Lifestyles of the Stars

Essential Vocabulary:

- Giant Molecular Cloud
  - Large molecular gas clouds
  - Up to 1 Million solar masses
- Cloud Core
  - Densest part of a molecular cloud
  - Generally where star formation begins to take place
  - Usually the center of the cloud
- Protostar
  - The first phase of a star's life
  - A star still in the process of forming
- Zero – Age Main Sequence
  - The time at which a star joins the main sequence
  - Hydrogen begins burning through fusion
  - Star enters stellar evolution
- Main Sequence Star
  - Stars burning hydrogen into helium
  - Stars in the main sequence on a HR – diagram
- Red Dwarf
  - A small, cool star in the main sequence
  - Generally spectral type of K or M
  - From .075 solar masses units to .5 solar masses
- Brown Dwarf
  - A star whose mass is insufficient for nuclear fission
  - Their masses are so low, it is generally measured in Jupiter masses
- Red Giant
  - A giant in a late phase of staller evolution
  - Low surface temperature, large radius
  - Generally fuse hydrogen into helium, other into carbon
- Planetary Nebula
  - Bright shell around a hot star
  - Generally composed of gas ejected from the star as a red giant
- White Dwarf
  - A small, dense star supported by electron degeneracy
  - Extremely dim
  - Final evolutionary state for smaller stars
- Supernova
  - Stellar explosion
  - Brightness increases by a factor of up to 1 Billion
  - Two types, Type 1 and Type 2
    - Type 1 – Caused by rapid fusion of carbon and oxygen in a white dwarf
    - Type 2 – Caused by the collapse of a star's core

- Neutron Star
  - A star whose composition is primarily neutrons tightly packed together
  - Extremely dense
  - Supported against gravity by neutron degeneracy
  - Remains of a star after a Type 2 supernova
  - Final state of stars with a mass greater than the Chandrasekhar limit, but insufficient to overcome neutron degeneracy
- Black Hole
  - A region in space with infinite gravitational attraction
  - No matter or radiation can escape
  - Final evolutionary state for large stars
- Parts of the HR – Diagram
  - Main Sequence
    - Continuous spectrum of stars
    - Filled with stars who are producing helium by fusing hydrogen in their cores
    - Runs from hot, bright stars to cool, dim stars
    - Stars move down and towards the right as they age
  - Red Giants
    - Group of stars branching above the main sequence
    - Runs perpendicular and above the main sequence from around 4,000K to 1,000K
  - White Dwarfs
    - Group of stars branching of the bottom of the HR – Diagram
    - Runs from around 20,000K to 4,500K
    - Have low luminosities
  - Birth Line
    - Predicated path on an HR – Diagram taken by protostars at the end of initial accretion
    - Not a defined line – varies from star to star
- Evolutionary Track
  - Path in an HR – Diagram which shows stars as they evolve over their lives
  - Shows the changing properties of stars over time
- Vogt – Russell Theorem
  - The idea that the initial mass and composition of a star determine the course of its life
  - Never proven
  - Require the star to exist without external influences
- Thermo – Gravitational Equilibrium
  - A point at which a star is in equilibrium with internal and external pressures
  - Stars often fluctuate in and out of equilibrium
- Nuclear Processes
  - Proton – Proton Chain
    - A fusion reaction to convert hydrogen into helium
    - Often used by smaller stars, like the Sun
    - Requires high temperature to overcome Coulomb repulsion
  - CNO Cycle
    - Alternate to the Proton – Proton Chain

- Catalytic Cycle
- Used by larger stars

Advanced Vocabulary:

- T – Tauri Star
  - Pre – main sequence star
  - Small (less than three solar masses)
  - Intense emission lines
- Asymptotic Giant Branch (AGB)
  - Portion on an HR – Diagram above the Main Sequence, near the Red Giant Branch
  - Contains large, cool stars
  - Generally burn helium
- AGB Star
  - A star in the AGB
  - Pulsates due to changes in the thermo – gravitational equilibrium
  - These pulsations can burn of the outer shell, resulting in a planetary nebula
- Pulsar
  - 'Pulsating star'
  - A rotating neutron star with an extremely strong magnetic field
  - Emits a powerful beam of electromagnetic radiation
  - The period of this beam's visibility from Earth is often used to research pulsars
  - Originally thought to be alien communication
- Magnetar
  - A kind of neutron star with an extremely powerful magnetic field
  - This magnetic field results in the emission of energetic radiation
  - This field can heat up the surface of a magnetar to millions of degrees
- RR Lyrae Star
  - Also called RR Lyrae variables
  - Often used as standard candles for distance measurement
  - In the instability strip on an HR – Diagram
  - Brightness varies periodically due to changes in the size of the star
  - These variations come from changes in the thermo – gravitational equilibrium
- Classical Cepheid Variable Stars
  - Variable stars similar to RR Lyrae stars
  - Tend to be far brighter, and have longer periods
- Electron Degeneracy
  - Degeneracy pressure caused by the Pauli Exclusion Principle for Electrons
  - Pushes outward against gravitational collapse
  - Overcome in neutron stars and black holes
- Neutron Degeneracy
  - Degeneracy pressure from the Quantum Degeneracy Principle for Quarks
  - Pushes outward against gravitational collapse
  - Overcome in black holes
- Parts of the HR – Diagram

- Instability Strip
  - A rectangular region perpendicular to the main sequence that lies above
  - Contains pulsating stars like RR Lyrae, Cephid Variables and W Virginia Variables
  - Pulsations are due to changes in the thermo – gravitational equilibrium of stars, and occasionally the path between Earth and the star
- AGB
  - A portion of the HR Diagram that is asymptotic to the horizontal branch, which lies to the right of the main sequence
  - Stars here have a burning helium core, surrounded by a hydrogen shell

❖ Nuclear Processes

- R – Process
  - Creates heavier elements during the core – collapse in a supernova
  - Creates most of the heavy elements (above iron)
- S – Process
  - Creates heavier elements by neutron capture
  - Requires preexisting seed nuclei
  - Generally takes place in AGB stars