Convert to ν from λ

$$B_\nu(T)\,d\nu\,d\Omega = B_\lambda(T)\,d\lambda\,d\Omega$$

(i) $$B_\nu(T) = \frac{2hc^2\left(\frac{\nu}{c}\right)^5}{e^{h\nu/kT}-1}$$ because $\nu\lambda = c$

$\Rightarrow \frac{c}{\lambda} = \nu$

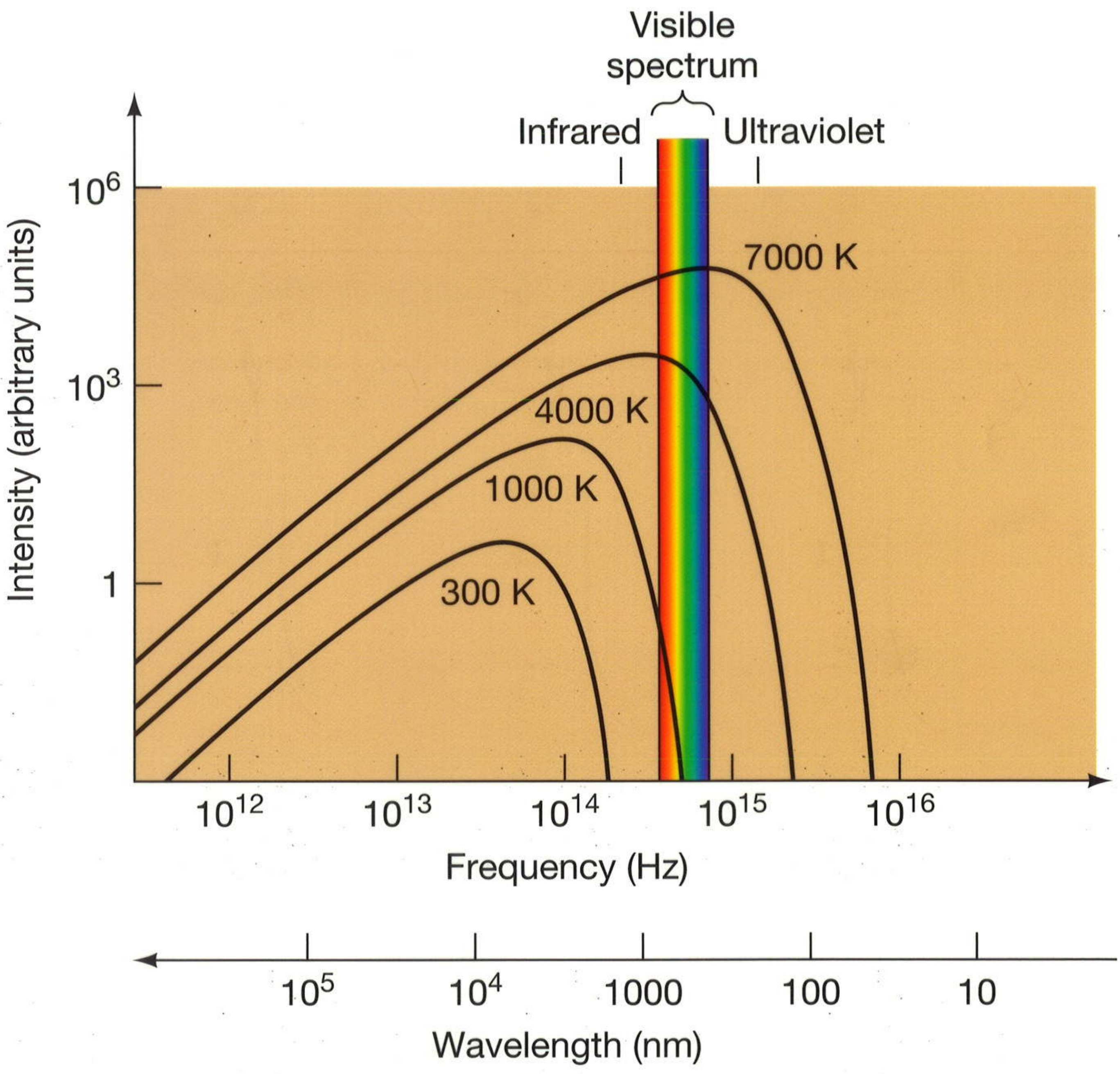
(ii) $$d\lambda = \left|-\frac{c}{\nu^2}\right| d\nu$$

$$\Rightarrow B_\nu(T)\,d\nu = \frac{2hc^2\left(\frac{\nu}{c}\right)^5}{e^{h\nu/kT}-1}\left(\frac{c}{\nu^2}\,d\nu\right)$$

