Analyzing spectra lecture tutorial (pg 71-74)
the luminosity of a star depends on both its size and its temperature
earlier, when talking about blackbody spectrum, we found that objects at different temperatures emit different amounts of light at different wavelengths
How is this information used in practice to break the degeneracy between luminosity and size?
Spectral Classification
Astronomers have developed filters that only allow light at specific wavelengths. This allows us to select out narrow pieces of the blackbody spectrum and compare the amount of light being emitted at different wavelengths
The diagram illustrates the relationship between wavelength, frequency, and flux for different temperatures. The x-axis represents wavelength (nm) ranging from 1000 to 100, the y-axis represents flux (arbitrary units) ranging from $10^{-4}$ to 1, and the frequency (Hz) ranges from $10^{14}$ to $10^{16}$. The diagram shows three temperature curves: 30,000 K, 10,000 K, and 3000 K. The curves are labeled with points V and B, indicating specific wavelengths or flux values. The diagram also distinguishes between the infrared and ultraviolet regions.
Photometry works great if we want a blunt tool covering a wide range of wavelengths
but it suffers because dust between us and the star will make the star appear redder
But looking very closely at a narrow range of wavelength gives lots of information (absorption/emission lines, doppler shift, etc.)

Part of this information is the temperature of the star
But we don’t extract temperature based on the shape of the emission because we cover too narrow of a wavelength range (along with other complications)

instead we have to use a slightly more clever method
the relative strengths of the lines changes as the temperature of the star changes
very, very hot stars have more helium absorption

hot stars have strong hydrogen

cool stars have weak hydrogen and helium absorption lines, but stronger absorption lines from metals
(this is not simply a sign that they have very little hydrogen and helium and lots of metals)
Suppose we had three stars, all with the same mix of elements (hydrogen, helium, nitrogen, etc.)
Electron levels

Star 1

Star 2

Star 3

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Here we show the energy levels for one of those elements (e.g. hydrogen)
The only difference between these three stars is which energy state the electrons tend to live in.
What happens when photons from the interior of these stars travel out to their surface?
Star 2

Brightness vs. Wavelength
Star 3
Simply by changing the energy state of the electrons we can make some absorption lines stronger than others.
Why?

electrons can get some energy by collisions with other atoms

high temperature means more collisions -> electrons can get bumped to high levels

the electron energy levels are different for different atoms

at a given temperature some atoms will have all of their electrons in an ‘absorption-ready’ state while others will not

this defines which atoms create absorption lines and thus creates changes in the stellar spectra
'absorption-ready' state for an optical photon
Astronomers came up with different letters to describe the various line strengths

OBAFGKM (LTY)
‘Oh Be A Fine Girl/Guy Kiss Me’
Stars of spectral class M do not show strong lines of hydrogen in their spectra because

A. they contain very little hydrogen
B. the hydrogen lines are swamped by even stronger lines of other elements
C. their surfaces are so hot that most hydrogen is ionized
D. their surfaces are so cool that most hydrogen is in the ground state
A type B9 star is hotter than a type A0

A. True
B. False
The relative strength of flux in the B band compared to the R band is higher in a B9 star than an A0 star

A. True
B. False
Star A, of spectral type M4, has a larger flux than star B, which is spectral type G6. What can you tell about stars A and B?

A. Star A is colder than star B
B. Star A is closer than star B
C. Star A has a larger radius than star B
D. Not enough information