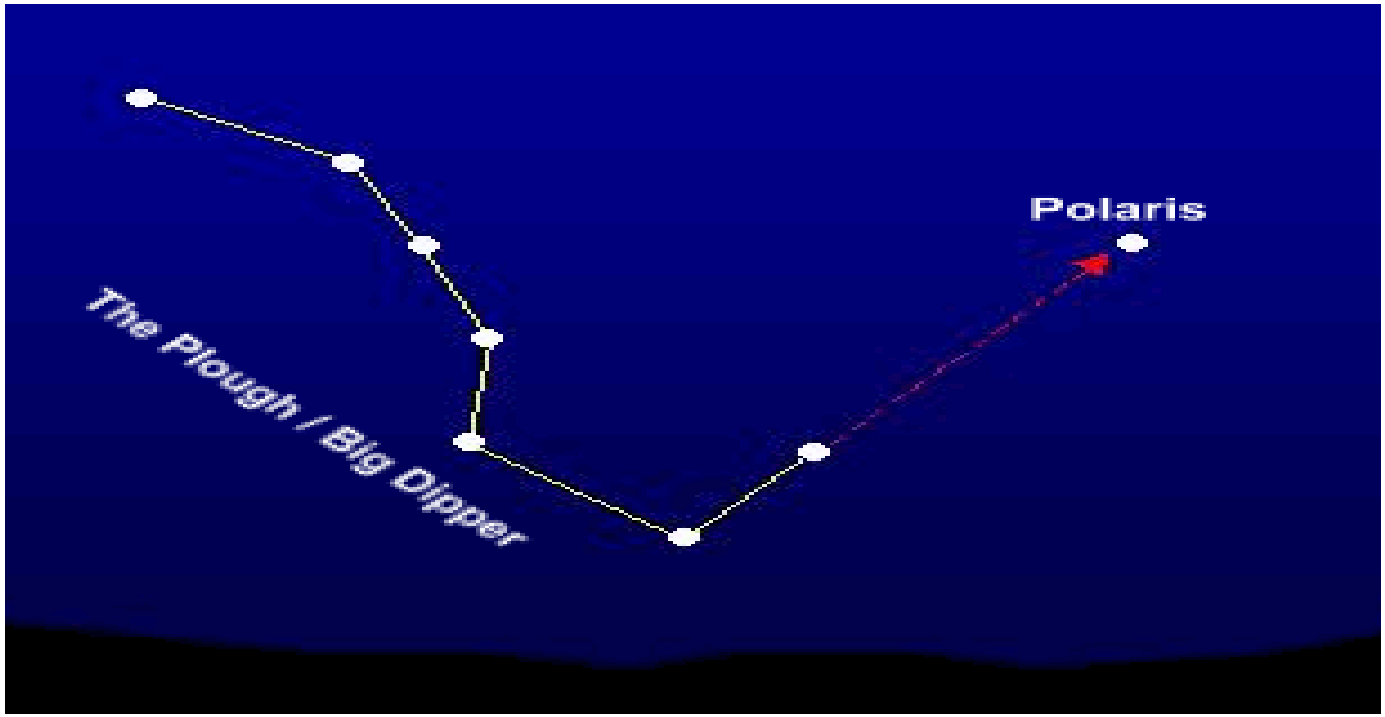
Rotation and Revolution

- Knowing that the Earth rotates on it's axis as it revolves around the Sun, what would explain our change of seasons?
- The Earth's Axis of Rotation- The Earth has a 23.5 degree tilt in it's axis of rotation. This tilt is responsible for seasonality on Earth.
- What ride at the Chatham Fair best represents the Earth's motions?

Which Direction are we looking?