$$B_\nu(T)\,d\nu = \left(\frac{2h\nu^3/c^2}{e^{h\nu/kT}-1}\right)d\nu$$

$$\boxed{B_\nu(T) = \frac{2h\nu^3/c^2}{e^{h\nu/kT}-1}}$$

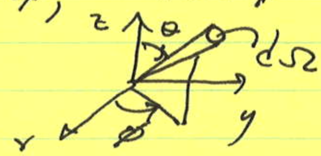
Figure 3.11 Blackbody Spectrum



b) Stefan-Boltzmann Equation

$$f = \int_0^\infty B(\lambda)\, d\lambda\, d\Omega = \text{flux}$$

$\overbrace{\text{solid } \measuredangle,\ \sin\theta\, d\theta\, d\phi}^{d\Omega}$



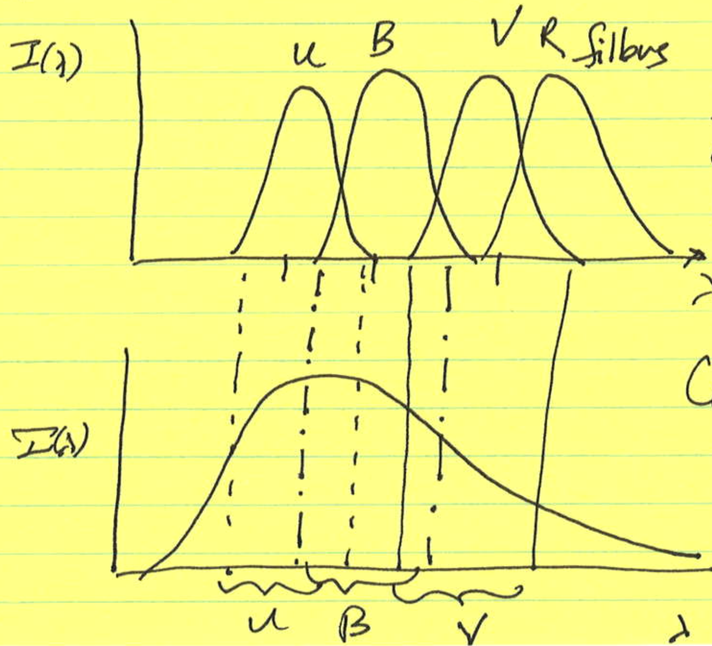
$$\boxed{f_{SB} = \sigma T^4 \qquad \sigma = 5.670\times10^{-8}\ W\, m^{-2} K^{-4}}$$

from the SB equation, define the effective temperature, T_{eff} from,

$$\boxed{\underline{L_* = 4\pi R_*^2 \sigma T_{eff}^4} \Longrightarrow T_{eff}^4 = \frac{L_*}{4\pi\sigma R_*^2}}$$

T_{eff} doesn't necessarily agree w/ T from Wien law (*s aren't blackbodies)

Continued: Broad Band Photometry



Johnson Photometric system

	$\bar{\lambda}$	$\Delta\lambda$	Tm
U	365nm	68nm	~40%(??)
B	440nm	98nm	~40%
V	530nm	90nm	~63%
R	700nm	220nm	
I	900nm	240nm	

Compare energy in each band to get colors

Magnitude Scale

Pogson (1856) noted the brightest *s differed in brightness from the faintest *s by about a factor of 100!

The magnitude difference was 5 between the top and bottom on a logarithmic scale $\Rightarrow$

$$\Delta m = 1 \Rightarrow \frac{I_2}{I_1} = 10^{1/5}$$

or in general,

$$\frac{I_2}{I_1} = 10^{\frac{1}{5}(\Delta m)}$$

$$\Rightarrow \frac{2\Delta m}{5} = \log_{10}\left(\frac{I_2}{I_1}\right) = \log_{10} I_2 - \log_{10} I_1$$

$$\text{or} \quad \underbrace{\Delta m = 2.5 \log_{10}\left(\frac{I_2}{I_1}\right)}_{\text{defines apparent magnitude}}$$

I are observed intensities of 2 *s

$$\Rightarrow \Delta m = 2.5\left[\log_{10}\left(\frac{L_2}{4\pi d_2^2}\right) - \log_{10}\left(\frac{L_1}{4\pi d_1^2}\right)\right]$$

Suppose we let $L_1 = L_2 = L_*$ and consider $d_2 = 10\,pc$, by definition

$$\Rightarrow m - M = 2.5\log_{10}\left(\frac{d}{10pc}\right)^2 = 5\log_{10}\left(\frac{d}{10pc}\right)$$

