##### Stars Part II – Stellar Evolution



**Overview:**

* Protostar
* Main sequence star
* Red giant

•White dwarf or…

•Supernova -

•Neutron star or

•Black hole

#### Protostar Formation

#### Life on the Main Sequence

* Energy comes primarily from the Proton-Proton cycle:
* 1H + 1H = 2H + e+ + ν
* 1H + 2H = 3He + γ
* 3He + 3He = 4He + 1H + 1H
* (requires heat and pressure)
* Heat energy balances gravity
* 4He accumulates at the core of the star.

#### Rate Of Burn

* Big stars are Brief, Bright, and Blue
* Diminutive stars are Durable, Dim and reD
* **L = mn where 3 < n < 4**



#### The Death of a star

#### Turning into a Red Giant

#### Helium Fusion

* He core gets hot and dense enough, He begins to fuse:
* 4He + 4He = 8Be + γ
* 4He + 8Be = 12C + γ
* 4He + 12C = 16O + γ (mainly)
* 4He + 16O = 20Ne + γ
* 4He + 20Ne = 24Mg + γ

#### Carbon Fusion (IFF m > .7Msun)

* 12C + 12C = 24Mg + γ
* 16O + 16O = 28Si + 4He
* Nuclei as heavy as 56Fe and 56Ni can be created if the star core is hot enough.

#### Globular Clusters

#### Planetary Nebulas

#### Supernova

* If m > 1.4 Msun. (Chandrasekhar limit)
* Collapse from planet to Portland size
* Brighter than a whole galaxy

#### Neutron Stars

* Proton + electron = neutron
* Spin

**Pulsars**

* In 1967, Antony Hewish, Jocelyn Bell Burnell
* Pulsars emit pulses some as short as 1/40th of a second.

**Black Holes**

* If M > 2-3 Msun (Oppenheimer-Volkoff limit)
* Vescape > c

**Quasars**