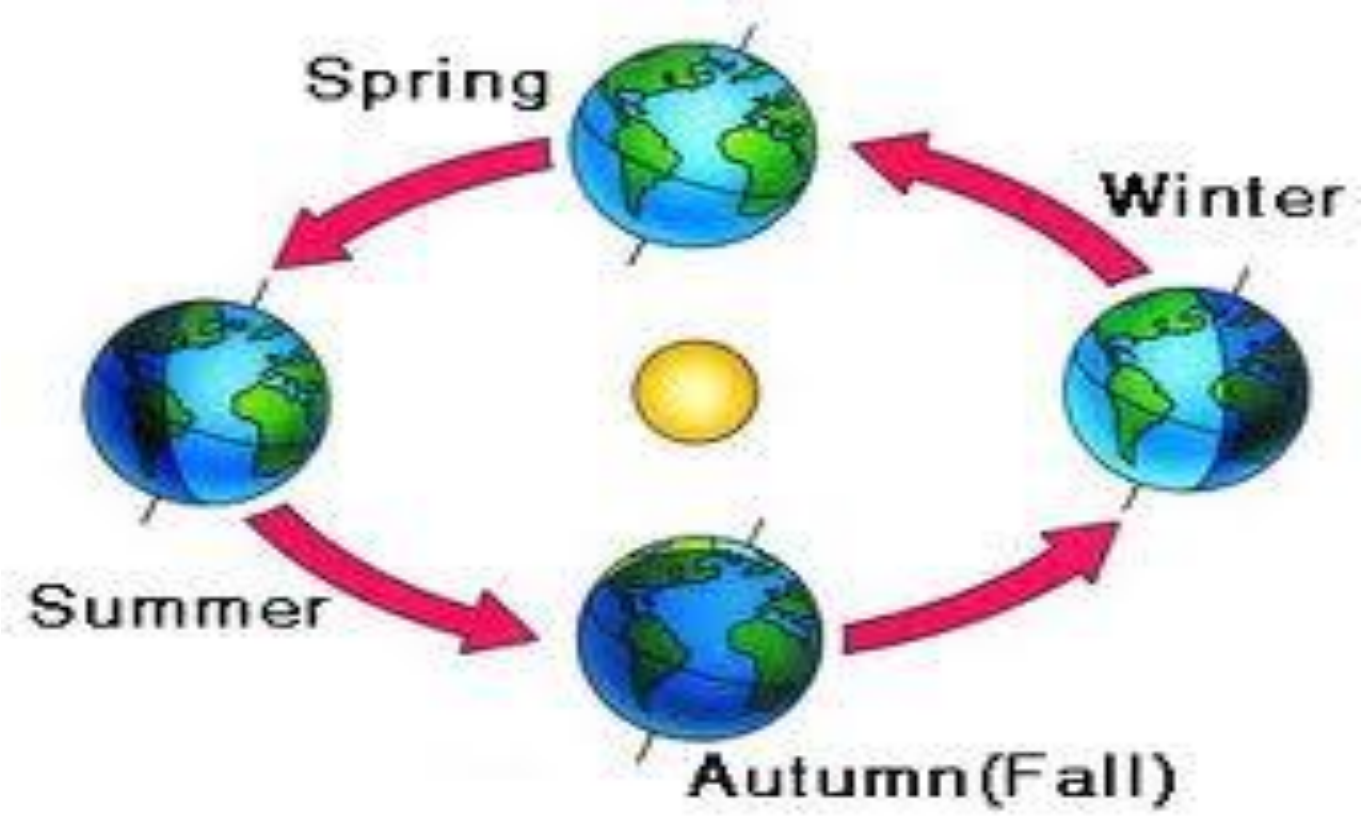
Polaris & the pointer stars

- The two outer stars of the Big Dipper point to Polaris.



Reasons for Seasons

http://www.youtube.com/watch?v=buqtdpuZxvk

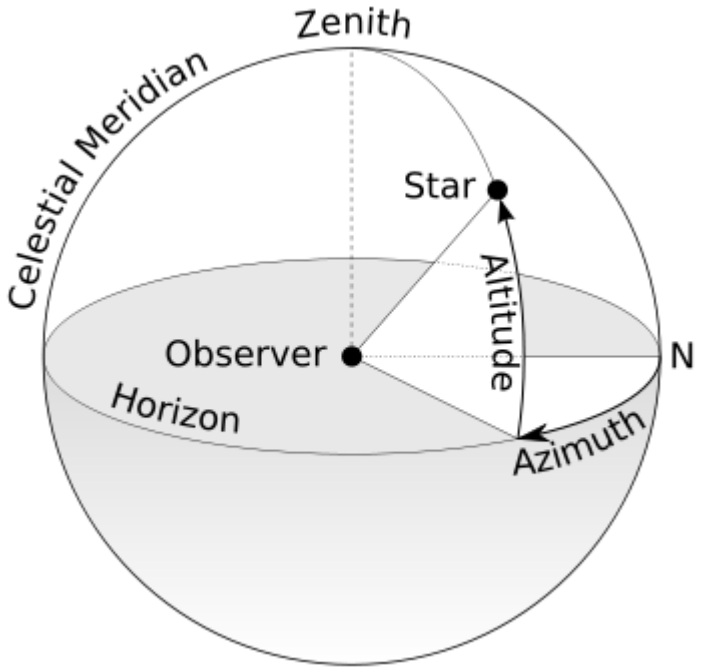


Locating position on the Earth

- Polaris, the North Star– Polaris sits directly over the North Pole, the center of our axis of rotation.
- What would explain why all the other stars rotate around Polaris at 15 degrees per hour?
- We have never been to the Sun so how do we know that these really are the Earth's motions? What proof have we?

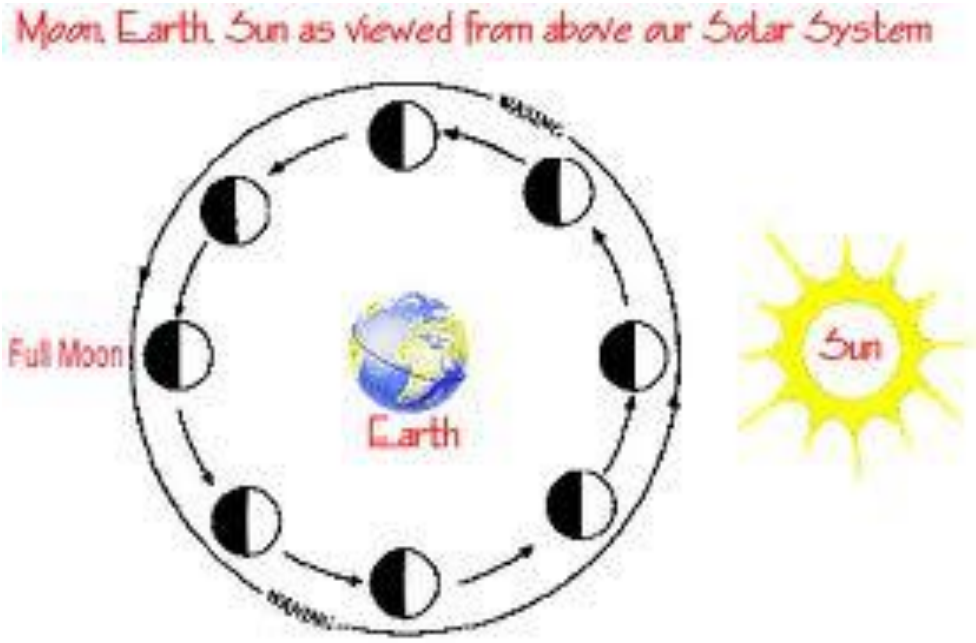
Celestial Navigation

- We use Azimuth- compass directions
- Altitude- angular distance above the horizon.