Figure 17.7 Apparent Magnitude

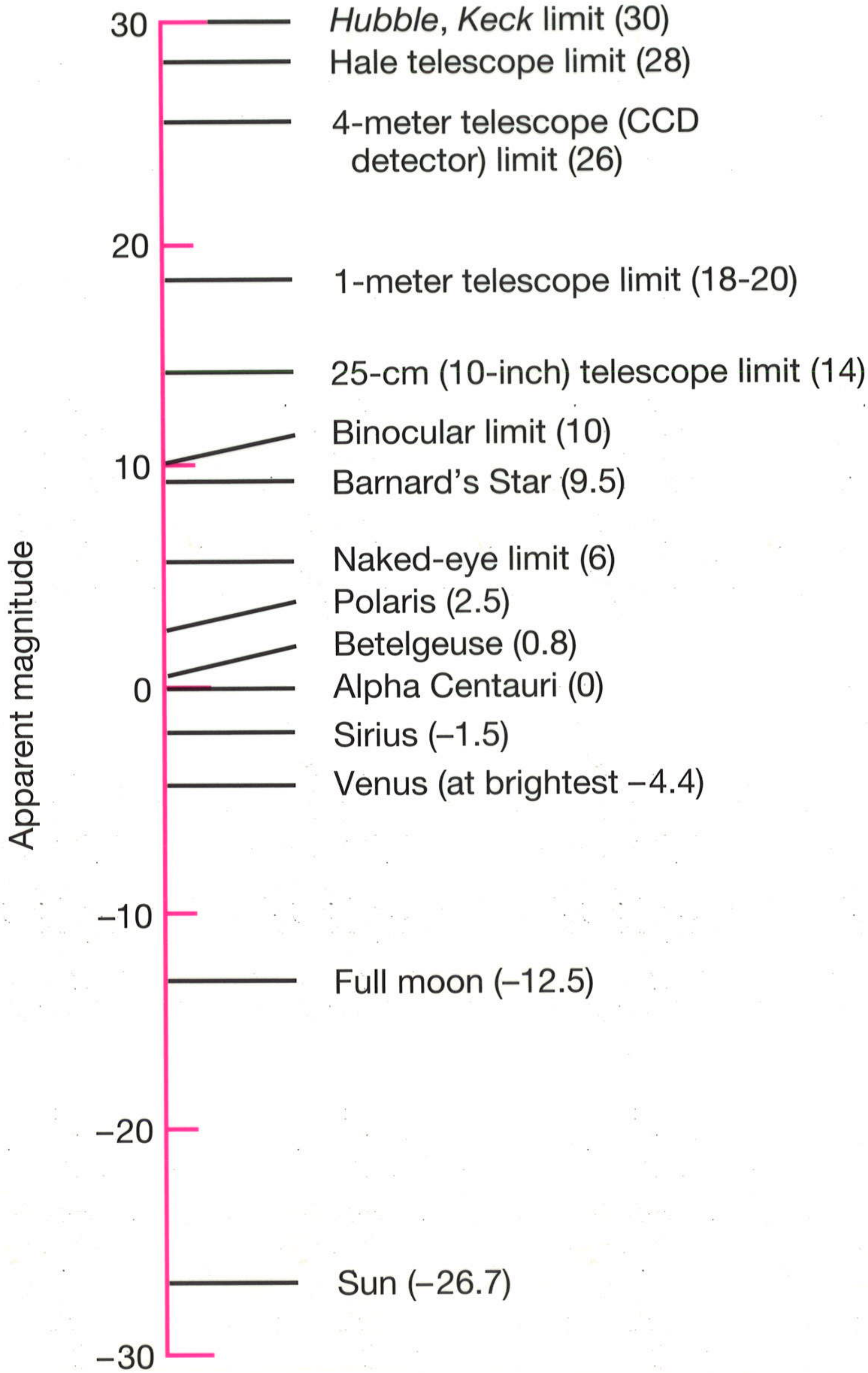


TABLE 17.1 Stellar Colors and Temperatures

$\frac{\text{B flux}}{\text{V flux}}$	Approximate Surface Temperature (K)	Color	Familiar Examples
1.3	30,000	blue-violet	Mintaka (δ Orionis)
1.2	20,000	blue	Rigel
1.00	10,000	white	Vega, Sirius
0.72	7000	yellow-white	Canopus
0.55	6000	yellow	Sun, Alpha Centauri
0.33	4000	orange	Arcturus, Aldebaran
0.21	3000	red	Betelgeuse, Barnard's Star

(13) line temperature (from spectra)

