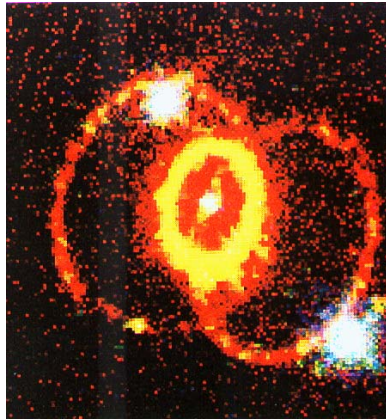


## The Stars

“Stars are giant fusion reactors in space.”



“All stars have a beginning and an ending.”

## Some Facts About The Sun

- Distance from the Earth: 1AU = 149,598,000 km
- Core, convection zone, and photosphere
- Energy travels from core to convection zone in tens of thousands of years
- Light travels from Sun’s photosphere to Earth in 8.3 min.
- Mass =  $1.99 \times 10^{30}$  kg ( $3.33 \times 10^5$  Earth masses)
- Composition: 74% hydrogen, 25% helium, 1% other elements
- Temperature: Surface (photosphere)—5800 K, Core— $1.55 \times 10^7$ K
- No distinct outer boundary—solar wind

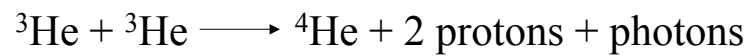
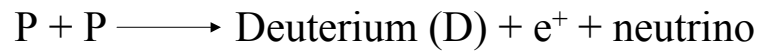
## How Do We Know The Life-Cycle of Stars?

- Electromagnetic Radiation
  - Direction, Distance, Composition, Temperature, Direction of Movement
- Telescopes
  - Earth based (visible and radio)
  - Space based
    - Hubble
    - Compton Gamma Ray Observatory
    - Chandra X-ray Observatory

## Star Formation

- Clouds of gasses and other debris (mainly hydrogen) is collected into ever tighter packets due to gravitational attraction.
- As the matter is packed tighter together the core gets hot.
- Very large aggregates of matter have cores sufficiently hot to ignite fusion reactions.
- Equilibrium is established: gravity contracts the matter, fusion reactions expand (explode) matter.
- The larger and more massive the star, the more furious the fusion reactions in the star's core.

## Hydrogen Burning



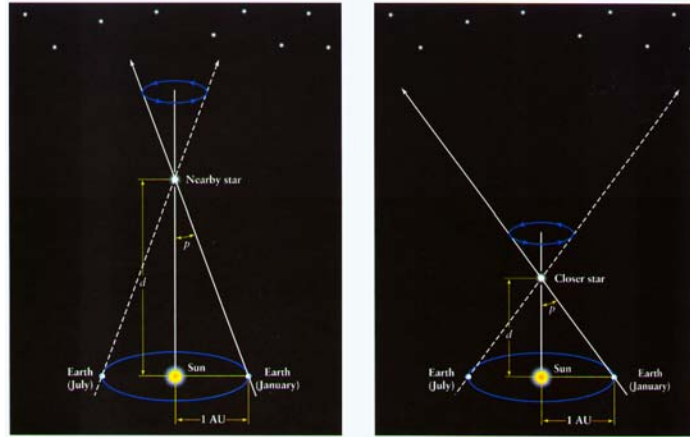
The Sun consumes over  $6 \times 10^{11}$  kg of hydrogen per second.

It has been burning hydrogen for 4.6 billion years and will continue for approximately another 5 billion years.

## Determination of the Distance to Stars

- Variables: luminosity (magnitude), spectrum of light emitted
- Light Year – 6.2 trillion miles; the distance light travels in one year
- Parsec – 3.3 light years
- Nearby stars—use parallax method
- Distant stars – use Cepheid star method

## Stellar Parallax



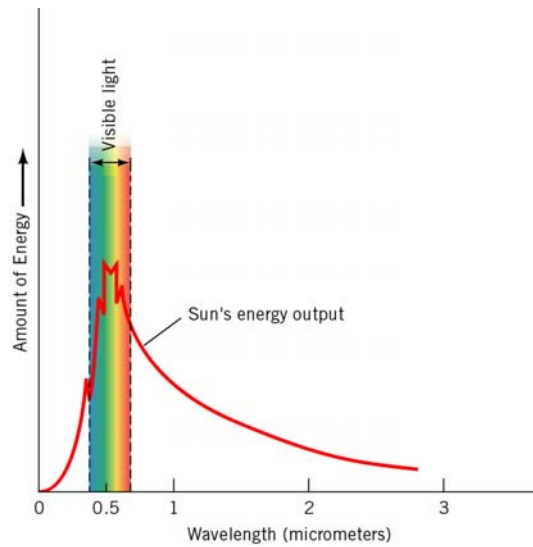
$d$  = distance in parsecs;  $p$  = parallax angle in arcseconds

AU = Astronomical Unit;  $d = 1/p$

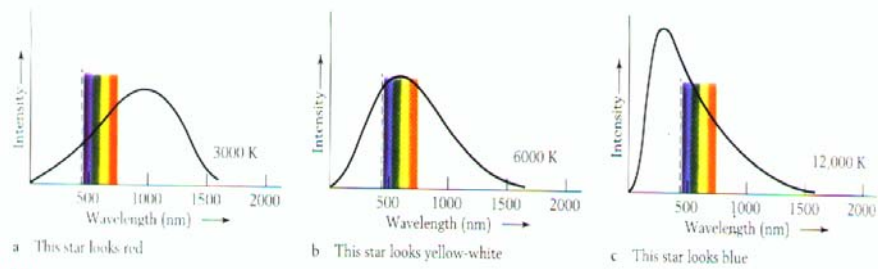
## Cepheid Stars

- First discovered in constellation of Cepheus
- Constantly change from bright to dim at a constant rate
- Rate of change dependent upon magnitude of the star
- Can be used as rulers to determine the distance to galaxies