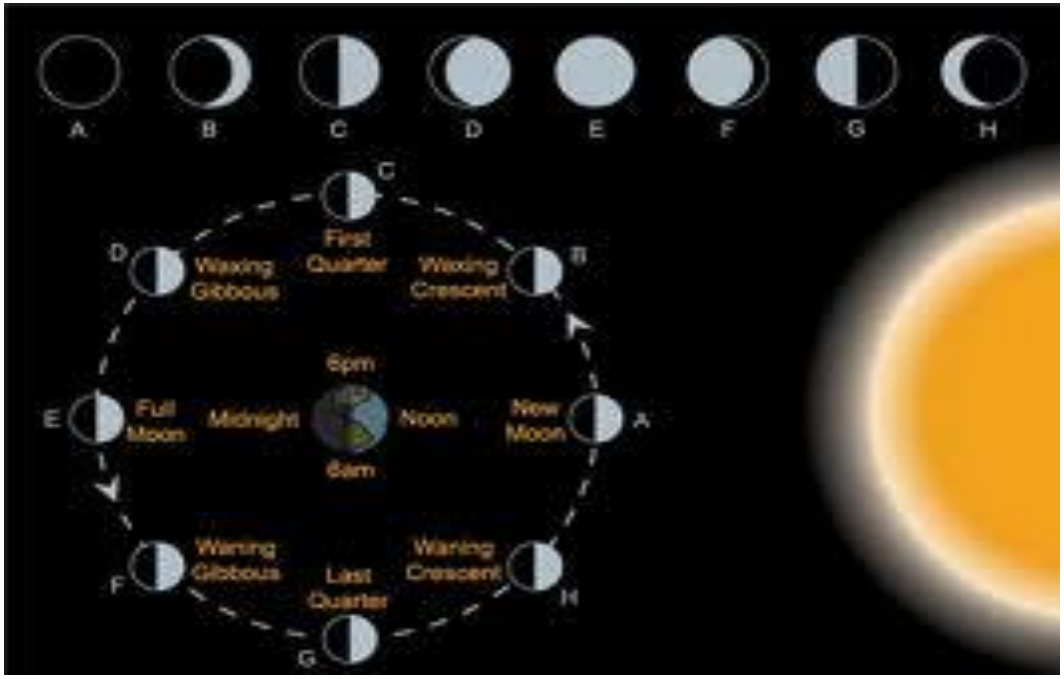
Earth – Moon Relations

- Not to scale



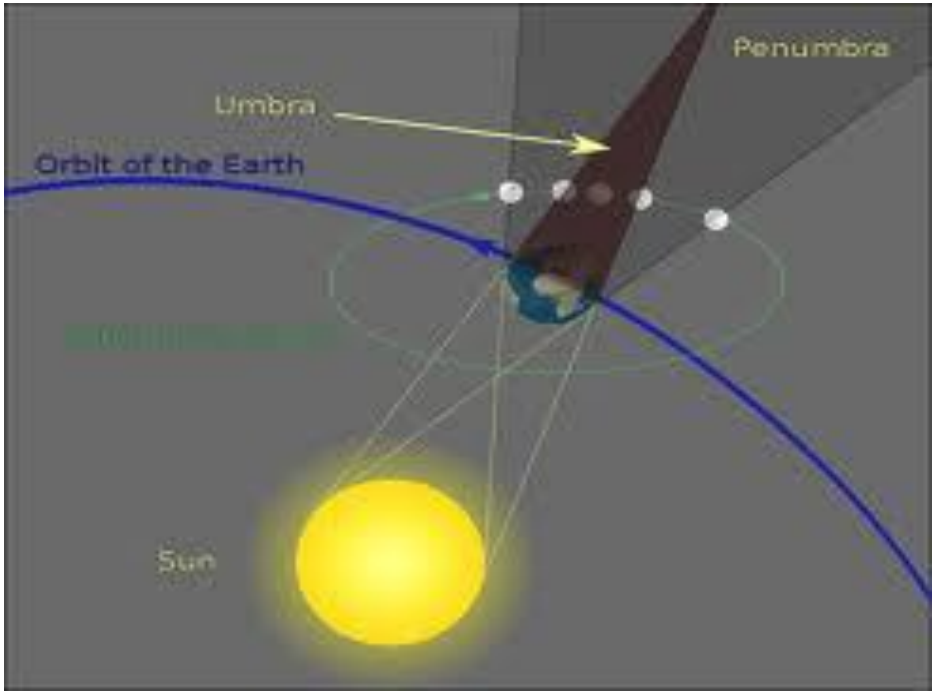
Lunar Cycle

- It takes 27.3 days for the Moon to orbit the Earth. Yet it takes 29.5 days for a complete lunar cycle, full moon to full moon



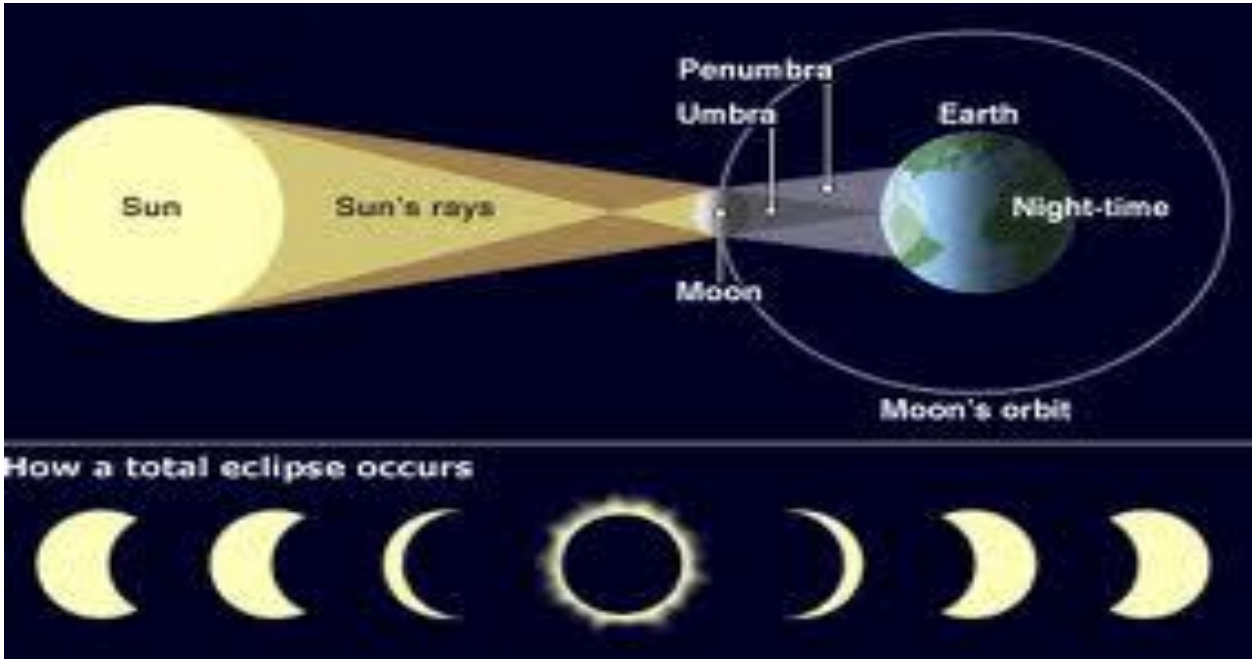
Lunar and Solar Eclipse

- Lunar Eclipse- When Sun, Earth and Moon align so the shadow of the Earth falls on the moon.



