Midterm #3 Topics, 1

Mars
- *Basic properties*
- *Moons*
- *Surface features*
- *Internal structure*
- *Atmosphere*
- *Water*

Icy gas giants
- *Atmosphere*
- *Internal Structure*
- *Wind & storms*
- *Magnetosphere*

Jupiter
- *Atmosphere*
- *Magnetosphere*
- *"Vacuum cleaner"*
- *Thermal emission*

Galilean moons: Io, Europa, Ganymede, Callisto
- *Composition*
- *Tidal locking, heating*

Saturn
- *Rings, composition, origin*
- *Shepherd moons*
- *The Roche limit*
- *Titan*

Uranus
- *Rotation*

Neptune
- *Discovery*

Asteroids
- *Composition, origin*
- *Ceres*
- *Lagrange points*

Dwarf planet
- *Definition (vs planet)*
- *Pluto, Eris, Sedna, etc*

Oort cloud

Comets
- *Origin, composition*
- *Gas tail, dust tail*
- *Dust trail, meteorites*

Exoplanets
- *Detection methods*
- *Properties*

Life in Solar System ?
- *Definition, properties*
- *Hardy, simple lifeforms*
- *Mars, Europa, Enceladus*

Midterm #3 Topics, 2

Sun

Blackbody radiation source
Temperature
Size
Composition
Sunspots, 11 year cycle
Corona, solar wind
Internal structure

