ASTR 1020: Stars & Galaxies
February 11, 2008

- *MasteringAstronomy* Homework on The Properties of Stars is due Feb. 18th.
- Reading: Chapter 15, section 15.1.
- Meet at Fiske Planetarium for class on Feb. 15th.

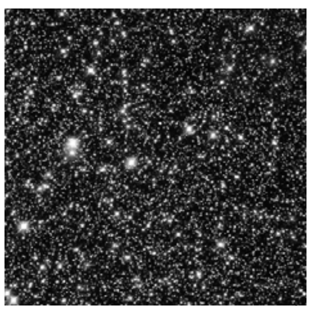
Astronomy Picture of the Day

View looking south from the historic mountain top Pic du Midi Observatory combines moonlit domes, a winter night sky, and the snowy peaks of the French Pyrenees. Encroaching on the night, lights from the La Mongie ski resort illuminate the mountain slopes. The night sky features stars of the constellations Orion and Gemini with a bright planet Mars very near the top edge, left of center.

Today's Class: Measuring temperatures of stars

Stellar temperatures

Spectral classes



Astronomer's Toolbox: What do we know how to do now?

- Measure distance: parallax, good to nearby stars but not beyond
- Measure absolute luminosity:
  measure apparent brightness and distance, infer luminosity

Today: temperature

Clicker Question

A star whose spectrum peaks in the infrared is

a) Cooler than our Sun.
b) Hotter than our Sun.
c) Larger than our Sun.
d) More luminous than our Sun.

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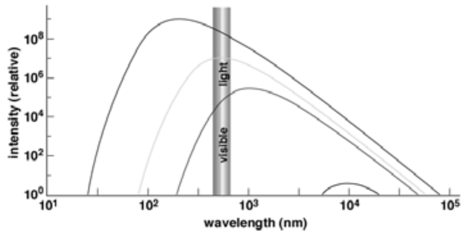
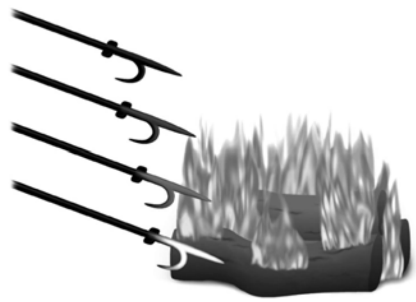
Two ways to measure temperature

1) Thermal spectrum (i.e. Chapter 5)

Hotter = bluer; cooler = redder

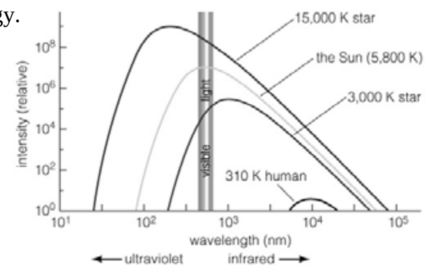




Every object emits ***thermal radiation*** with a spectrum that depends on its temperature

Properties of Thermal Radiation

1. Hotter objects emit more light per unit area at all frequencies.
2. Hotter objects emit photons with a higher average energy.



Hottest stars:

50,000 K

Coolest stars:

3,000 K

(Sun's surface is 5,800 K)

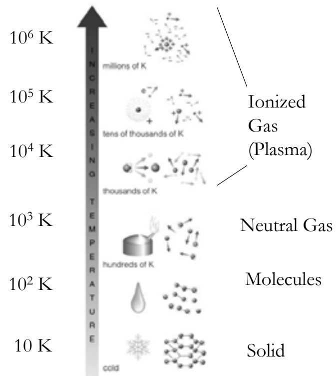
2.) Spectral class

- Different atoms and molecules can be characterized as "tough" or "fragile"
- The more complex, the more fragile
- Fragile types are more easily ionized or knocked apart by collisions in high temperature regions

→ If there are signs of fragile atoms and molecules, the temperature must be low

Ranking common atoms and molecules

- Helium- toughest, "inert gas";
  ionized Helium even tougher!
- Hydrogen- pretty tough
- Heavier atoms (Oxygen, Calcium)- fragile
- Molecules- most fragile



Level of ionization also reveals a star's temperature

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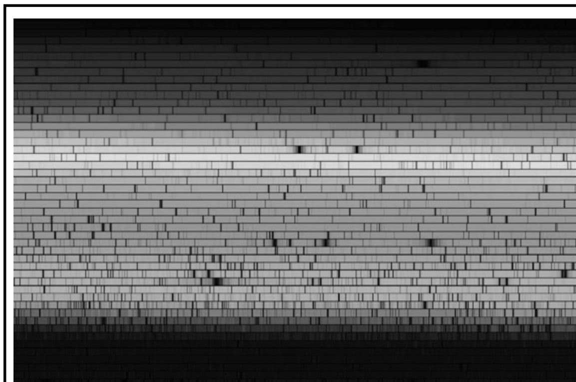

Absorption lines in star's spectrum tell us ionization level

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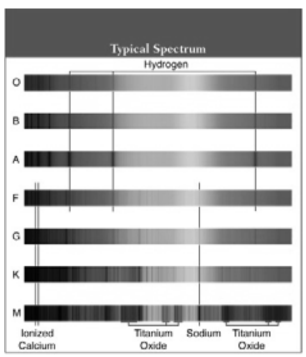
Spectral Classification

Hottest stars: ionized helium only

Hot stars: Helium, hydrogen

Cooler stars: hydrogen, heavier atoms

Coolest stars: molecules, (complex absorption bands)



A bit of history

- World War I, Harvard College
- Women were hired as "calculators" to help with a new survey of the Milky Way
- Most had studied astronomy, but were not allowed to work as scientists

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- Original classification of spectra was:
- A = strongest hydrogen
- B = less strong hydrogen etc.
- Annie Jump Cannon realized that a different sequence made more sense

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Clicker Question

Which of the following statements about spectral types of stars is *true*?

a) The spectral type of a star can be used to determine its surface temperature.
b) The spectral type of a star can be used to determine its color.
c) A star with spectral type A is cooler than a star with spectral type B.
d) All of the above are true.

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Clicker Question

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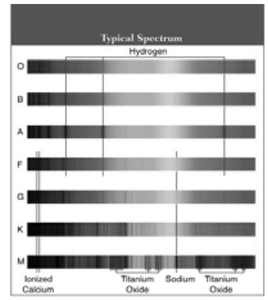
Cannon's sequence: OBAFGKM

- Ranked stars from hottest to coolest.



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- Important: the different spectral lines seen are **NOT** primarily because stars are made of different elements
- Most stars are made mostly of hydrogen
- The variety in spectra is due to temperature via the **survival of** electrons attached to atoms and molecules in at the star's surface

Cecelia Payne-Gaposchkin figured this out

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OBAFGKM

- Oh Be a Fine Guy/Gal, Kiss Me!

O = bluest, hottest

G = yellow (Sun)

M = reddest, coolest

What have we learned?

- How do we measure stellar luminosities?
  - If we measure a star's apparent brightness and distance, we can compute its luminosity with the inverse square law for light
  - Parallax tells us distances to the nearest stars
- How do we measure stellar temperatures?
  - A star's color and spectral type both reflect its temperature

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