Solar Eclipse

- Solar Eclipse- When the Sun, Moon and Earth align so the shadow of the Moon falls on the Earth.



Solar and Lunar Eclipse

- Using the foam ball and the lamps, simulate a lunar eclipse.
- Now simulate a solar eclipse.

Planets

- How do planets differ from stars? Is it their size, temperatures or motions?
- Hint- the word planet is Greek for “wanderer”
- A planet is a naturally occurring satellite made of rock, ice or gas that orbits a star.

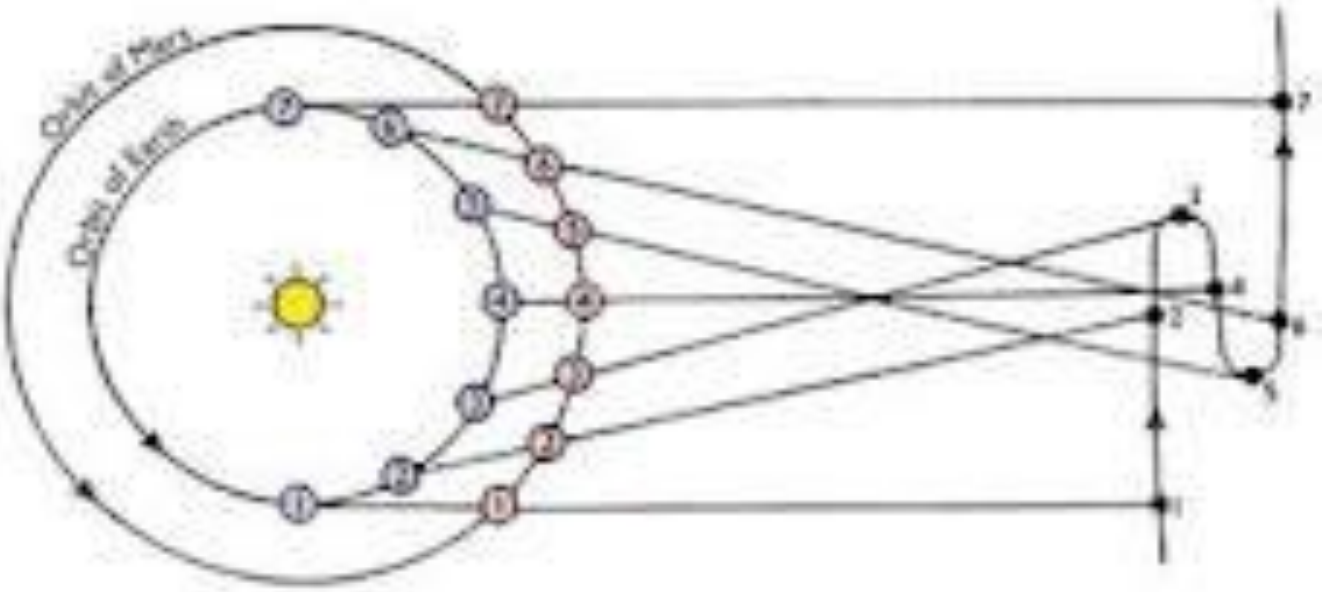
Retrograde Motion

- The apparent zig-zag motion of a planet as it orbits the Sun.
- The path of a planet over several months zigs and zags.

Retrograde Motion Cont

http://www.youtube.com/watch?v=72FrZz_zJFU

- Retrograde motion really is what we see, but it is not what is happening. What could possibly cause that?