Bohr atom

a) $E = T + W$ for Virial theorem, $2T + W = 0$

$$\Rightarrow \boxed{E = -\frac{1}{2}W + W = +\frac{1}{2}W = -\frac{e^2}{2r}}$$

b) $-\frac{e^2}{r^2} + \frac{m_e v^2}{r} = 0$, force balance

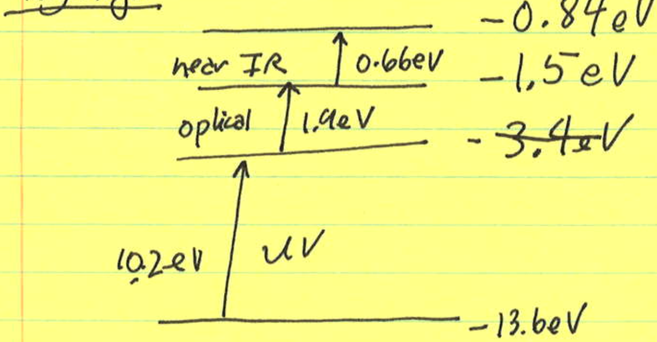
quantized angular momentum $\rightarrow$ in QM, $mvr = n\hbar$, $v = \frac{n\hbar}{mr}$

$$\Rightarrow -\frac{e^2}{r^2} + \frac{m_e}{r}\left(\frac{n^2\hbar^2}{m^2 r^2}\right) = 0$$

$$\Rightarrow \boxed{r_n = \frac{n^2\hbar^2}{me^2} = \text{Bohr radius squared}}$$

$$\Rightarrow \boxed{E_n = -\frac{e^2}{2}\left(\frac{me^2}{n^2\hbar^2}\right) = -\frac{13.6\,\text{eV}}{n^2}}$$

hydrogen



note: $1\,\text{eV} = 1.602 \times 10^{-19}\,\text{J}$

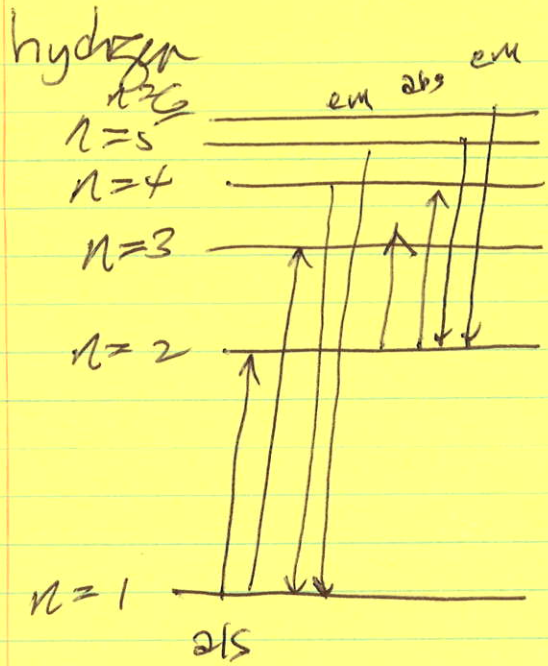
$\Rightarrow 10\,\text{eV} = 1.602 \times 10^{-18}\,\text{J}$

& $\frac{hc}{\lambda} = 1.60 \times 10^{-18}\,\text{J}$

$$\lambda = \frac{6.63 \times 10^{-34}\; 3 \times 10^{8}}{1.60 \times 10^{-18}}\,\text{m}$$

$\simeq 1.3 \times 10^{-7}\,\text{m}$

$\simeq 1{,}300\,\text{Å}$ in near UV



(1) ends or starts at $n=1$

UV { Lyman series, $\Delta n = 1$ α
$= 2$ β
$= 3$ γ
$= 4$ δ
$= 5$ ϵ

(2) ends or starts at $n=2$

opt { Balmer series

(3) ends or starts at $n=3$

opt, IR { Paschen series

(4) ends or starts at $n=4$

IR Brackett series

(5) ends or starts at $n=5$

IR Pfund series

e.g. → Lyman α, $-13.6\,eV \rightarrow 3.4\,eV = 10.2\,eV$

$$\text{engy} = 10.2\,eV \times \frac{1.602\times 10^{-12}\,\text{erg}}{1\,eV}$$

$$= 1.63\times 10^{-11}\,\text{erg}$$

$$E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E} = 1.216\times 10^{-5}\ \text{cm}$$

$$= 1{,}216\ \text{Å}$$

$$1\ \text{Å} = 10^{-8}\ \text{cm}$$

Excitation

a) $E = 1.63 \times 10^{-11}$ erg

(i) $E = kT_{ex} = 1.63 \times 10^{-11}$ erg $= 1.38 \times 10^{-16}\, T_{ex}$

$\Rightarrow T_{ex} \simeq 1.2 \times 10^{5}$ K

(ii) actually it is the tail that excites $\Rightarrow$

$T < T_{ex}$

b) $E \simeq 13.6$ eV $\Rightarrow T_{ion} \approx 2 \times 10^{5}$ K

(ii) actually tail excites $\Rightarrow T_{ion} < T_{ion}$