- The universe is a large collection of billions of galaxies
- A galaxy is a large collection of billions of stars
- Our solar system is in the Milky Way galaxy.
- Gravitational Field Strength varies per planet due to the mass of the planet. The higher the mass, the more gravitation field strength. Vice Versa.

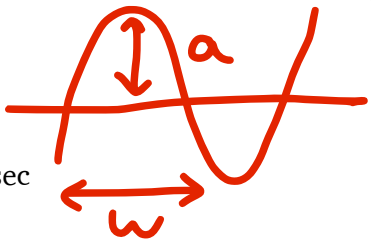
gravitational force:

- causes moons to orbit planets
- causes the planets to orbit the Sun
- causes artificial satellites to orbit the Earth
- causes comets to orbit the Sun - orbit in an oval shape around sun.

Evidence of big bang

- Light from other galaxies are red-shifted, and therefore galaxies are moving away.
- The further the galaxy, the more red-shifted, and the faster they are moving away.
- Galaxies are emitting Cosmic Microwave Background Radiation (CMBR - short wavelengths of gamma radiation) which is heat left over as a result of the original explosion.

Waves:
- Amplitude
- Wavelength
- Frequency = number of waves/sec



Starts from a small point.

Doppler effect:

- Frequency change of a wave caused by relative motion between wave and observer. Compression and stretching of waves as a result of moving object.

Object is moving towards the observer.	Object is moving away from the observer.
Waves get shorter	Waves get longer/stretch
Frequency increases	Frequency decreases
Sound: Higher pitch	Sound: Lower pitch
Light: More blue, blue-shift	Light: More red, red-shift

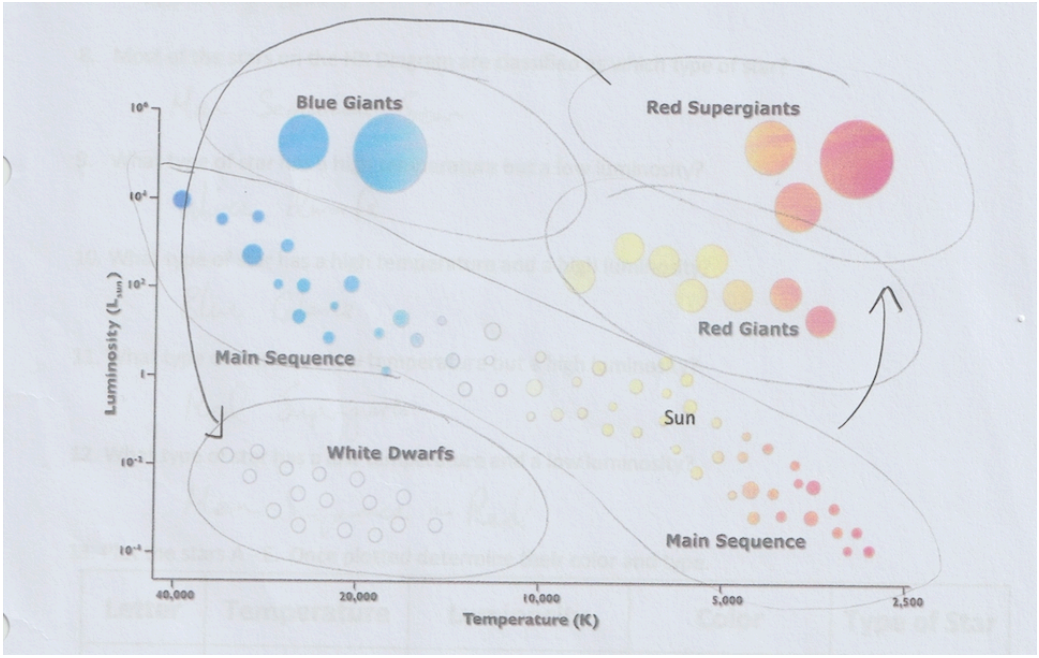
Doppler Equation:

$$\frac{\lambda - \lambda_0}{\lambda} = \frac{v}{c}$$

Orbital Speed Equation:

$$v = \frac{2 \times \pi \times r}{T}$$

Hertzsprung-Russel Diagram:



Variables:

Luminosity
Temperature (from hot to cold)

Star like our Sun:	Massive Star:
Nebula - A cloud of dust and gas is pulled together by gravity.	**Nebula** - A cloud of dust and gas is pulled together by gravity.
Protostar - As cloud gets smaller, it begins to heat up. Nuclear reaction begin to occur. (Very high pressure and temp.) - Fusion, small nuclei (hydrogen) join together.	**Protostar** - As cloud gets smaller, it begins to heat up. Nuclear reaction begin to occur. (Very high pressure and temp.) - Fusion, small nuclei (hydrogen) join together.
Main Sequence Star - Nuclear reactions heat the star and outward pressure balances compression due to gravity.	**Main Sequence Star** Nuclear reactions heat the star and outward pressure balances compression due to gravity.
Red Giant - Most of the hydrogen is used up and core collapses but outer layer expand.	**Red Supergiant** - Most of the hydrogen is used up and core collapses but outer layer expand.
Shell of gas - Outer layers of the star thrown off and rest is pulled together by gravity to form a white dwarf.	**Supernova** - The whole star rapidly collapses and then explodes.
White Dwarf - No fusion reaction happening anymore. - Will gradually cool down to become a black dwarf.	**Blackhole** - If what is left is more than 4 times the mass of the sun, material is pulled together to form a black hole. **Neutron Star** - If what is left is less than 4 times the mass of the sun, material is pulled together by gravity to form a neutron star.

planetary nebula

White Dwarfs:
- Size of around Earth
- Almost entirely carbon and glowing with residual heat of fusion process. Continuously cooling down.

Supergiants:
- Large masses, resultant gravity allows them to fuse hydrogen quickly.
- Life is much shorter than main sequence star.
- Rapidly collapse under gravitational force.

Neutron Star:
- Atom has collapsed.
- Electrons are pushed into the nucleus, and electrons become neutrons.
- Are very, very dense.

Absolute Magnitude of Stars:
- Absolute magnitude, M is magnitude of the star if placed at distance of 10 parsecs from Earth (size of star looked from same distance).
- By consider stars at fixed distances, astronomers can compare real brightness of stars.