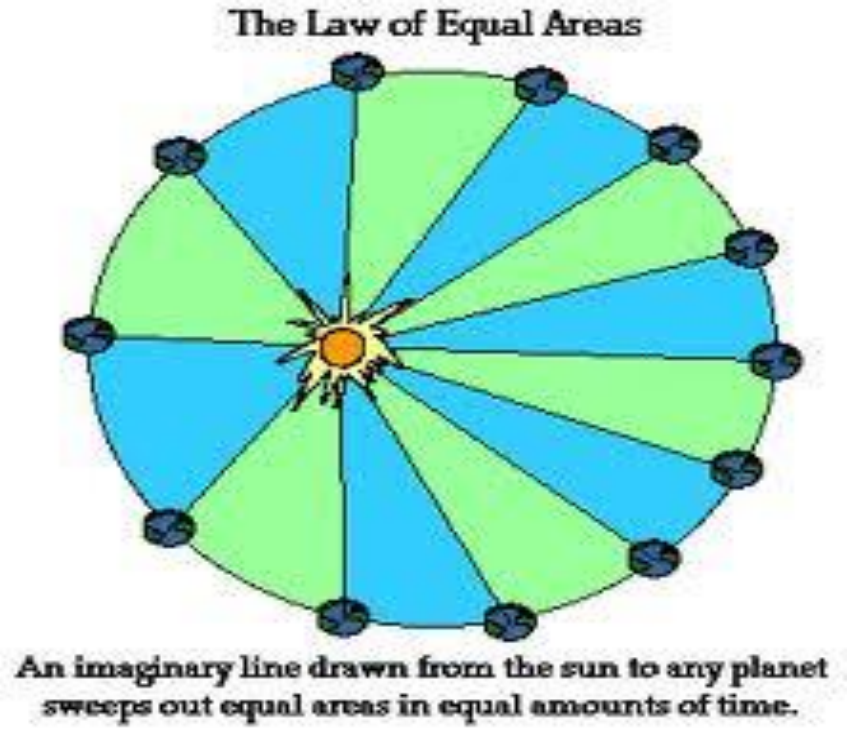
The Original Odd Couple

- Tycho Brahe VS. Johannes Kepler

Kepler's 3 Laws

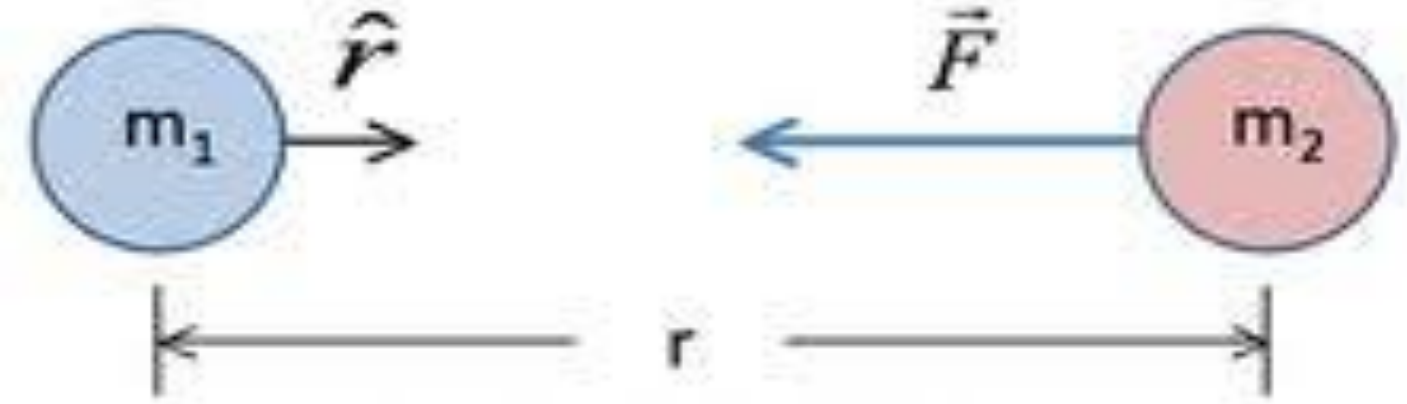
http://www.youtube.com/watch?v=lm9Ej-YMXto

- The path of the planets around the Sun is an Ellipse.
- Planets cover equal areas in equal times
- Planets move faster closer to the Sun



Along Came Isaac Newton

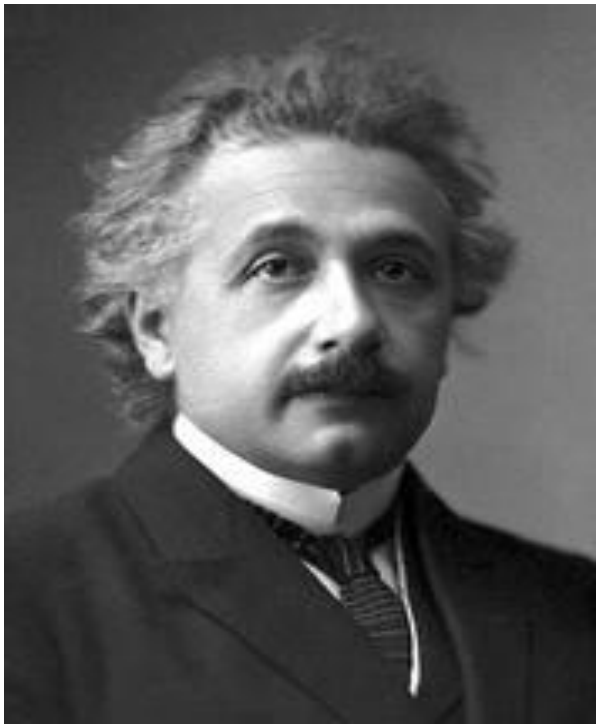
Universal Law of Gravity



$$F = G\frac{m_1 m_2}{d^2}$$

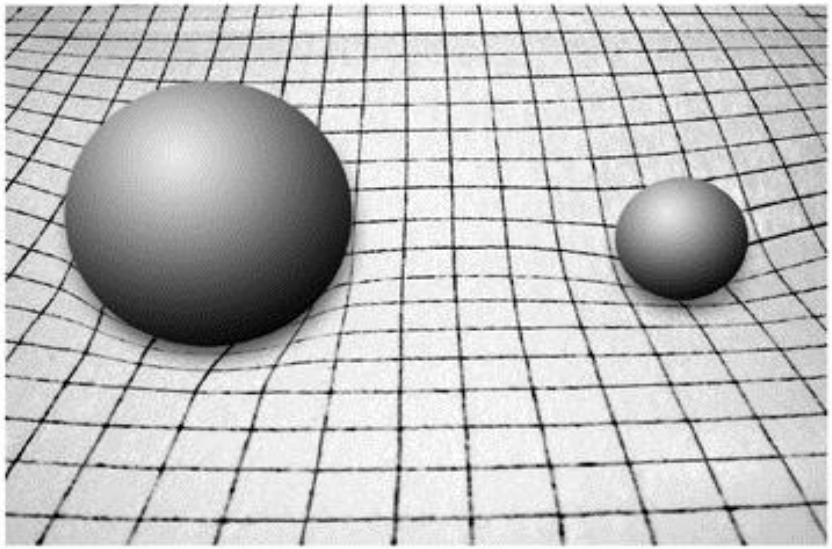
Albert Einstein and Gravity

- Einstein solved the problem Newton came across. How does gravity work?



Gravity as explained by Einstein

- Imagine space is the surface of a trampoline and a star is a big bowling ball at the center.



Gravity and space time

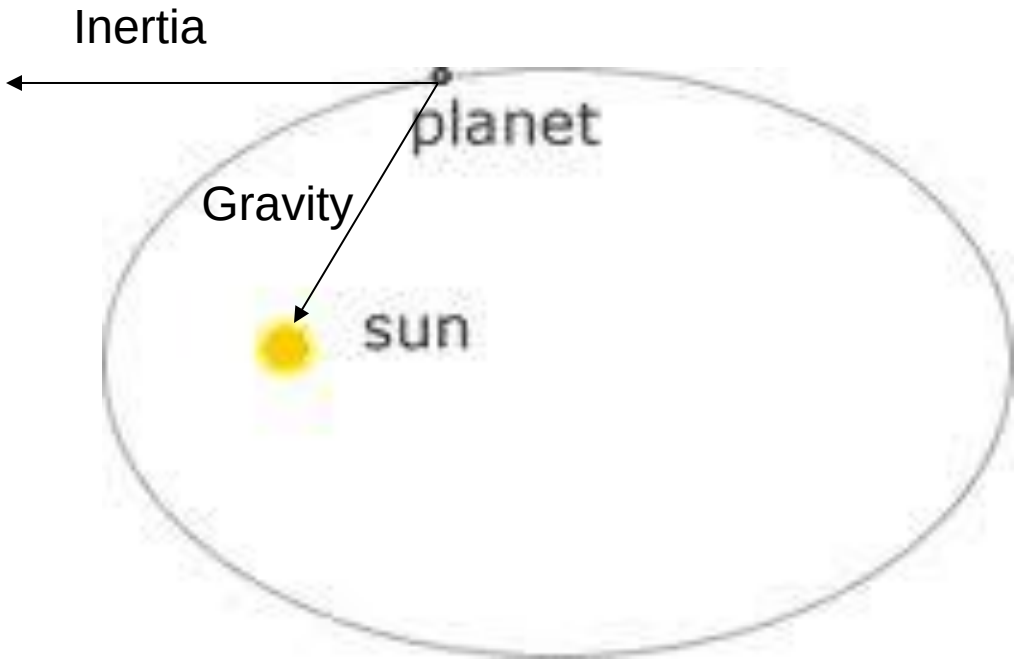
- http://www.youtube.com/watch?v=AAqSCuHA0j8
- How did Einstein's theory of general relativity change our understanding of gravity?
- Is gravity like a magnet pulling on things?
- Or is gravity just the shape of space near heavy objects?

