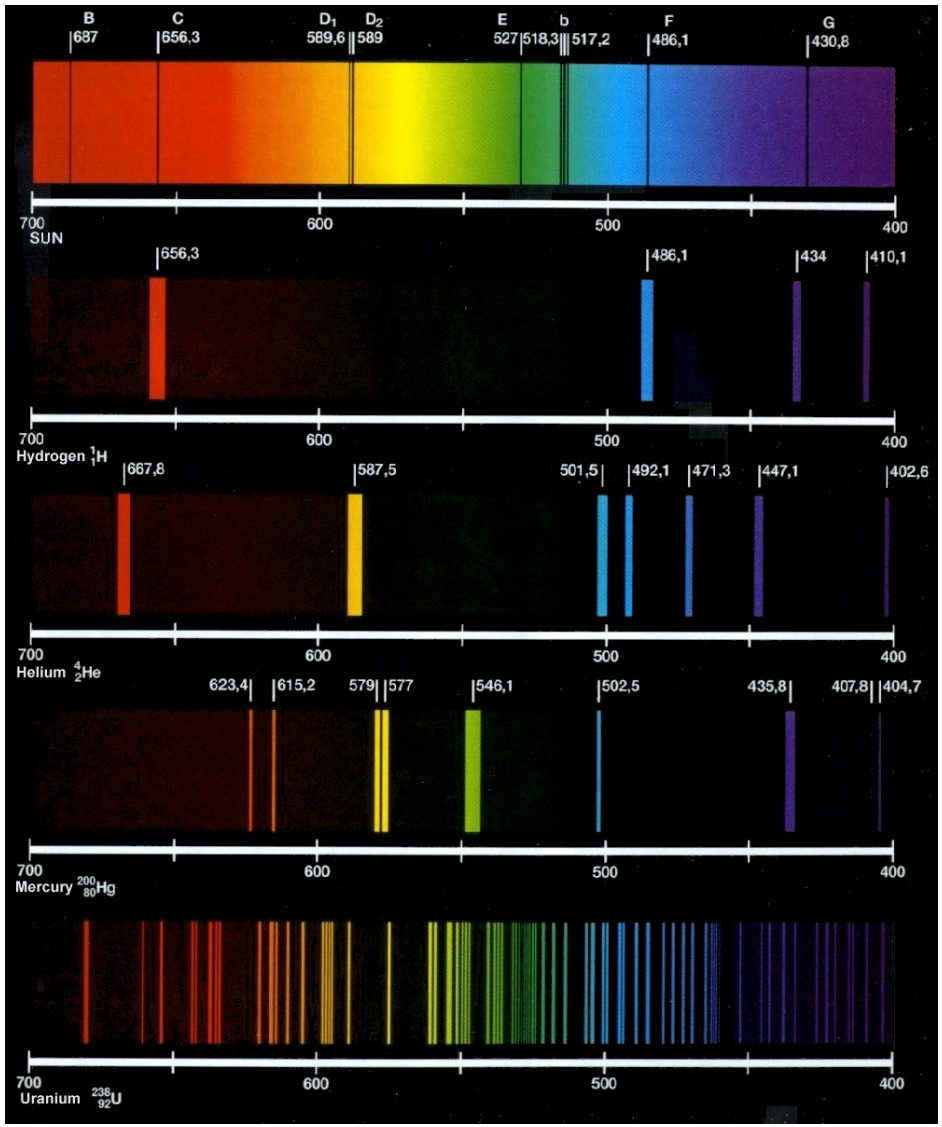
Sun & Stars

Ch. 24 Section 3

Ch. 25 Section 1

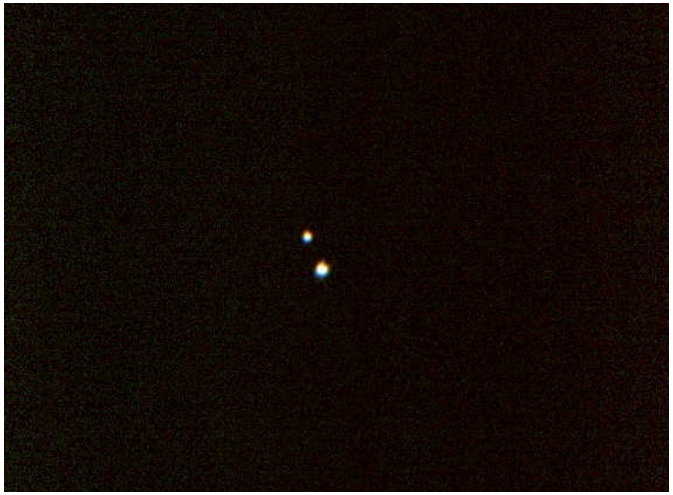
What elements make up stars?

