The Observed Properties of Stars

Stars look like points of light in the sky.

How similar are they to the Sun?

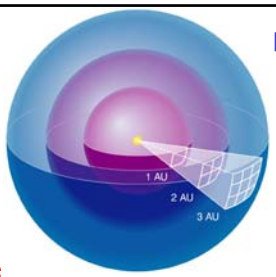
What do we need to measure about these stars in order to make "models" that can be compared to our model of the Sun?

The Observed Properties of Stars

Clicker question: *Which of the following things did we NOT need to know about the Sun in order to compute an accurate model of its interior?*

A. Chemical composition
B. Luminosity
C. Mass
D. Diameter
E. We needed to know all of the above

Finding the luminosity
[11.1]



[Fig. 11.1/11.2]

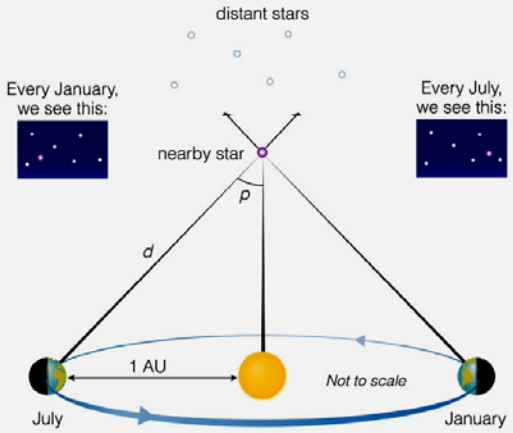
$$F = \frac{L}{4\pi r^2}$$

$$L = 4\pi r^2 F$$

- *Luminosity* = Energy/unit time
- But we measure *flux* incident on Earth
  = Energy/unit time /unit area

➔ Also must know distance *r*

- For nearby stars, use parallax:

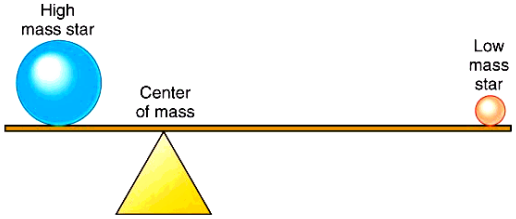


[Fig. 11.2/11.3]

Stellar masses
[11.1]

- Binary stars
- Use Newton's form of Kepler's 3rd law:

$$P^2 = \underbrace{\frac{4\pi^2}{G}}_{\text{constant}} \frac{a^3}{m_1 + m_2}$$

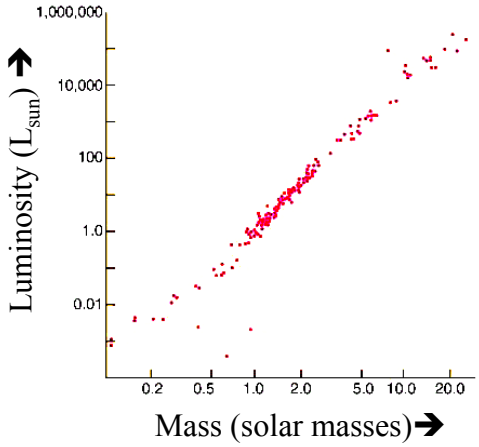


Orbits are about center of mass.

applet

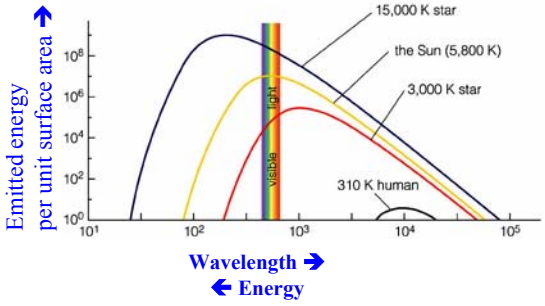
Mass - Luminosity Relation

- Key observational result for theoretical interpretation of different types of stars.



Finding the star's diameter

[Fig. 5.10]



- Total energy emitted *per unit surface area*

Stefan-Boltzmann Law: $E = \sigma T^4$

- Total energy from whole star:

$$L = E \times (\text{surface area}) = (\sigma T^4) \times (\pi D^2)$$

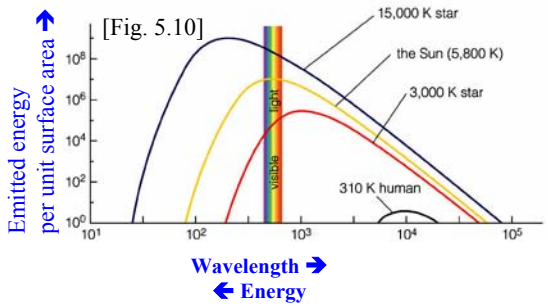
Surface area of sphere of diameter D

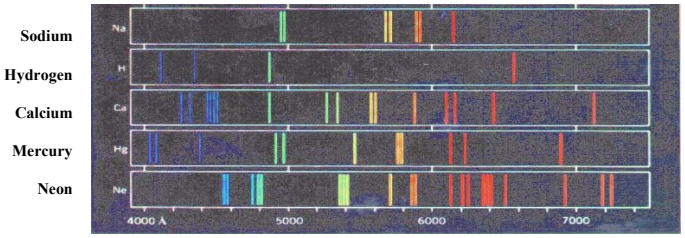
Luminosity

Taking a star's (surface) temperature

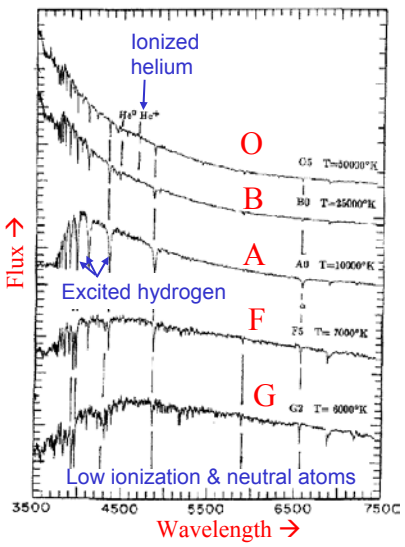
Two Ways:

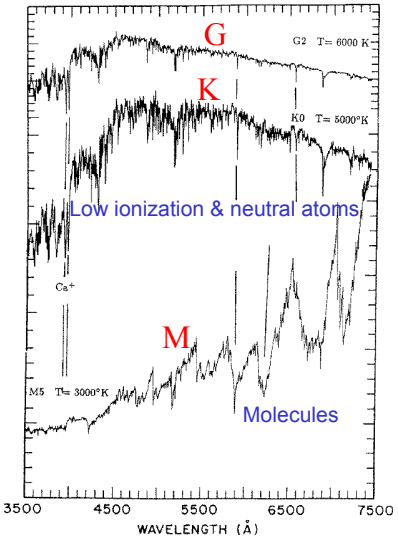
- Thermal radiation curve
- Spectroscopy





Different stars have very different-looking spectra.



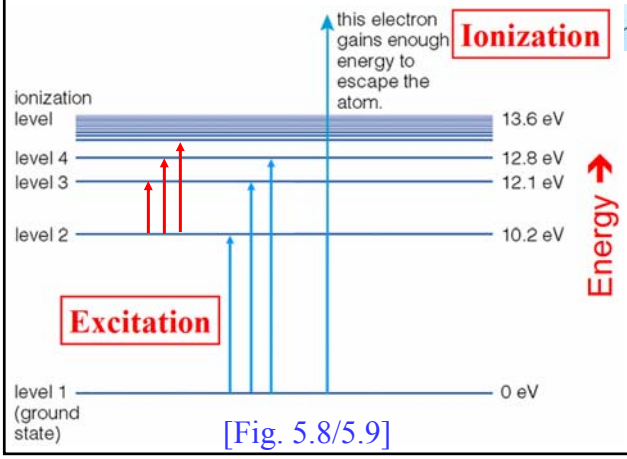


What causes these differences?

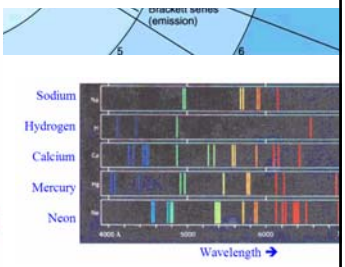
1. Ionized atom has entirely different energy level structure
➔Entirely different set of absorption lines.

2. Excitation, ionization can also be caused by *collisions* between atoms.

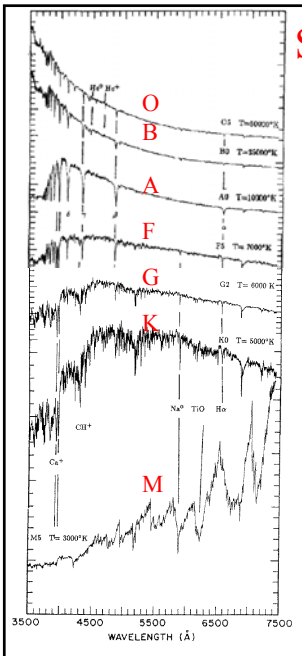
3. Higher temperatures ➔ More energetic collisions ➔
   - electrons in higher levels on average.
   - atoms in higher ionization states on average.