Orbital Velocities

Planet	Orbital Circumference	Period of Revolution (hrs)	Orbital Velocity (KM/ HR)
Mercury	360,000,000 km	2112 hrs	172550 km/hr
Venus	690,000,000 km	5400 hrs	127777 km/hr
Earth	940,000,000 km	8766 hrs	107232 km/hr
Mars	1,400,000,000 km	16448 hrs	87116 km/hr
Jupiter			
Saturn			
Uranus			
Neptune			

Ellipses and Gravity

- Gravity pulls planet towards Sun
- Inertia wants to carry planet in straight line away from Sun



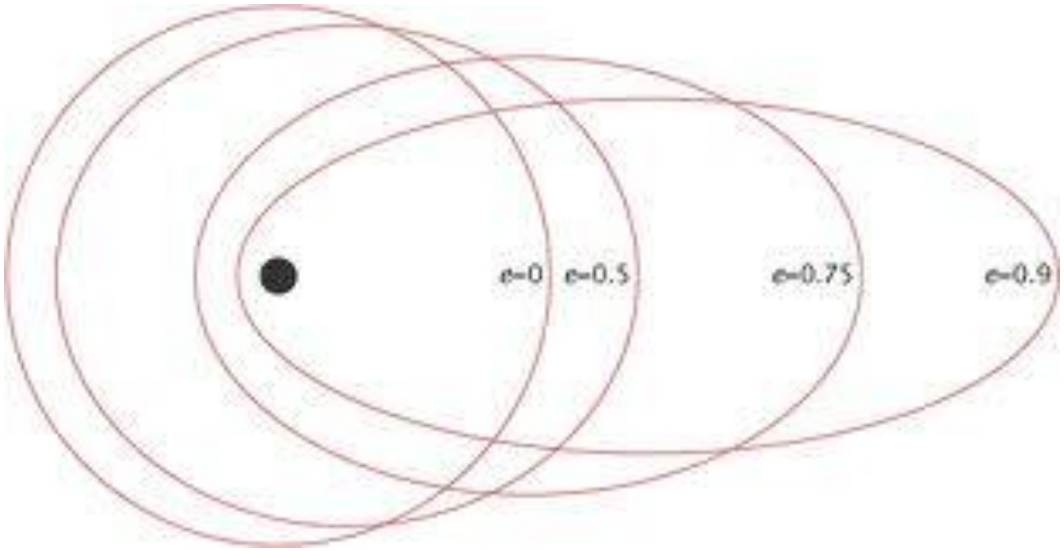
Eccentricity of an ellipse

- Eccentricity= <u>Distance between foci</u>
  Length of major axis
-

An elliptical orbit of a planet
(greatly exaggerated)

Eccentricity Cont.

- The eccentricity of a perfect circle = 0
- The eccentricity of a flat line= 1

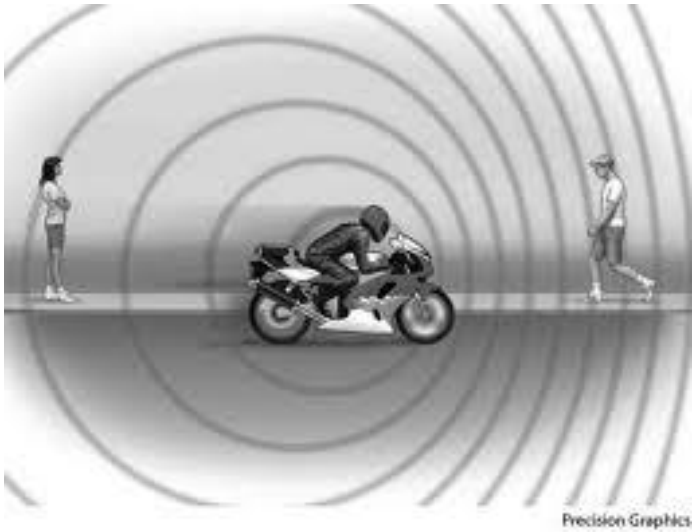


Stars

- Large balls of Hydrogen that burn to produce light, heat and more complex elements.
- Our Sun is the closest star to us. The distance between the Sun and Earth is 150,000,000 km.

Expansion of the Universe

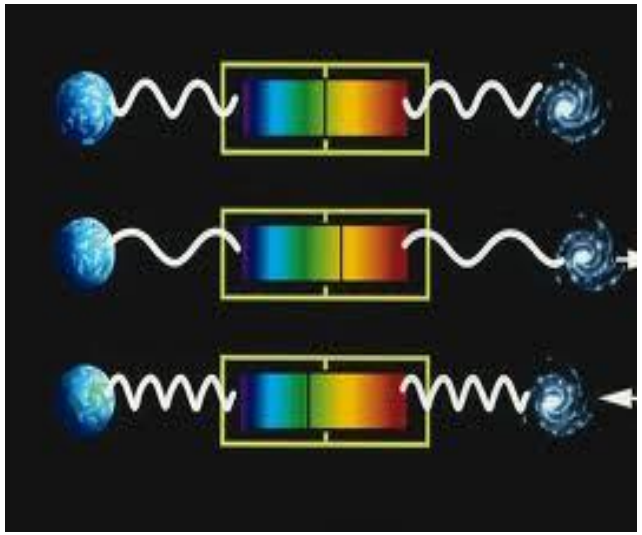
- Doppler Effect- The change in light or sound wavelengths resulting from the source moving towards or away from the observer.