- Almost all stars are
  - 73% Hydrogen
  - 25% Helium
  - 2% other
- Ex. of emission spectra
  - Burning gas releases energy @ diff wavelengths
  - Corresponds to a color



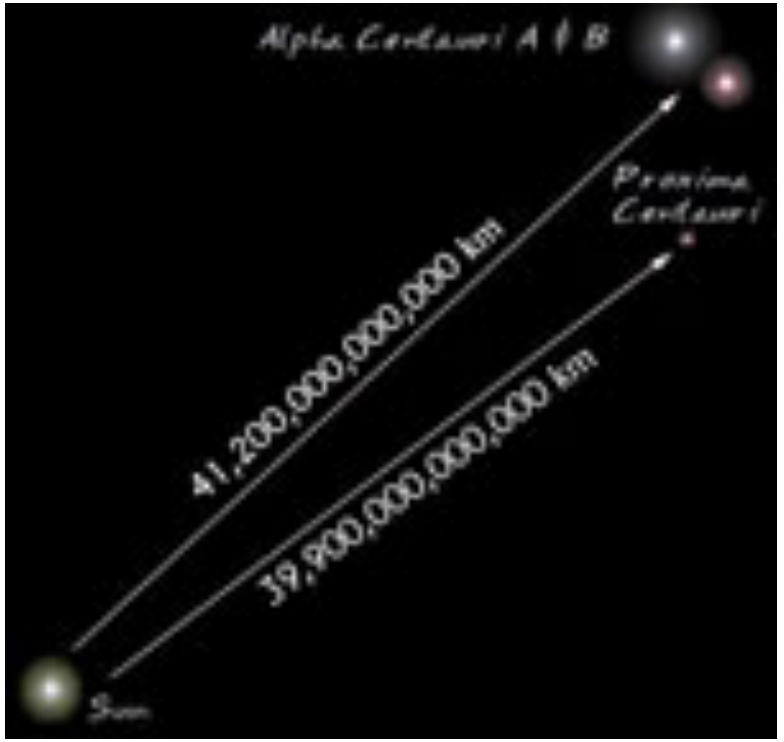
How are distances to stars measured?

- Astronomical Units (AU): avg distance from Sun-Earth
- Light-year (ly)= 9.461 X 10^{12} km
  - **DISTANCE** light travels in 1 year
- Parsec (pc)= 3.26 ly
  - 3.086 X 10^{13} km



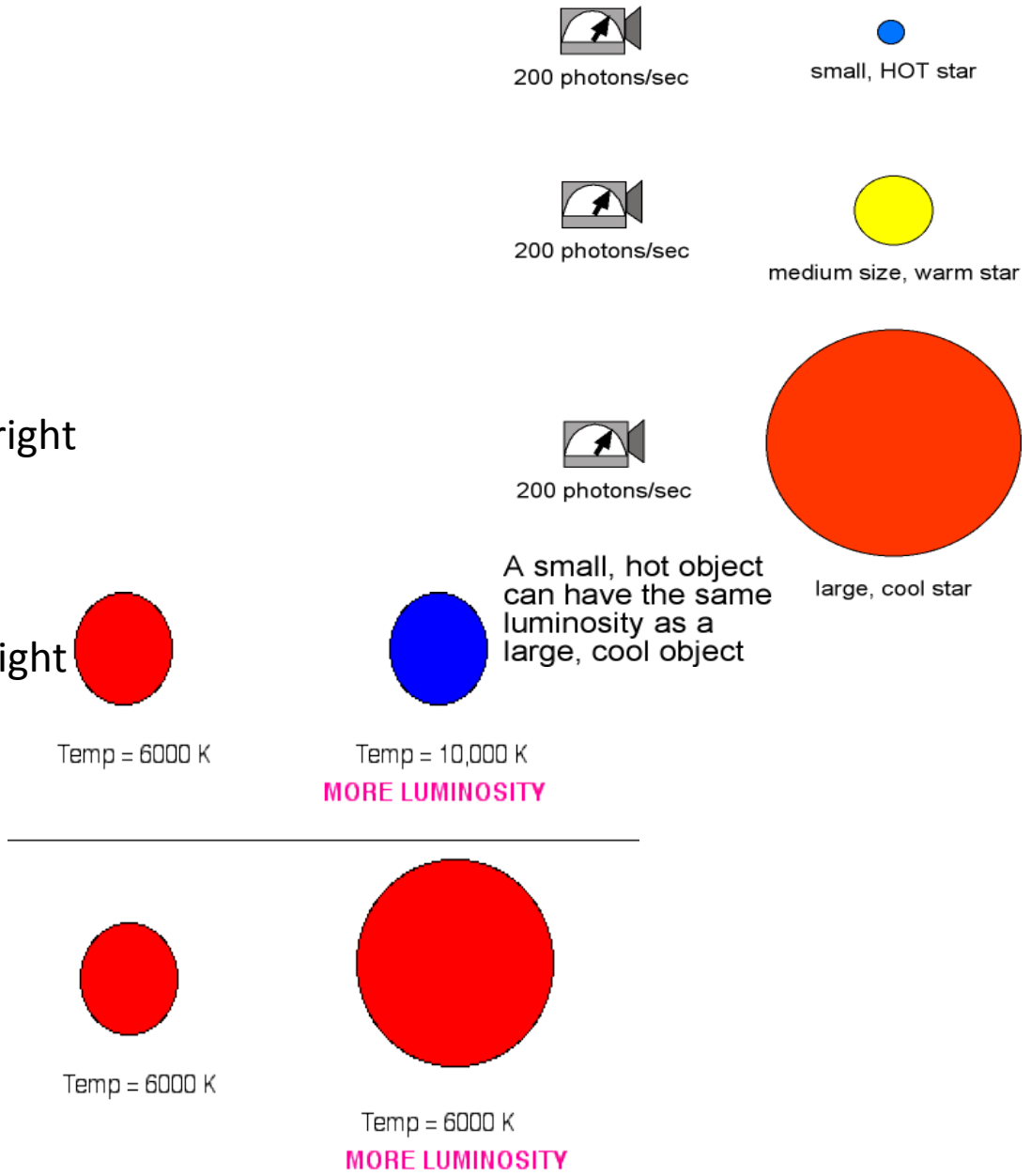
Proxima Centauri: closest star to Sun (4.2 ly) but dimmest in cluster

