Lec #10: 14 SEP 11 Spectral Classification

- LAST TIME: Color, "Continuous" Emission Spectrum
  - Colors and Color Indices
  - Blackbody Radiation
  - Effective Temperature
- TODAY: Spectral Classification
  - Overview of Blackbody Radiation and Effective Temperature
  - Spectral Classification History and Procedure
- NEXT WEEK: HR Diagram
  - 2-D classification
  - Measuring Mass
  - Mass - Luminosity Relation Spectral Type

2. The Planckian Brightness Distribution

- The functional form of intensity v. wavelength exactly matches an analytic expression...

$B_\lambda(T) = 2hc^2/\lambda^5 \, [e^{hc/\lambda KT} - 1]^{-1}$ erg/s cm^{-2} Å^{-1} sr^{-1}

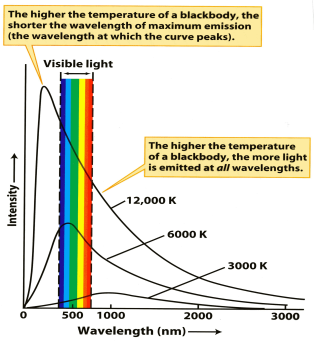
or...

$B_\nu(T) = 2h\nu^3/c^2 \, [e^{h\nu/KT} - 1]^{-1}$ erg/s cm^{-2} Hz^{-1} sr^{-1}

- We'll worry more about the angular distribution later. For now, the observed flux is

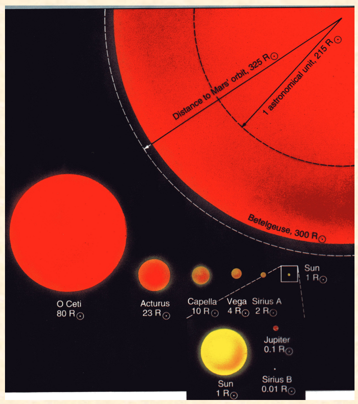
$f = \pi B$ erg/s cm^{-2} Å^{-1}

Blackbody Radiation



Explore for yourself:

1. applet on our website
2. download "Spectrum Explorer" for your computer (or use it in 104)



From L and T_{eff} we can calculate Radius:

$L = 4\pi R^2 \sigma T^4$

But which T?

Can you think of any way to measure radius?

- eclipses
- interferometry

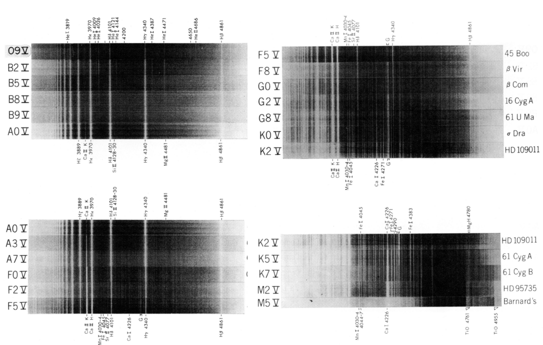
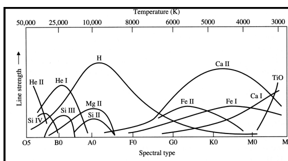


Figure 8.2 Stellar spectra for main-sequence classes B0–F5. (Figure from Abt et al., *An Atlas of Low-Dispersion Grating Stellar Spectra,* Kitt Peak National Observatory, Tucson, AZ, 1968.)

Figure 8.3 Stellar spectra for main-sequence classes F5–M5. (Figure from Abt et al., *An Atlas of Low-Dispersion Grating Stellar Spectra,* Kitt Peak National Observatory, Tucson, AZ, 1968.)



Ionized Helium in O, B stars

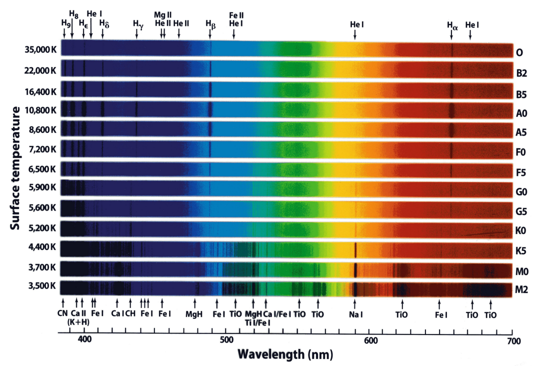
Hydrogen Balmer lines peak at ~ A0 (Vega)

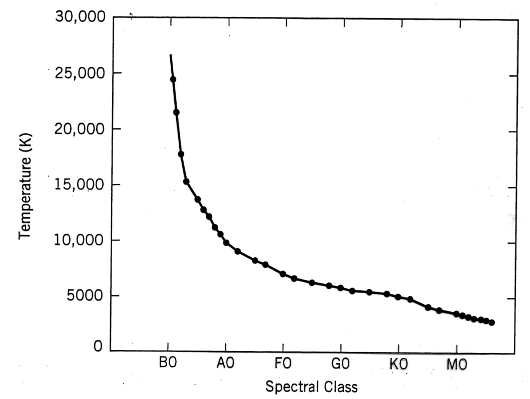
Ca II H & K strongest in G, K stars

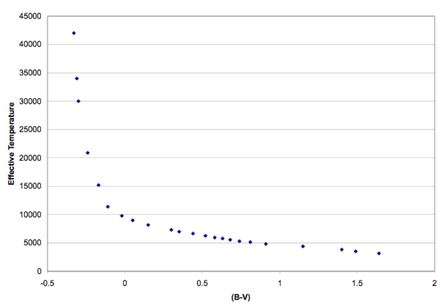
Molecular lines prominent in late M's

Why? temp? composition?

Spectral Type	Characteristics
O	Hottest blue-white stars with few lines. Strong He II absorption (sometimes emission) lines. He I absorption lines becoming stronger.
B	Hot blue-white stars. He I absorption lines strongest at B2. H I (Balmer) absorption lines becoming stronger.
A	White stars. Balmer absorption lines strongest at A0, becoming weaker later. Ca II absorption lines becoming stronger.
F	Yellow-white stars. Ca II lines continue to strengthen as Balmer lines continue to weaken. Neutral metal absorption lines (Fe I, Cr I).
G	Yellow stars. Solar-type spectra. Ca II lines continue becoming stronger. Fe I, other neutral metal lines becoming stronger.
K	Cool orange stars. Ca II H and K lines strongest at K0, becoming weaker later. Spectra dominated by metal absorption lines.
M	Coolest red stars. Spectra dominated by molecular absorption bands, especially titanium oxide (TiO). Neutral metal absorption lines remain strong.







Data from "Astrophysical Quantities" 4E (Allen)

Notice that B-V is single-valued (but not linear) function of Temp.

Measured properties cover a large range:

	min	max	range
Luminosity	10^{-4}	10^{4}	10^{8}
Radius	10^{-2}	10^{3}	10^{5}
Mass	10^{-1}	10^{2}	10^{3}
Temperature	2500	25000	10^{1}

(L, R, M in Solar Units; T in Kelvin)

must plot them on a log-log plot

what do we put on the axes? why?