Solar fusion

Proton-proton fusion chain
$E=mc^2$
Power output, lifetime of Sun

Observing Stars

Apparent magnitude, brightness
Luminosity & distance

Star properties

Luminosity, intensity, size
Temperature, color
Mass

Luminosity vs Mass

Luminosity $\propto$ Mass $^{3.9}$

Luminosity vs Temperature

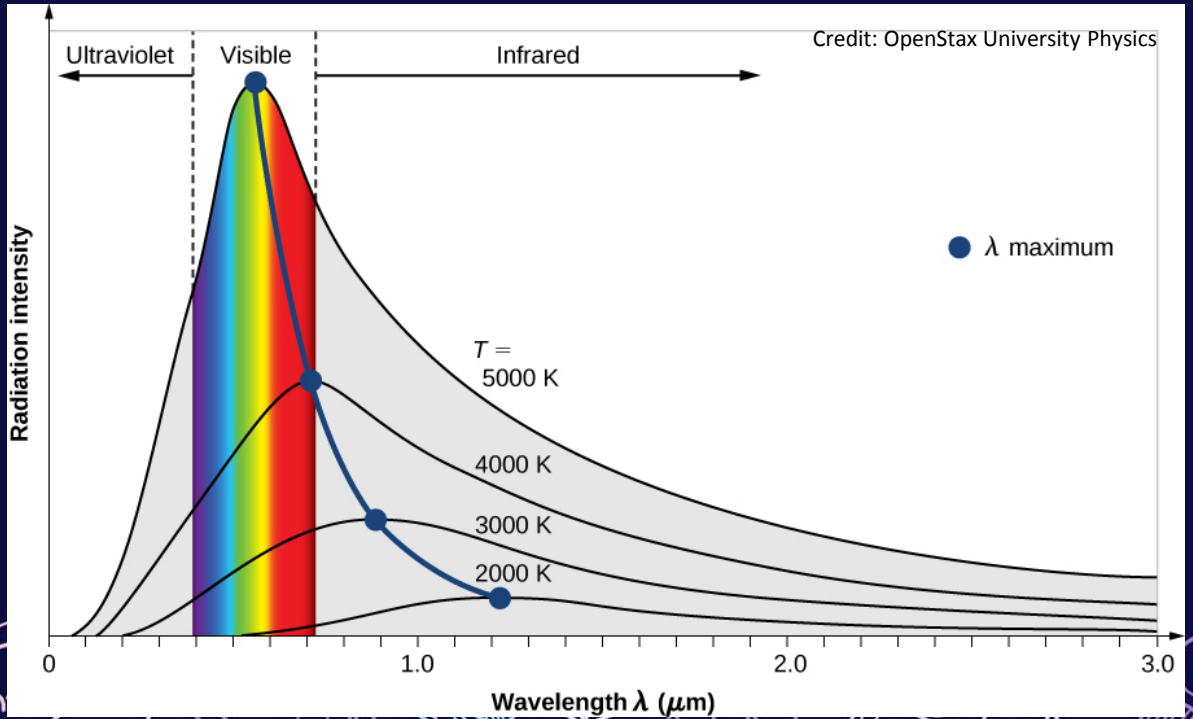
H-R diagram
Main sequence

Stellar Classification

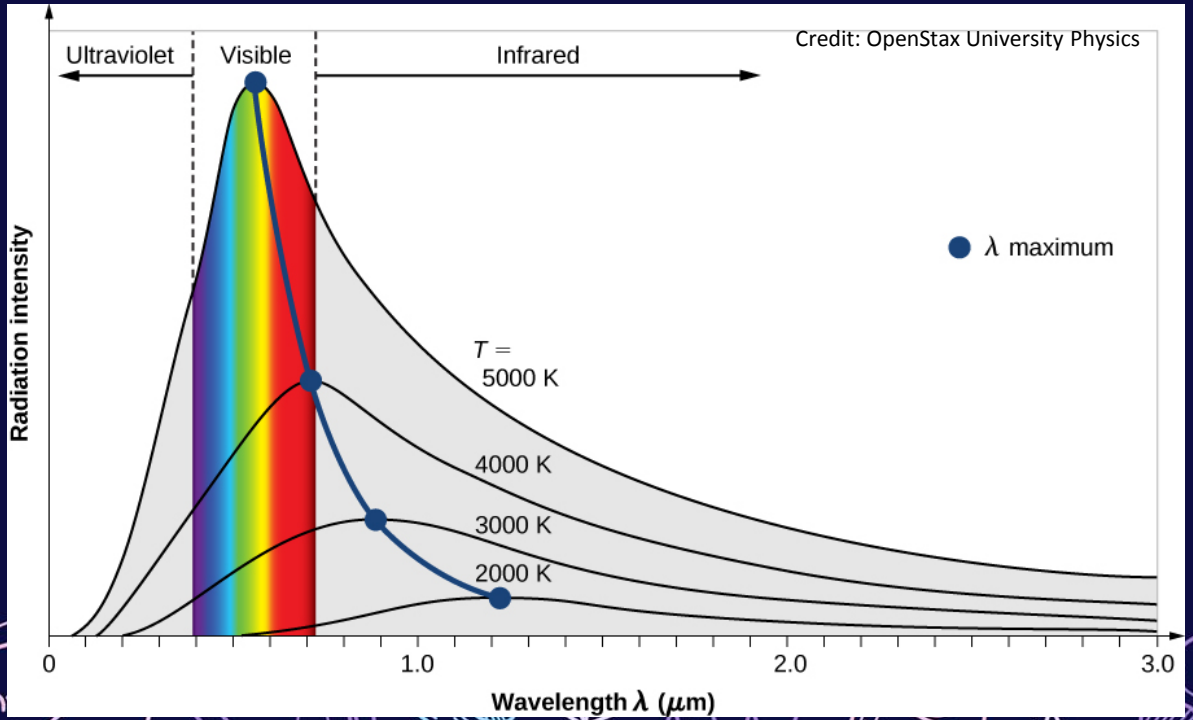
11.15.19

What do we see?