Alpha Centauri A & B: sep. by distance of Sun-Uranus (4.4 ly), brighter



How are stars classified?

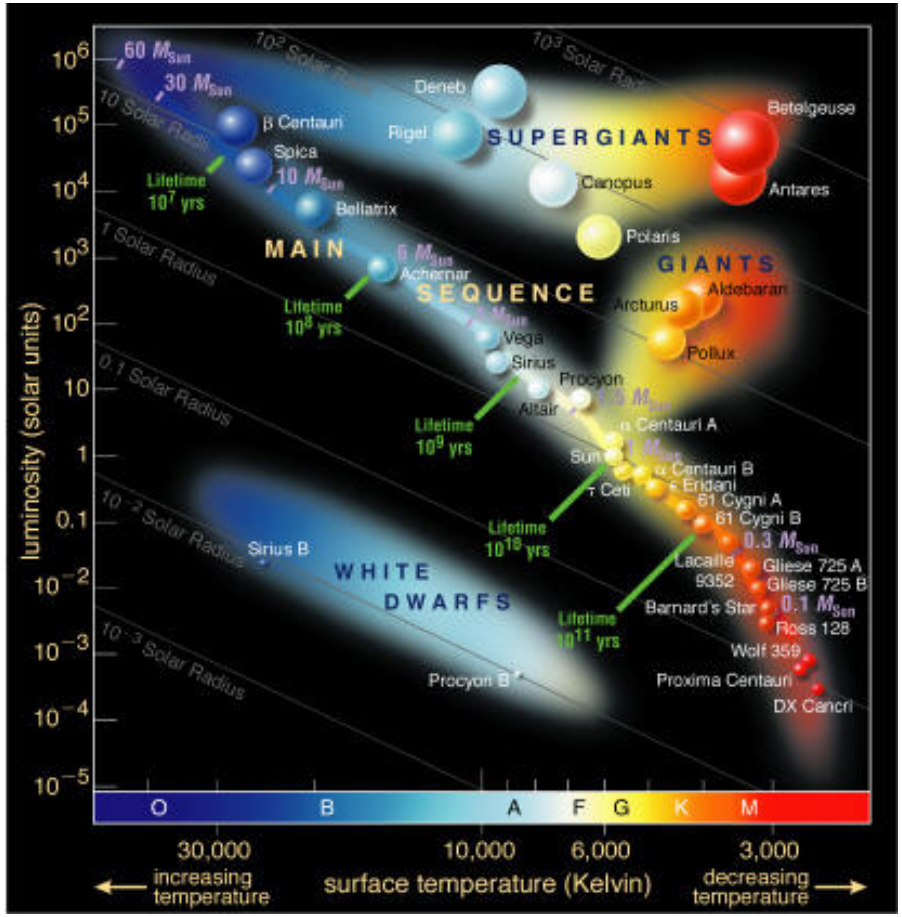
- Mass: determines life span
- Diameter
- Temperature
- Luminosity: power/energy released (Watts)
- Magnitude: brightness
  - **Apparent magnitude**: how bright it appears in sky
    - How it looks from Earth/@ equal distances
  - **Absolute magnitude**: how bright it WOULD be @ 10 pc
    - At equal distances
- Factors determine a star's spectral class…