## Energy Output of the Sun

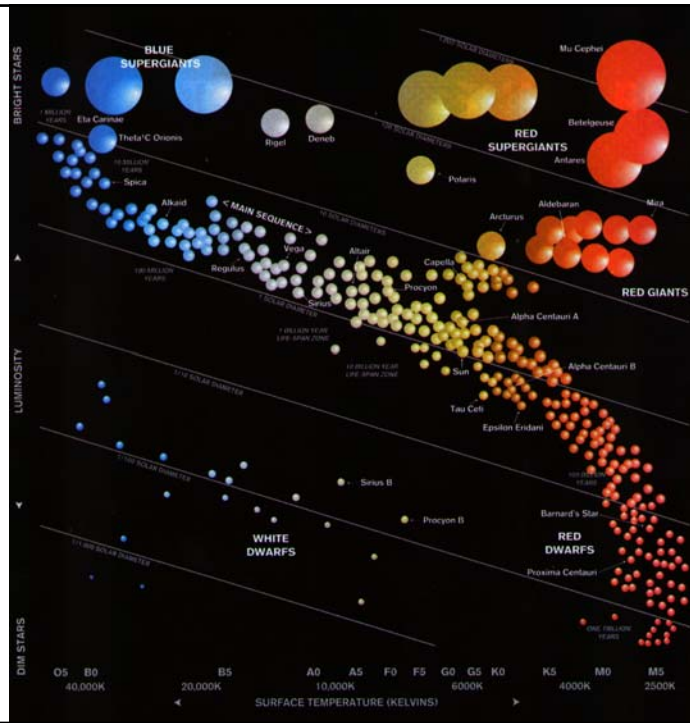


## Energy Output of Stars Cooler and Warmer than the Sun

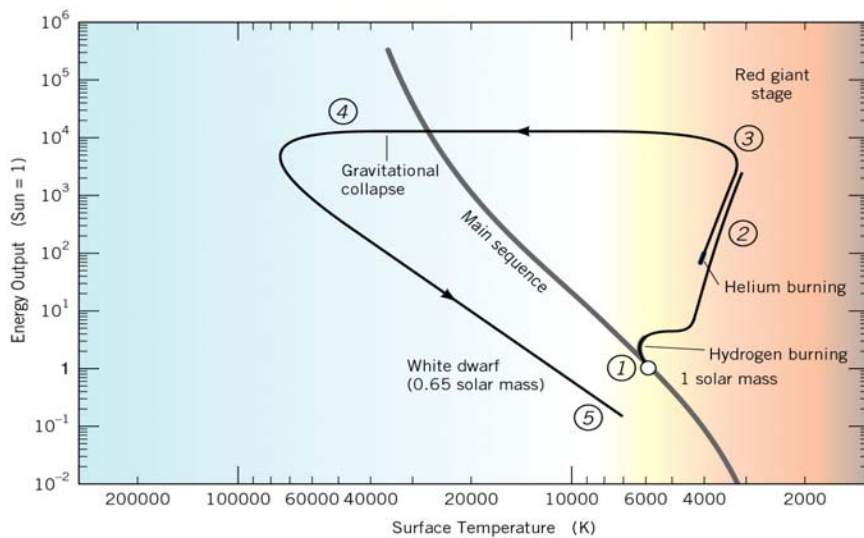


# The HR Diagram

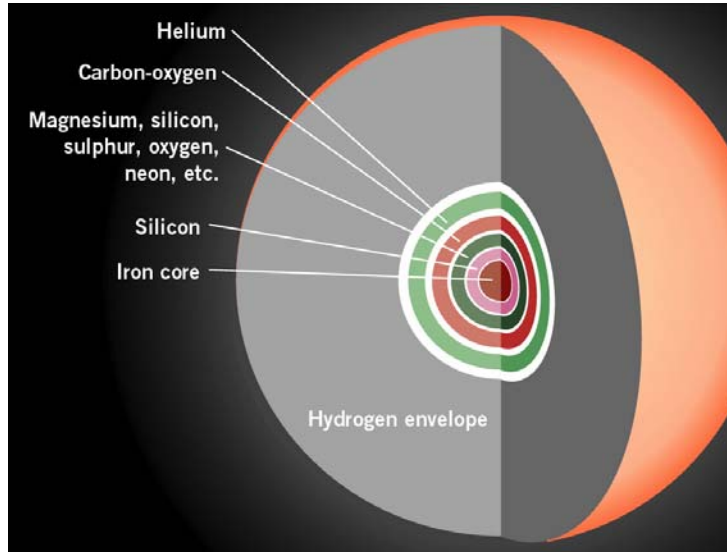
Hertzsprung-Russell



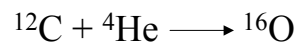
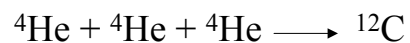
# The Life-Cycle of a Star



## Large Stars Have Concentric Shells of Fusion Reactions



## Fusion Reactions In Large Stars



Similar reactions occur to form all elements up to iron Fe. Atoms larger than Fe formed upon explosion of supernovas.

## The Death of Stars

- White dwarfs
- Supernovas
- Neutron Stars and Pulsars
- Black Holes