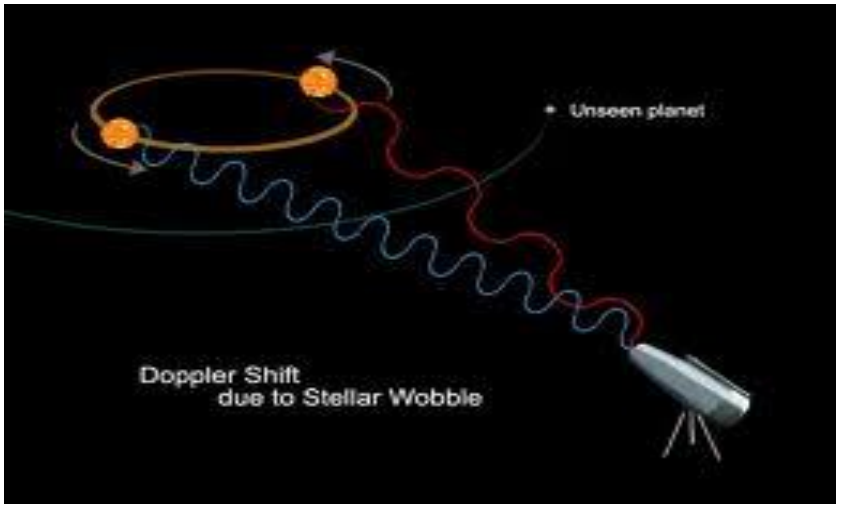


Red Shift/ Blue Shift

http://www.youtube.com/watch?v=LIvVzJ6KZpk

- Red Shift- The change in light wavelength/ color as an object moves away from you.
- Blue Shift- The change in light wavelength/ color as an object moves toward you.

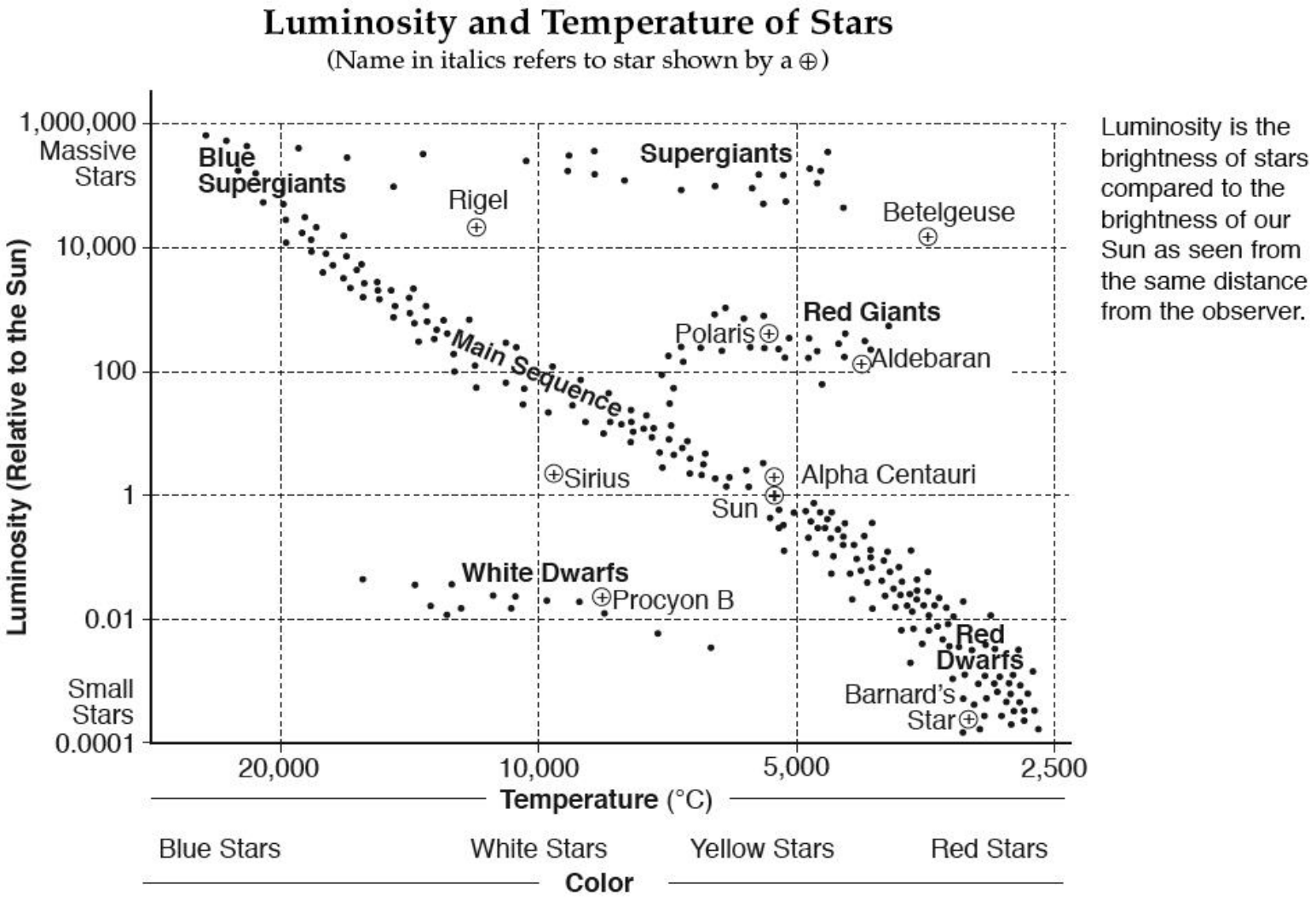




What does Red Shift mean?

- It means that everything in the universe is expanding, moving away from our galaxy. And the rate of expansion is increasing!
- In theory the universe could expand faster than the speed of light.
- It’s a big deal.