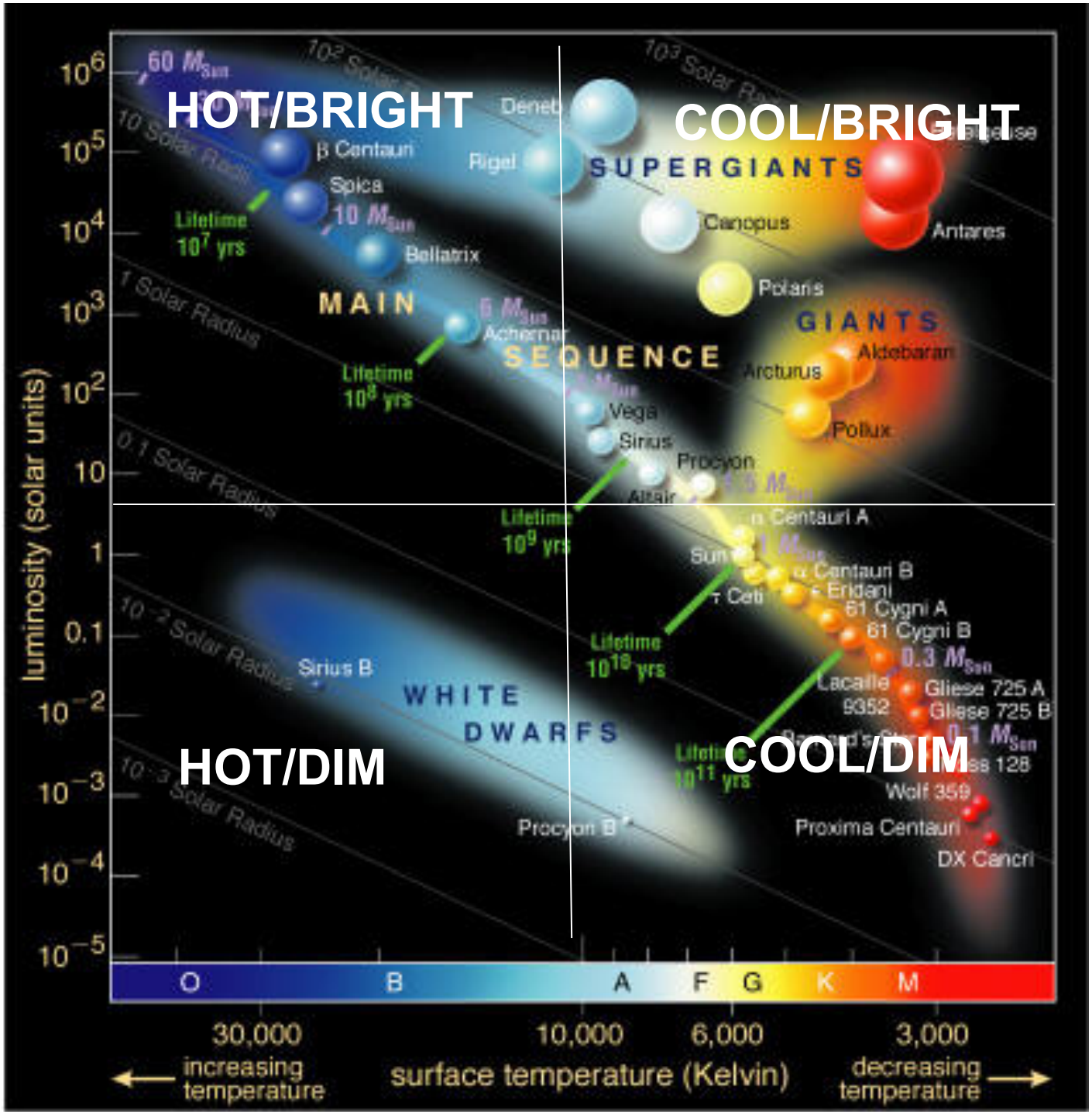


What is spectral class you ask?

- A way of classing stars based on properties
- Temperature:
  - OBAFGKM [**O**h **B**e **A** **F**ine **G**irl/**G**uy, **K**iss **M**e](stars first identified were A and so on…)
  - Hottest→Coolest
  - Blue→Red
- Subclasses indicated by 0-9
  - Specific indication of temp
  - Sun=G2→5800 K
- Hertzsprung-Russell diagram
  - X=temperature
  - Y=luminosity/brightness
- Main sequence=where 90% stars occupy

