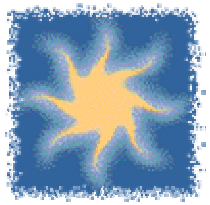
Stars

What you need to learn

- What the structure and processes of the Sun are
- What properties are used to observe and measure stars
- How stars change during their lives and what is left when they die

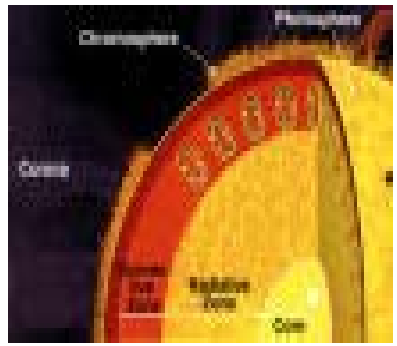
The Sun



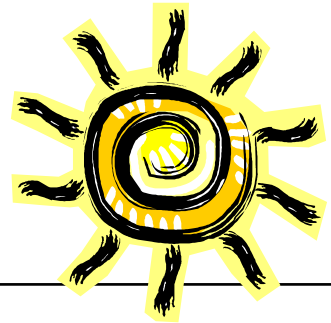
- Largest object in our solar system
  - Equal to 109 Earths or 10 Jupiters
  - 330,000 more massive than Earth
    - Contains 99% of all the mass of the solar system
- The liquid core is probably 13 times more dense than lead
  - Very hot core = 1×10^7 K
  - Consists of plasma (most common state of matter)

Layers of the Sun

- Visible surface is called the photosphere (average temp. = 5800K)
- Chromosphere is the 2nd layer which appears red when seen
- Top layer is called the corona which is only visible with special instruments



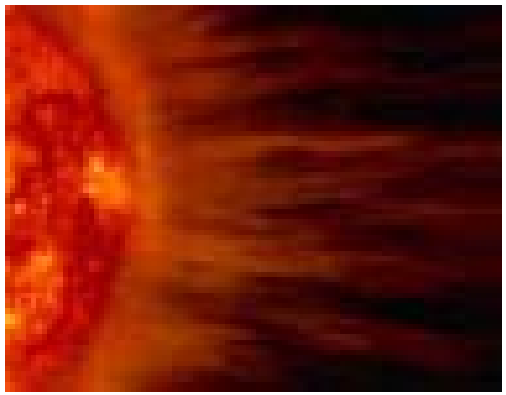
Solar Wind



- Gases that flow outward from the corona at high speeds
  - They are charged particles traveling at a fast rate
  - When they collect in space you see an aurora

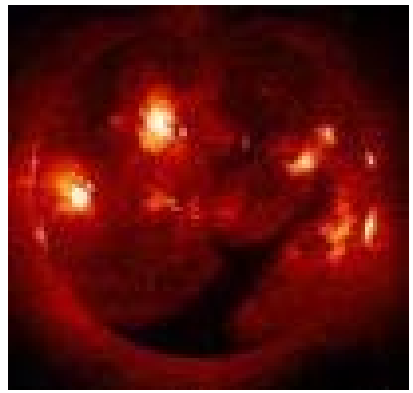
Solar Activity

- Sunspots: dark spots on the surface of the photosphere
  - They are actually very bright but cooler than surrounding areas
  - Occur in pairs because of their magnetic polarity and can last a couple of months
  - Cycle in number every 11.2 years, but when the Sun's poles reverse it takes 22.4 years
- Coronal holes: located over sunspot groups; low density regions
- Solar Flares: violent eruptions of particles
- Prominence: arc of gas that is ejected from the photosphere