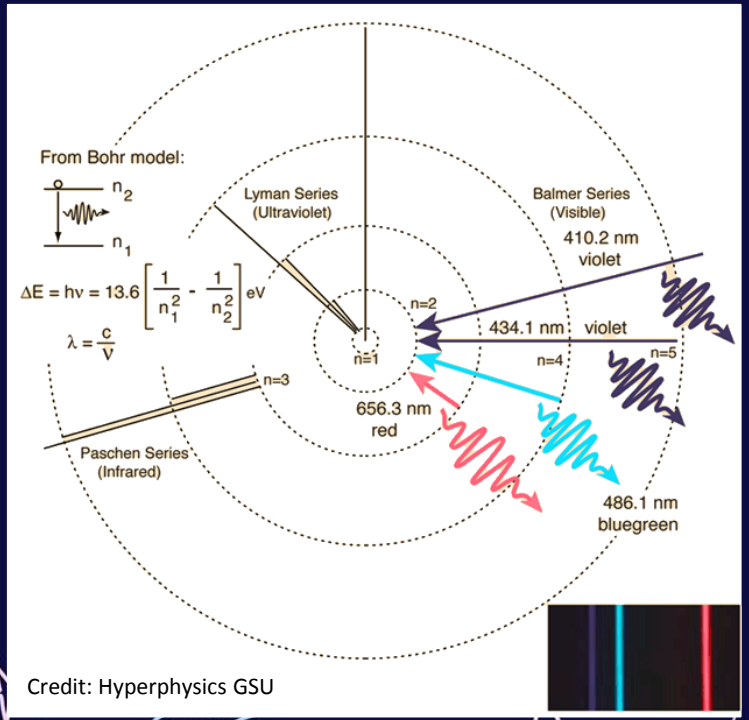
Why are stars different colors?



Why aren’t there green stars?

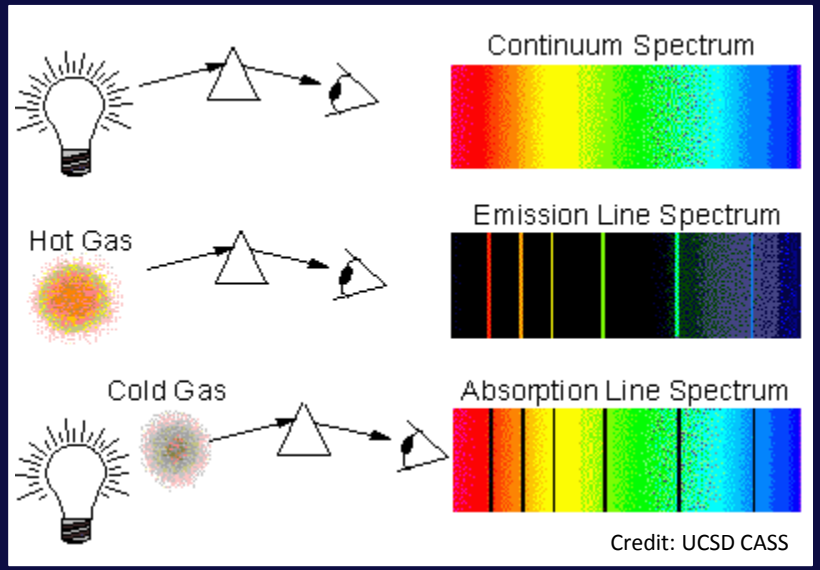


From stars down to atoms...