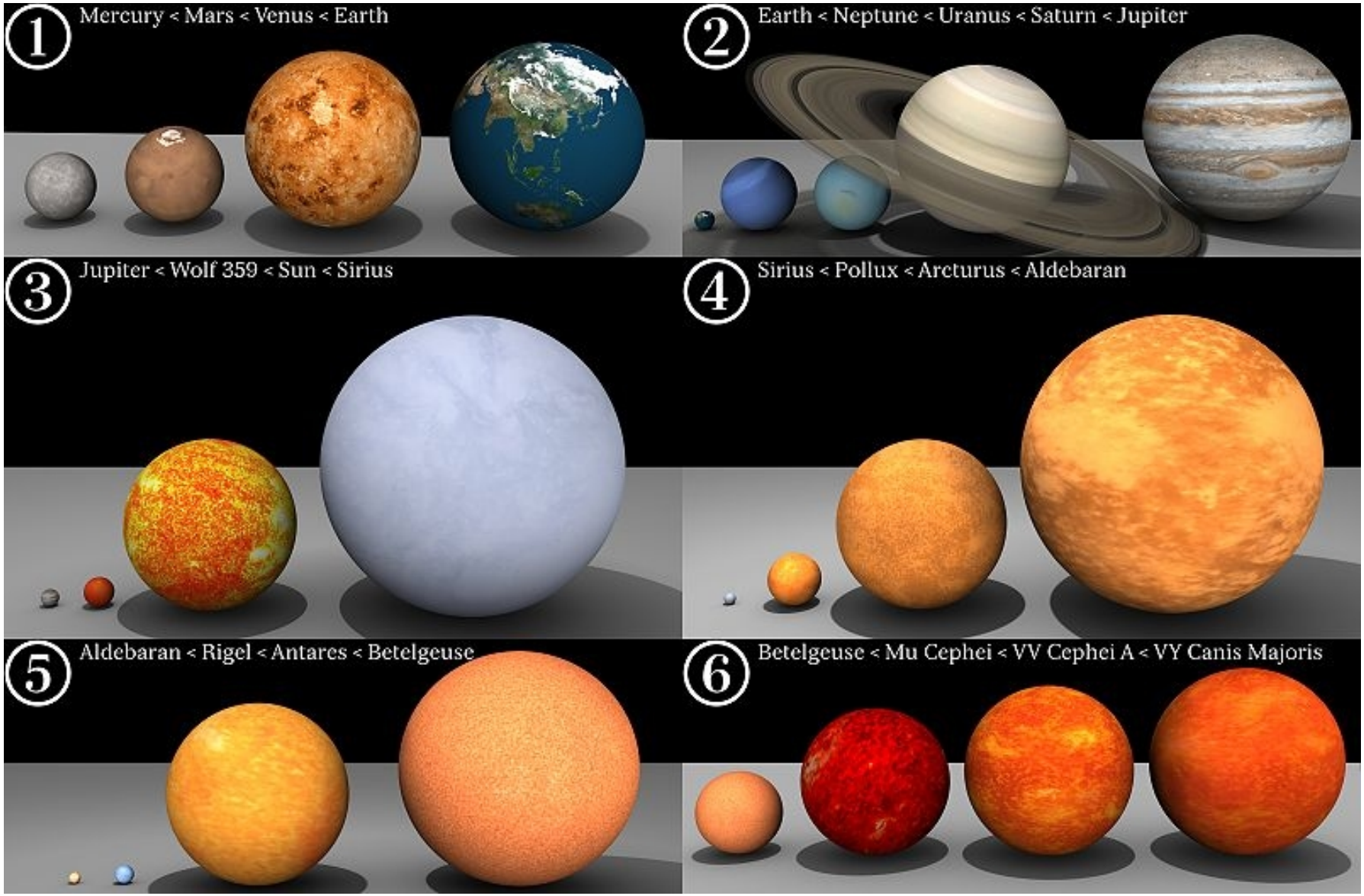
HR Diagram




HOT/BRIGHT
COOL/BRIGHT
HOT/DIM
COOL/DIM
SUPERGIANTS
GIANTS
MAIN SEQUENCE
WHITE DWARFS
Deneb
Rigel
β Centauri
Spica
10 M_{Sun}
Bellatrix
Lifetime 10^7 yrs
6 M_{Sun}
Achernar
Lifetime 10^8 yrs
Canopus
Antares
Polaris
Arcturus
Aldebaran
Pollux
Vega
Sirius
Procyon
Altair
Lifetime 10^9 yrs
α Centauri A
1 M_{Sun}
Sun
α Centauri B
τ Ceti
ε Eridani
61 Cygni A
61 Cygni B
0.3 M_{Sun}
Lifetime 10^{10} yrs
Lacaille 9352
Gliese 725 A
Gliese 725 B
0.1 M_{Sun}
Wolf 359
Proxima Centauri
DX Cancri
Sirius B
Procyon B
60 M_{Sun}
10 Solar Radius
1 Solar Radius
0.1 Solar Radius
luminosity (solar units)
10^6
10^5
10^4
10^3
10^2
10
1
0.1
10^{-2}
10^{-3}
10^{-4}
10^{-5}
O
B
A
F
G
K
M
30,000
10,000
6,000
3,000
increasing temperature
surface temperature (Kelvin)
decreasing temperature

Sun

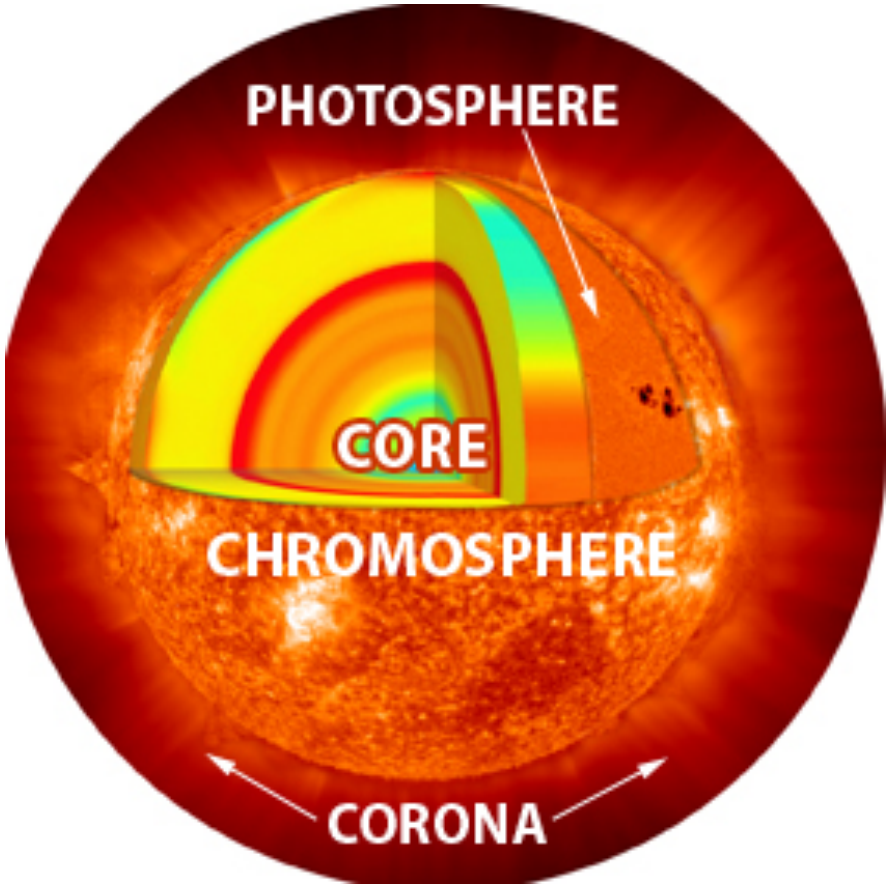
- Largest object in solar system
  - Mass=99% of all mass in SS
  - Diameter=109 Earth's fit across Sun
  - Density 1300kg/m^3 ~Jupiter
- Interior= plasma or ionized gases (only nuclei & electrons) at temps of 10,000,000 K
- Light produced each second = 4 trillion trillion 100-W lightbulbs
- ~5 billions years to go—will have used up all H core