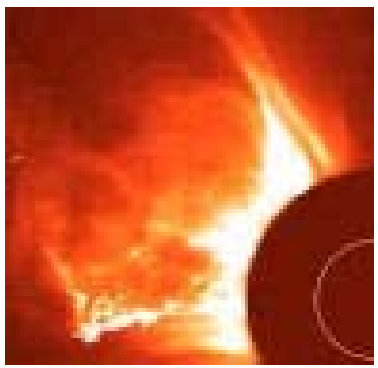


Solar wind

Sun spots



Coronal holes



Solar Flares

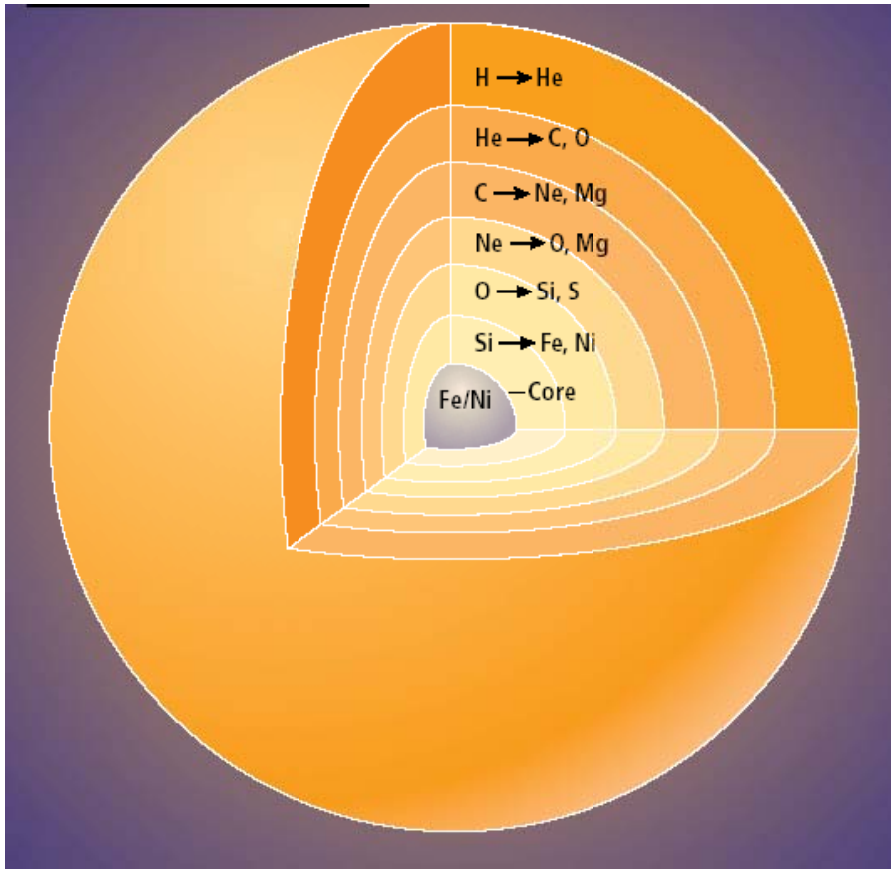
Prominence

Solar Interior

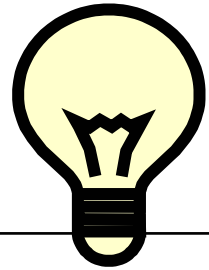
- Fusion (combining of lightweight nuclei) occur within the sun
- Fission (splitting of heavy atomic nuclei)

During this process matter is actually being lost (Einstein's theory of special relativity) and being converted to energy which powers the Sun

Structure of an Evolved Star

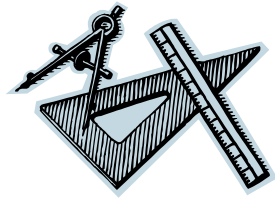


Energy from the Sun

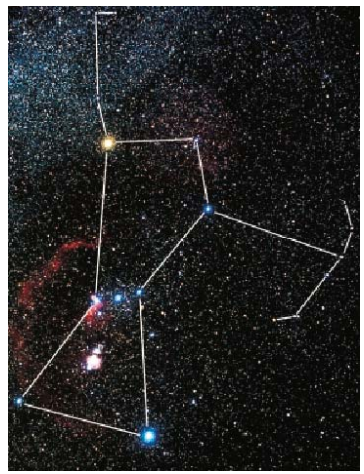


- The sun has burned up about half of its energy (about 5 billion years left)
- Above the Earth's atmosphere absorb about 1354 W of energy per 1 m^2 (13 100 watt lightbulbs could be powered from 1 m^2)
- Energy travels through space in the form of electromagnetic radiation

Measuring Stars



- Groups of stars are called constellations
  - 88 were named by the ancient Greeks
  - Groups of stars are actually very far away from each other
    - When 2 stars are gravitationally bound together and orbit a common center of mass they are called binary stars (most look like just one star)



Orion

Measuring Stars cont.

- Star distances are measured in light years or larger units called parsec
  - Parallax (apparent shift in position caused by the motion of the observer) helps scientists measure distances

Basic Properties of Stars

- Magnitude: how bright it appears
  - Stars can be compared by ranking them on a scale developed by the ancient Greeks
- Apparent Magnitude: how bright it appears to be
  - Uses a modified system
- Absolute Magnitude: the brightness an object would have if it were placed at a distance of 10 pc
  - Accounts for the distance
- Luminosity: Measure of energy output from the surface of a star per second

Spectra of Stars

- Classification of spectral types based on temperature
- Wavelength shifts: determine if stars are approaching or going away
  - Moving closer: shift toward shorter wavelengths (blue shifted)
  - Moving away: longer wavelengths (red shifted)
- Hertzsprung-Russell diagram: looks at mass, luminosity, temperature, and diameter of stars
  - Broad strip of the spectrum is called the main sequence

Stellar Evolution

- Mass governs a star's temperature, luminosity, and diameter
  - The more massive it is the hotter and more dense it is
  - The hotter it is determines the brightness
- Gravity and pressure balance each other in a star

Stellar Evolution

- If the temperature in the core of a star becomes high enough, elements heavier than hydrogen but lighter than iron can fuse together
- Stars such as the Sun end up as white dwarfs
  - Stars up to about 8 times the Sun's mass also from white dwarfs
  - Stars with masses between 8-20 times the Sun's mass end up as neutron stars
  - More massive stars end up as black holes
- A supernova occurs when the outer layers of the star bounce off the neutron star core, and explode outward