Credit: Hyperphysics GSU

~Spectroscopy~



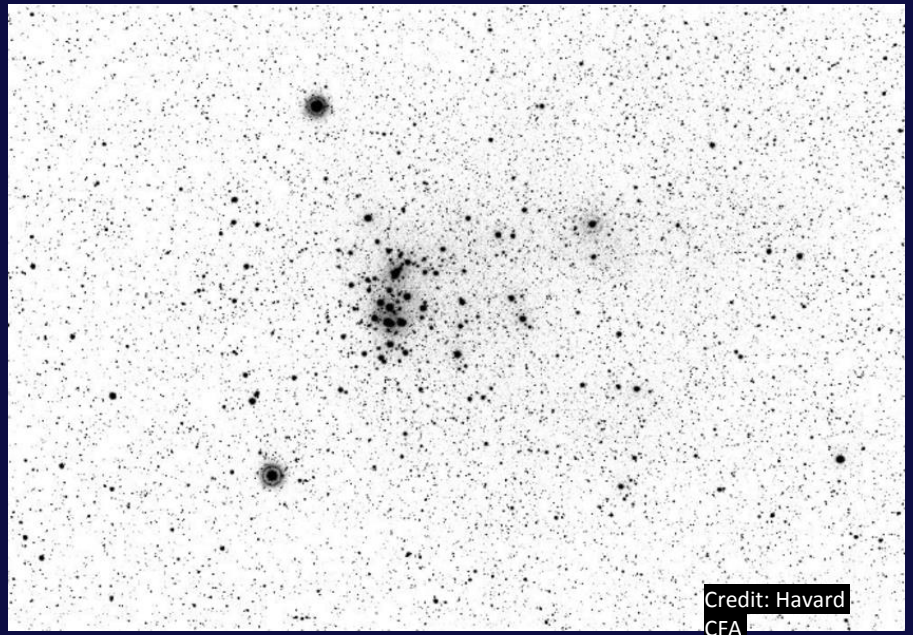
Draper Catalog and Williamina Fleming

- 1st photo of a stellar spectra (Vega's spectra, to be specific)
- Classified over 10,000 stars in the first version of the catalog
- Used letters A-Q
  - P for planetary nebula
  - Q for oddballs
- Antonia Maury rearranged the classification order

Credit: Havard CFA

Annie Jump Cannon

- Focused on Balmer lines and dropped a lot of letters
- Rearranged to
  - OBAFGKM
  - (Oh, be a fine guy/girl, kiss me)
- Classified over 350,000 stars
  - could do 3 stars a minute

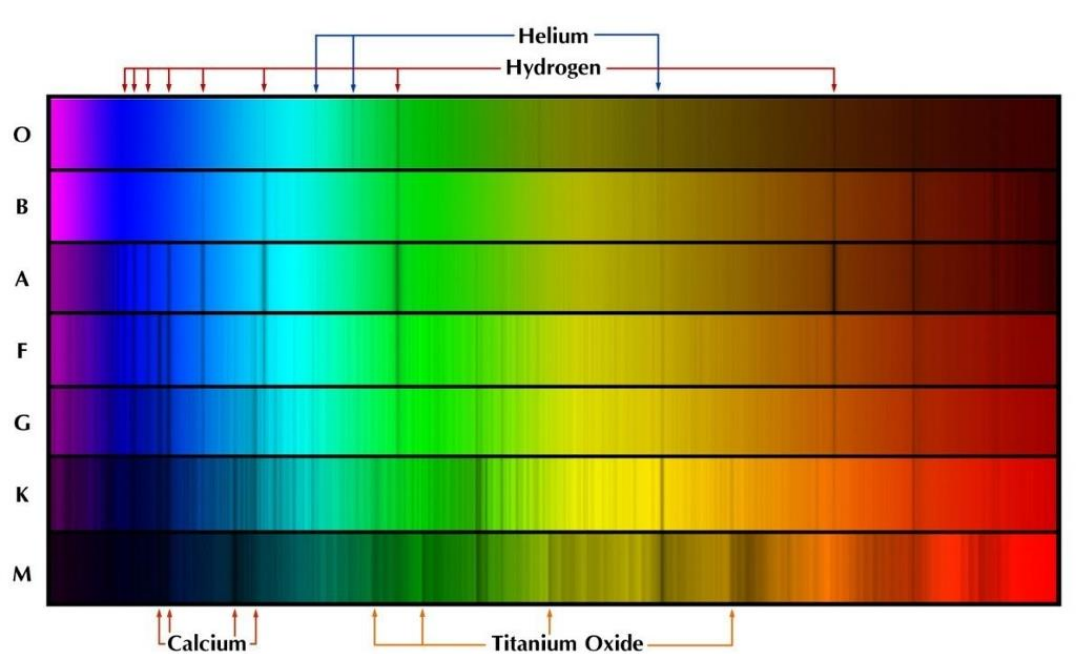


Glass Plates

- Those little smudges? Spectra!! About a cm long!! Dozens of them on this single photograph!
- Handwritten notes on which star is which and their classifications
- Over 500,000 glass places at the CFA
- Currently being digitized