1
Mercury < Mars < Venus < Earth
2
Earth < Neptune < Uranus < Saturn < Jupiter
3
Jupiter < Wolf 359 < Sun < Sirius
4
Sirius < Pollux < Arcturus < Aldebaran
5
Aldebaran < Rigel < Antares < Betelgeuse
6
Betelgeuse < Mu Cephei < VV Cephei A < VY Canis Majoris

Layers of Atmosphere of Sun

Name of Layer

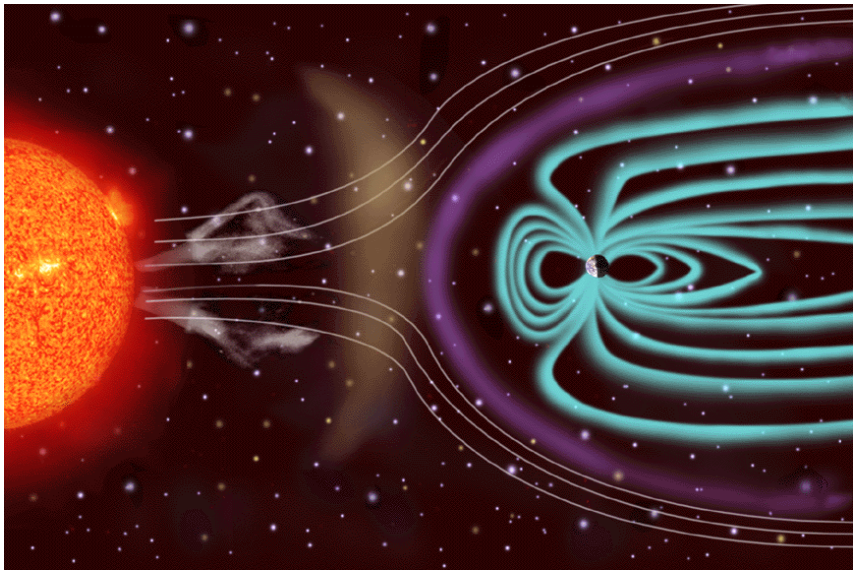
- Photosphere
  - Innermost layer
  - Visible surface of Sun
  - Releases visible light
  - 400 km thick, 5800 K
- Chromosphere
  - 2500 km thick, 30,000 K
  - Strongest emissions=red λ
  - UV wavelengths
- Corona
  - Several million km thick, 1-2 mill K
  - Low density of gas
  - Emit X rays
  - Very dim→ seen during eclipse when photosphere is blocked



Solar Wind

- Created by high speed gas flowing from corona
- At 1 AU: 400 km/s wind of ions (charged particles)
  - Deflected by Earth's magnetic field
  - Trapped in 2 huge rings called Van Allen Belt
- VA belts collide with gases in E's atmos to create an aurora

