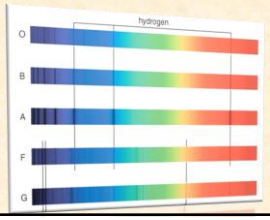
ASTR 1020: Stars & Galaxies

September 25, 2013

- Reading: Chapter 15, section 15.1.
- Exam 1 next class! Review Session tomorrow night, Sep. 26, at 7 pm in Duane G2B47.
- Naked eye observing session tonight at 8 pm.
- Volunteers for *Astronomy in the News* presentations.



Exam 1 will cover

- All material discussed in class, readings, recitations, and homeworks up through today's class.
- Textbook: Chapters 1 (Sections 1.1-1.2), Chapter 4, Chapter 5, Chapter 14, Chapter 15 (Section 15.1).
- *MasteringAstronomy* Homeworks on "Scales of the Universe", "Light and Spectroscopy", and "The Sun".

The Day of the Exam

- Bring a #2 pencil and eraser.
- Bring a calculator if you think you'll need one.
- You may bring an 8.5x11 inch, one-page study sheet (both sides) to the exam.
- Please be prepared to get started right away at 1:00 pm!

Astronomy Picture of the Day:

From the Hubble Space Telescope's Advanced Camera for Surveys, the cluster of galaxies Abell 1689 is seen to warp space as predicted by Einstein's theory of gravity -- deflecting light from individual galaxies which lie behind the cluster to produce multiple, curved images.

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

Today: temperature

Reading 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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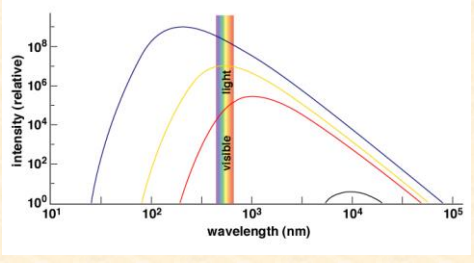
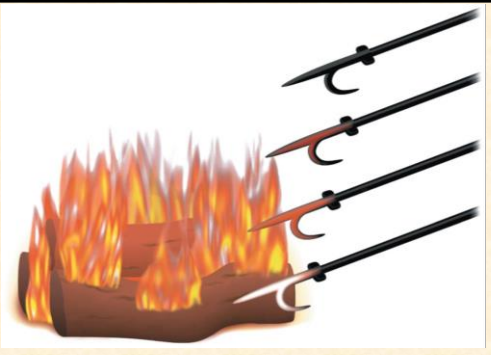
Two ways to measure temperature

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

Hotter = bluer; cooler = redder

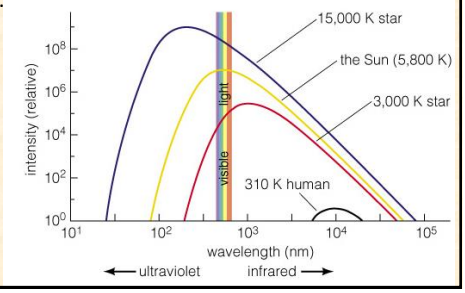


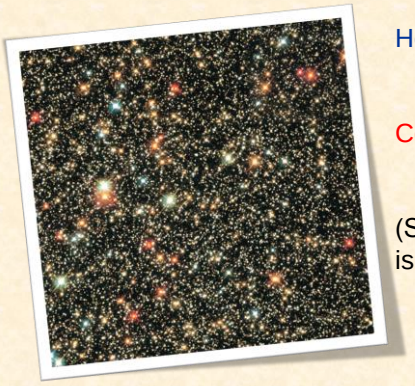


Every object emits ***thermal radiation*** with a spectrum that depends on its temperature

Properties of Thermal Radiation

- Hotter objects emit more light per unit area at all frequencies.
- 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

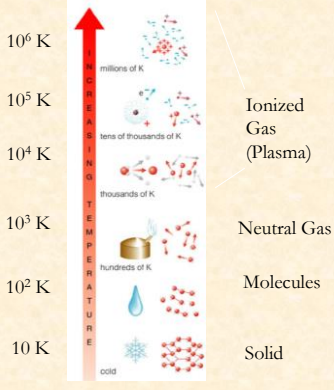
- Different atoms and molecules can be characterized as "tough" or "fragile"
- The more complex, the more fragile
- Fragile types are more easily ionized or knocked apart by collisions in high temperature regions

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

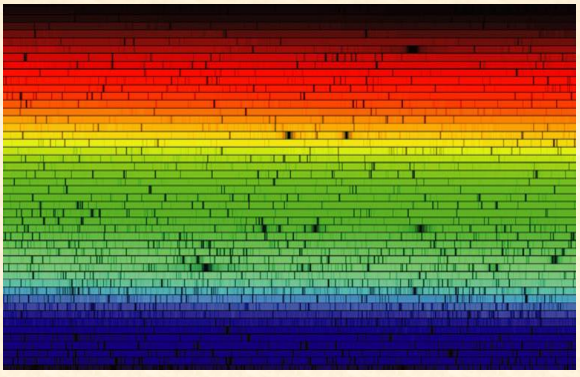
Ranking common atoms and molecules

- 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



Absorption lines in star's spectrum tell us ionization level

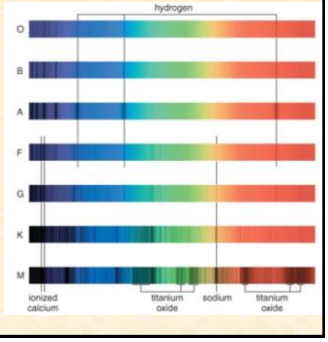
Spectral Classification

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 by Edwin Pickering as "calculators" to help with a new survey of the Milky Way.
- Most had studied astronomy, but were not allowed to work as scientists.

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

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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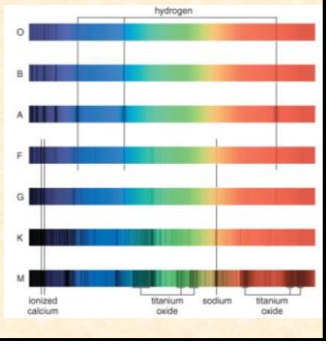
Cannon's sequence: OBAFGKM

- Ranked stars from hottest to coolest.



OBAFGKM

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

O = bluest, hottest

G = yellow (Sun)

M = reddest, coolest

- 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

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