Credit: Havard CFA

Spectral Classes



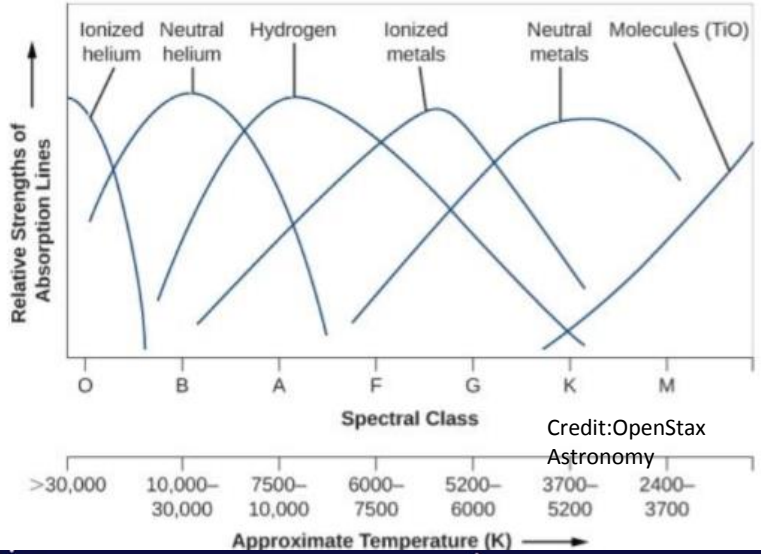
Credit: UNL Astronomy

Why different spectra?

Cecilia Payne-Gaposchkin

- Earned a Ph.D. from Harvard for her work
- Built on Saha's ionization theory
- Reasoned that stars' spectra are not different because of entirely different composition
  - Instead, differences are due to temperature

Ionization



Credit:OpenStax Astronomy

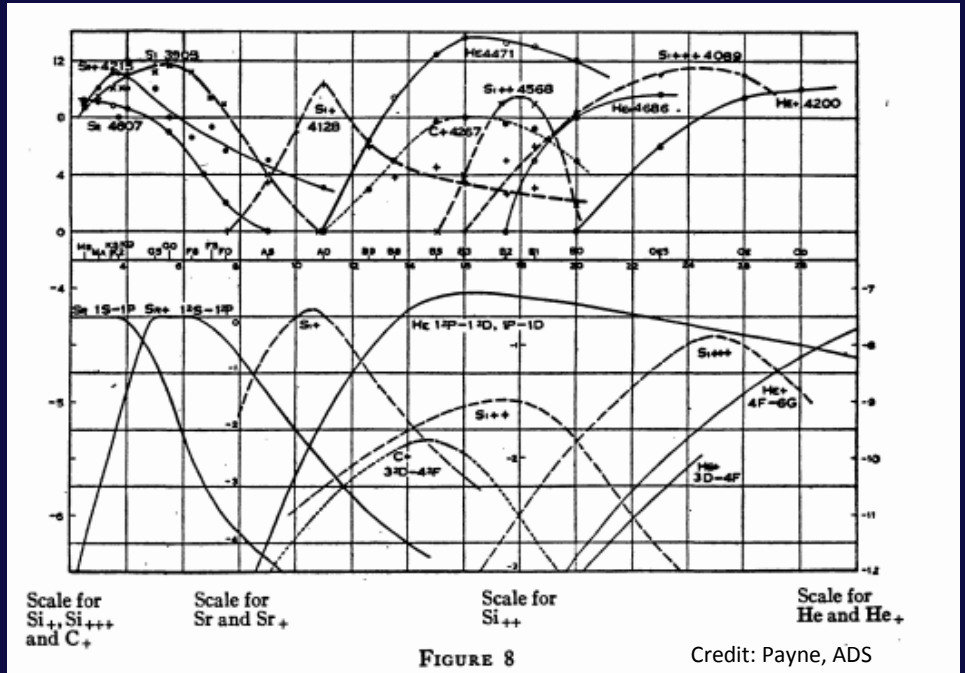
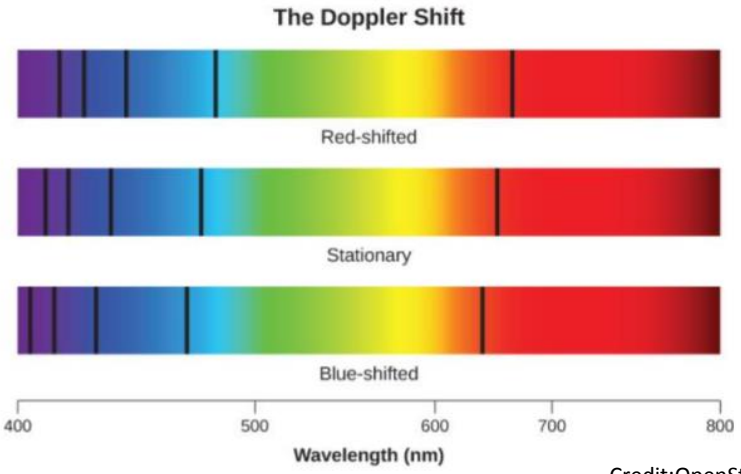