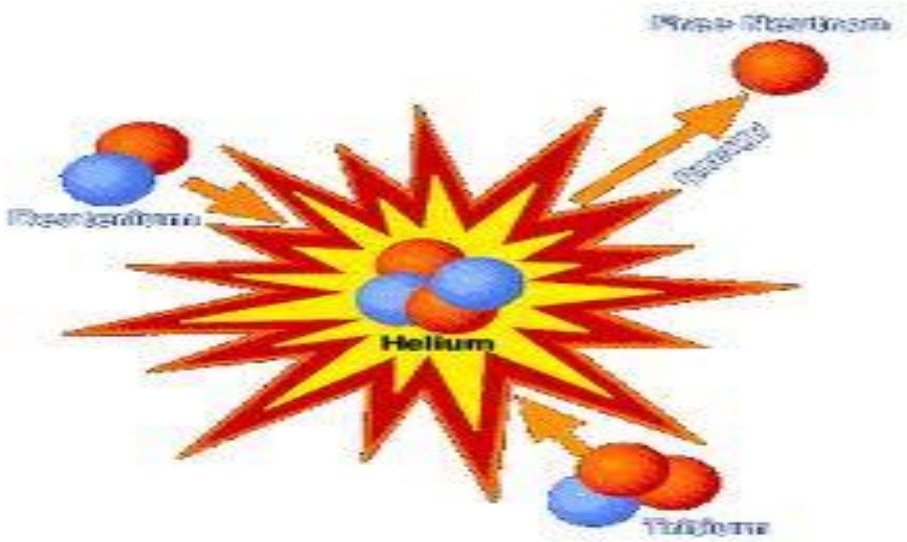
H-R Diagram



Luminosity is the brightness of stars compared to the brightness of our Sun as seen from the same distance from the observer.

Life and Death of a Star

- Stars begin as a collection of gasses and dust that are attracted together by gravity.
- Once there is sufficient mass the star ignites spontaneously and begins to fuse Hydrogen to Helium.



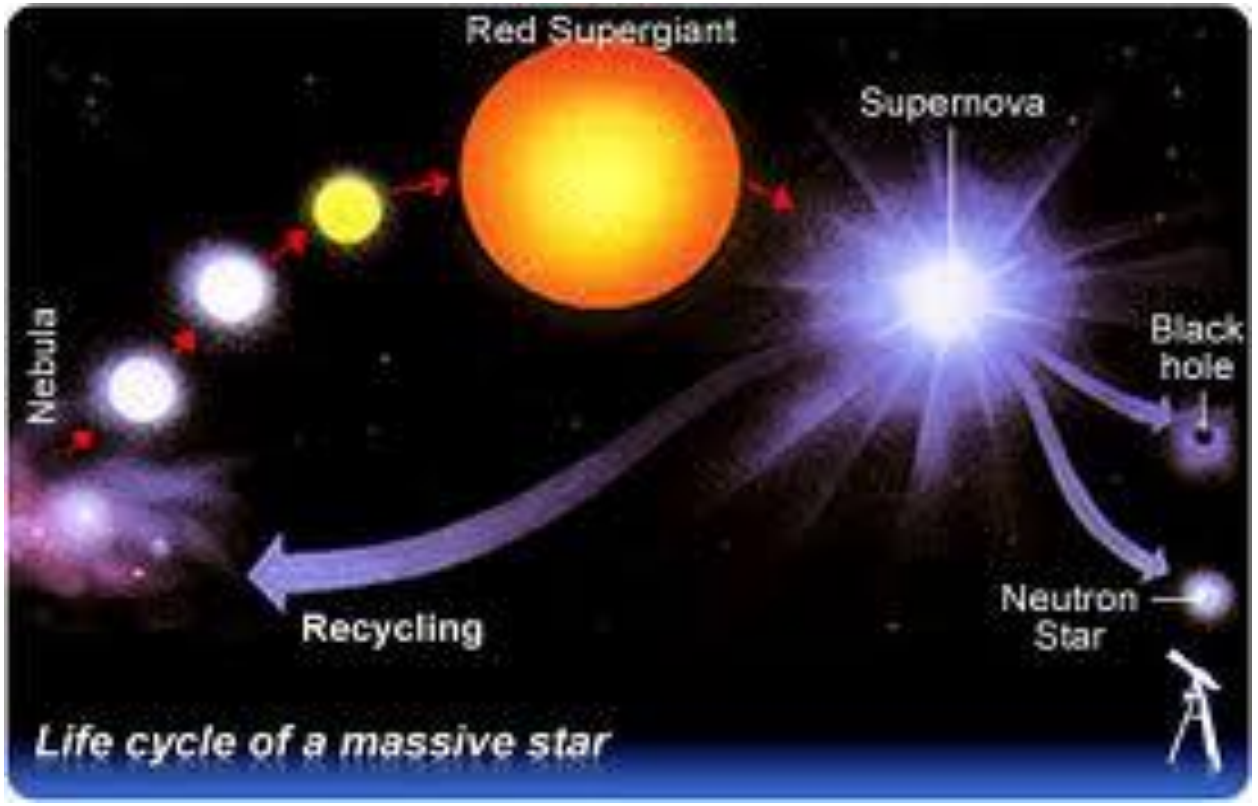
Death of a Star

- Stars begin to die when the force of internal pressure exceeds the gravitational force that holds them together. The star expands to become a Red Giant.
- A Red Giant will burn for a few million years then collapse.

Death of a Star

- The Red Giant Star collapses to form a:
- White Dwarf Star if it has a small mass
- A Neutron Star if it has a large mass.
- A Black Hole if it has a HUGE mass.
- Anyone of these may be preceded by a nova or supernova[http://www.youtube.com]

Life Cycle of a Star



Just how big is the Universe?

http://www.youtube.com/watch?v=oAVjF_7ensg

Are we alone in the Universe?

The Drake Equation

N = R* • fp • ne • fl • fi • fc • L

Where,

N = The number of civilizations in The Milky Way Galaxy whose electromagnetic emissions are detectable.

R* =The rate of formation of stars suitable for the development of intelligent life.

fp = The fraction of those stars with planetary systems.

ne = The number of planets, per solar system, with an environment suitable for life.

fl = The fraction of suitable planets on which life actually appears.

fi = The fraction of life bearing planets on which intelligent life emerges.

fc = The fraction of civilizations that develop a technology that releases detectable signs of their existence into space.

L = The length of time such civilizations release detectable signals into space.

Future Earths

- http://www.youtube.com/watch?v=v3Kcw0UrIFI
- Recent studies using the Kepler space telescope estimate that 22% of all stars have Earth-like planets orbiting them.

Science Fiction Ending…

- The only thing scarier than finding this in the universe is not finding anything at all.