[Fig. 5.8/5.9]



$$E = hf = \frac{hc}{\lambda}$$

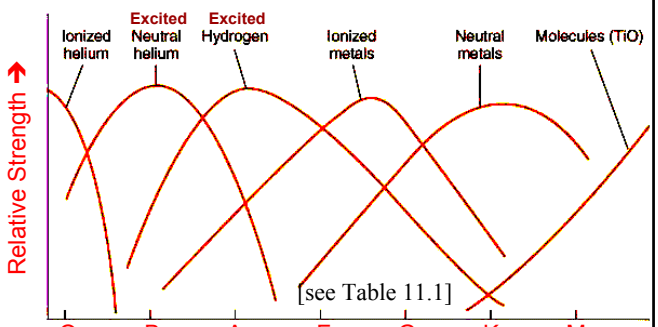


Stellar spectral types

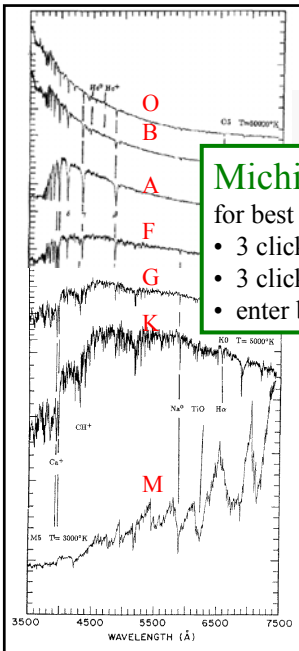
A Temperature Sequence

Higher temperatures ➔

More energetic collisions ➔
- electrons in higher levels on average.
- atoms in higher ionization states on average.



Spectral Type	O	B	A	F	G	K	M
Temperature	30,000		10,000		5800		3500

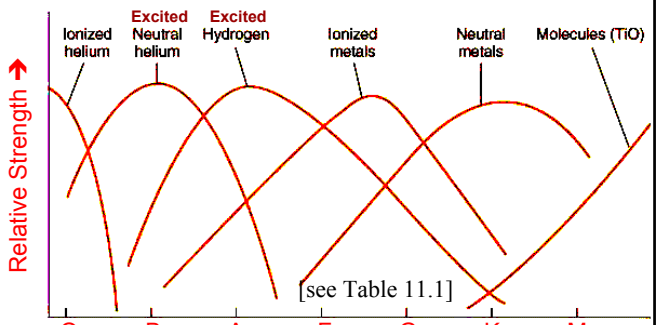


Measuring the surface temperatures of stars

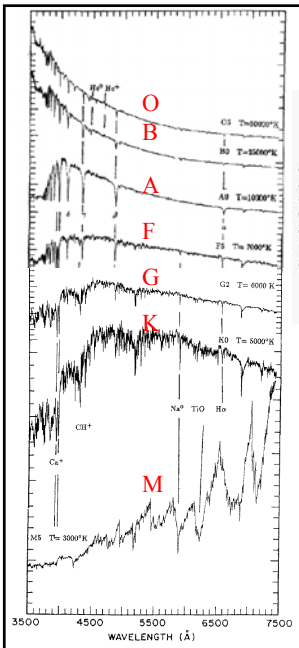
Michigan State Extra-Credit Lottery!

for best OBAFGKM mnemonic.

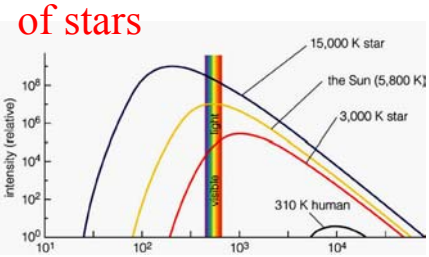
- 3 clicker points for entering.
- 3 clicker points for best answer that can be repeated in class.
- enter by email to baldwin@pa.msu.edu, before Midterm 3.

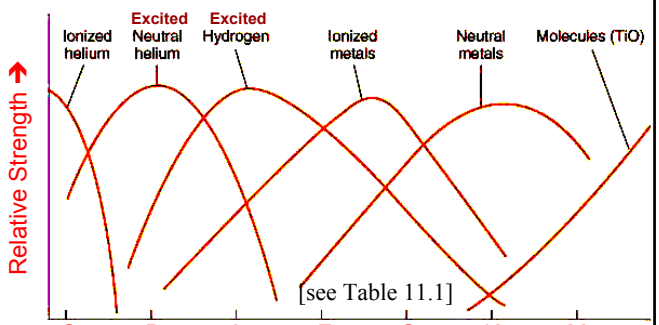


Spectral Type	O	B	A	F	G	K	M
Temperature	30,000		10,000		5800		3500



Measuring the surface temperatures of stars





Spectral Type	O	B	A	F	G	K	M
Temperature	30,000		10,000		5800		3500