FIGURE 8

Credit: Payne, ADS

Reproduced from H.C.256, 1924. Comparison between observation and ionization theory for the hotter stars. The observations are contained in the upper part of the diagram, and the theoretical curves (based on a partial electron pressure 1.3×10^{-4} atmospheres) are given in the lower part of the figure. For the upper half, ordinates are the observed intensities contained in Table XIX; abscissae are spectral classes from the Draper Catalogue. In the lower part of the figure, ordinates are logarithms of computed fractional concentrations; abscissae are temperatures in thousands of degrees. The abscissae of the upper and lower diagrams have been adjusted so that the observed and computed maxima coincide, thus forming a preliminary temperature scale.

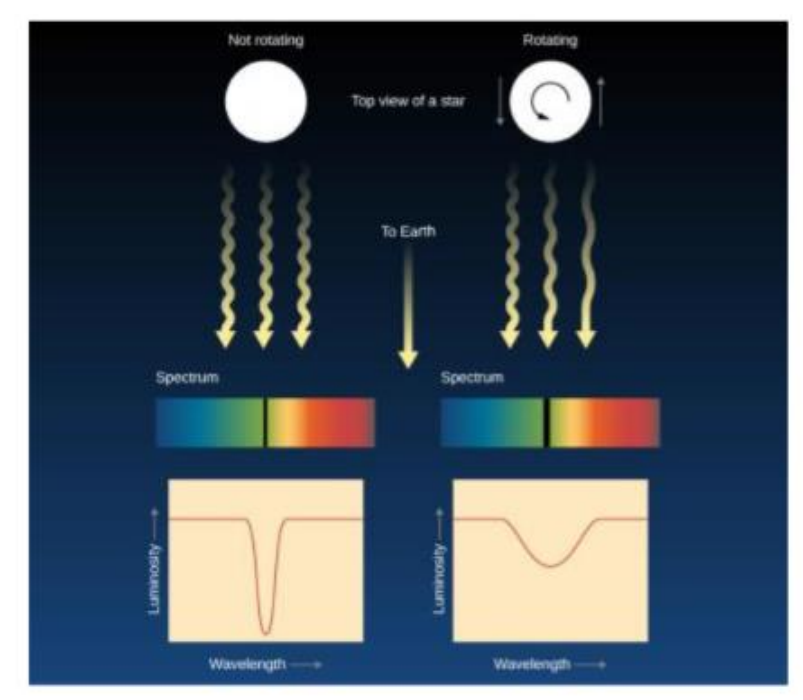
Doppler Shift



Credit:OpenStax Astronomy

Doppler-Shifted Stars. When the spectral lines of a moving star shift toward the red end of the spectrum, we know that the star is moving away from us. If they shift toward the blue end, the star is moving toward us.

Doppler Broadening



Credit:OpenStax Astronomy