Solar Wind / Van Allen Belts



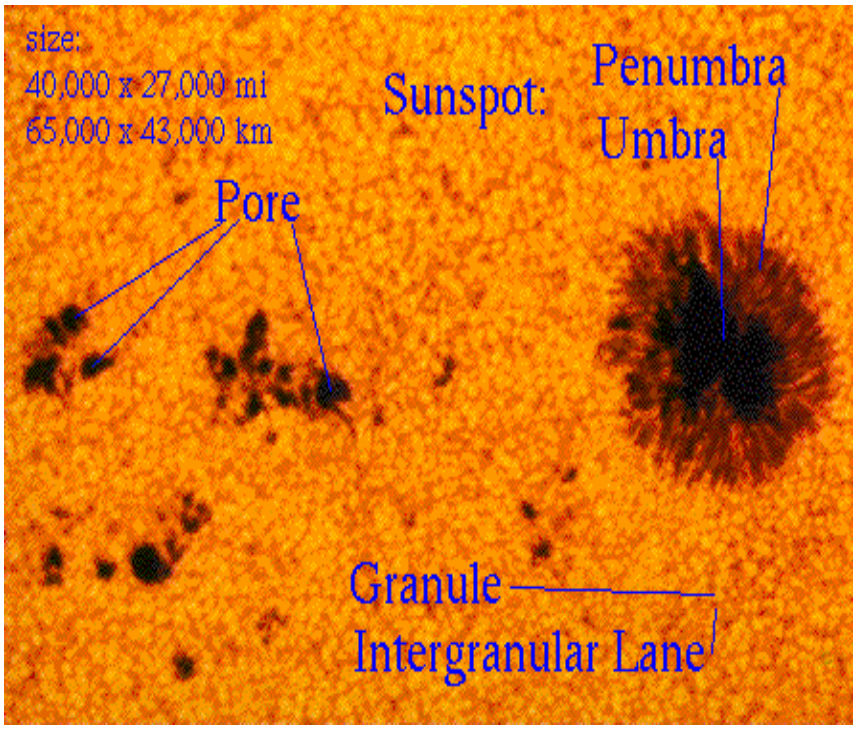
Aurora Borealis/Northern Lights

Solar Activity

Changes to Sun's features over periods of time…caused by the Sun's magnetic field

Sunspots

- Dark spots on photosphere where pressure of magnetic field pokes through
- Appear darker than surrounding area b/c cooler in temp (but are bright)
- Occur in pairs with a north & south pole; like magnets
- Over course of 11.2 yrs: starts w/ min #→max # then magnetic field reverses in polarity



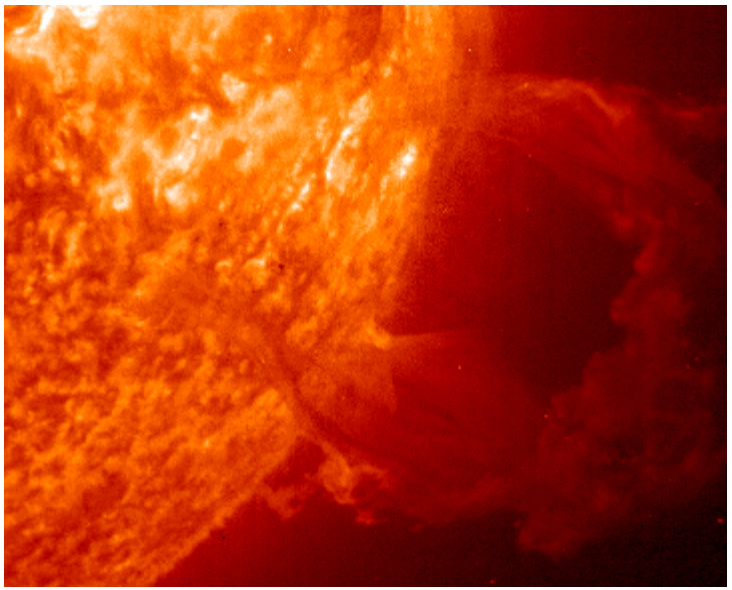
Solar flares and prominences

Solar Flares

- Violent eruptions of particles & radiation
- Can hit Earth & damage atmosphere, disrupt long-range radios, satell. & radar
- solar flame animation

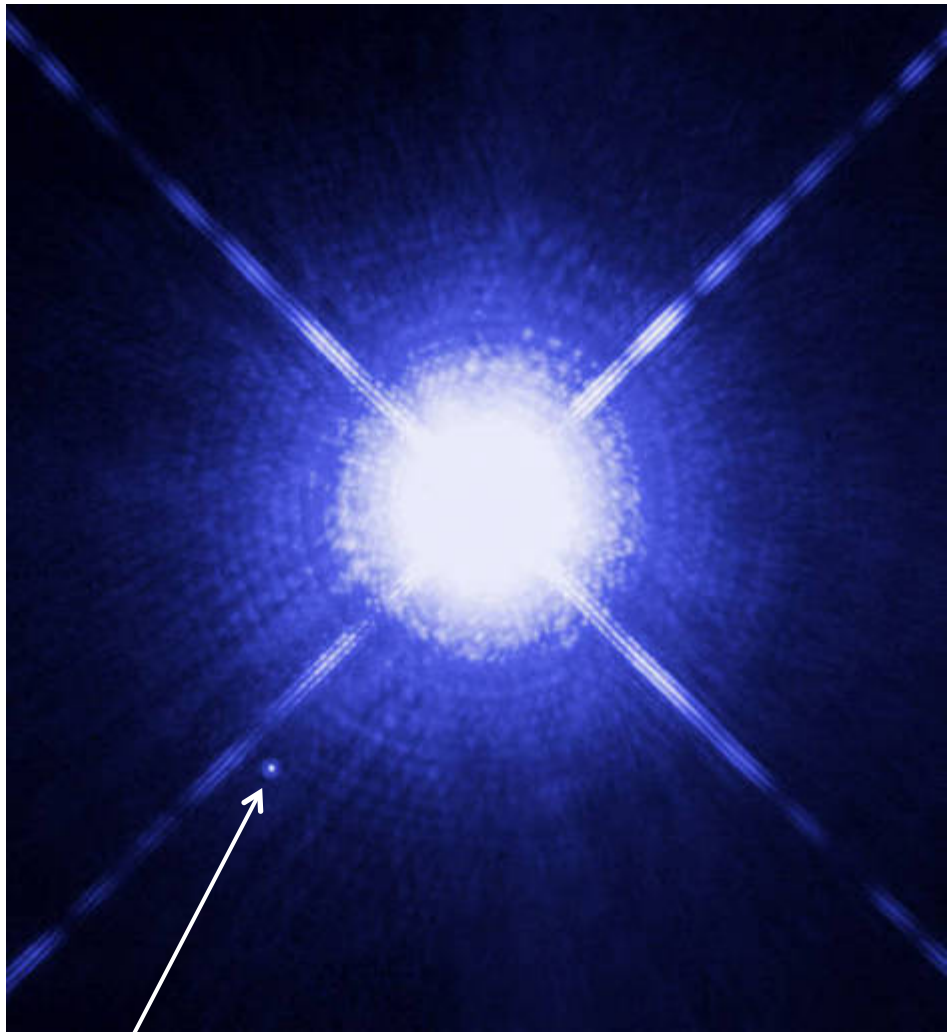
Prominences

- Arcs of gas ejected from chromosphere
- 50,000 K, hrs-mths long



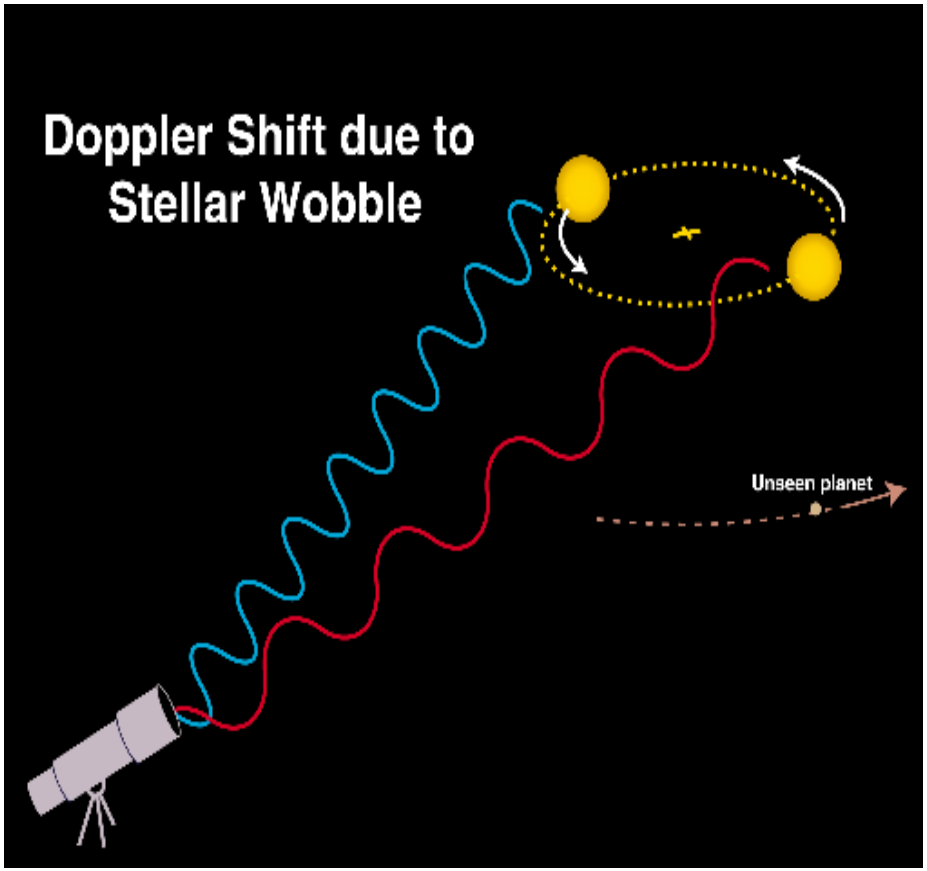
Binary Stars

- only 2 stars are <u>gravitationally bound</u> together
- orbit a <u>common center of mass</u>
- *More than ½ the stars in the sky are either binary stars or are part of a multiple-star system*
- *Most binary stars appear to be a single star to the human eye + with tele.→ too close and one is brighter*



Doppler Shift

- Way to tell that a star is one of a binary pair
- Doppler shift=subtle wavelength shifts
  - Star shifting **TOWARD** observer=**shorter** wavelength/**BLUESHIFT**
  - Star shifting **AWAY** from observer=**longer** wavelength/ **REDSHIFT**
    - *The higher the speed, the larger the shift.*
    - *Observe binary stars as they move about their center of mass toward/away from Earth*



Parallax

- Apparent shift in position caused by motion of observer
- ***Try this!*** Hold pencil out and alternate closing each eye→ notice "shift"?
- As E moves from one side of its orbit to opp. Side, a nearby star appears to shift
  - **The closer the star, the larger the shift**

  --the dist. to a star can be estimated from its parallax shift→ measuring **<u>angle</u>** of change

The larger the distance, the smaller the parallax (angle)

Parallax decreases with distance