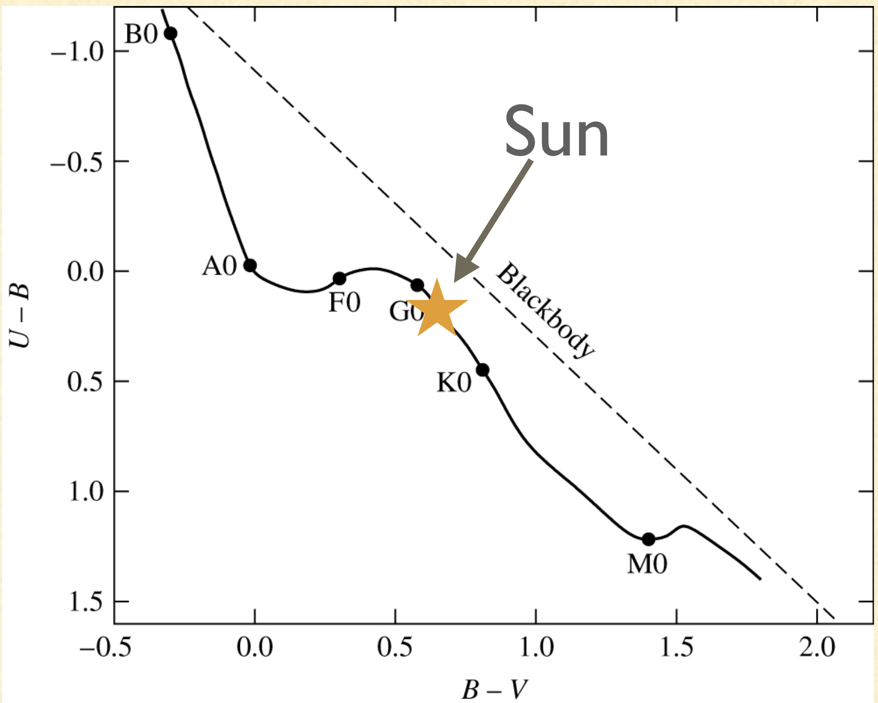
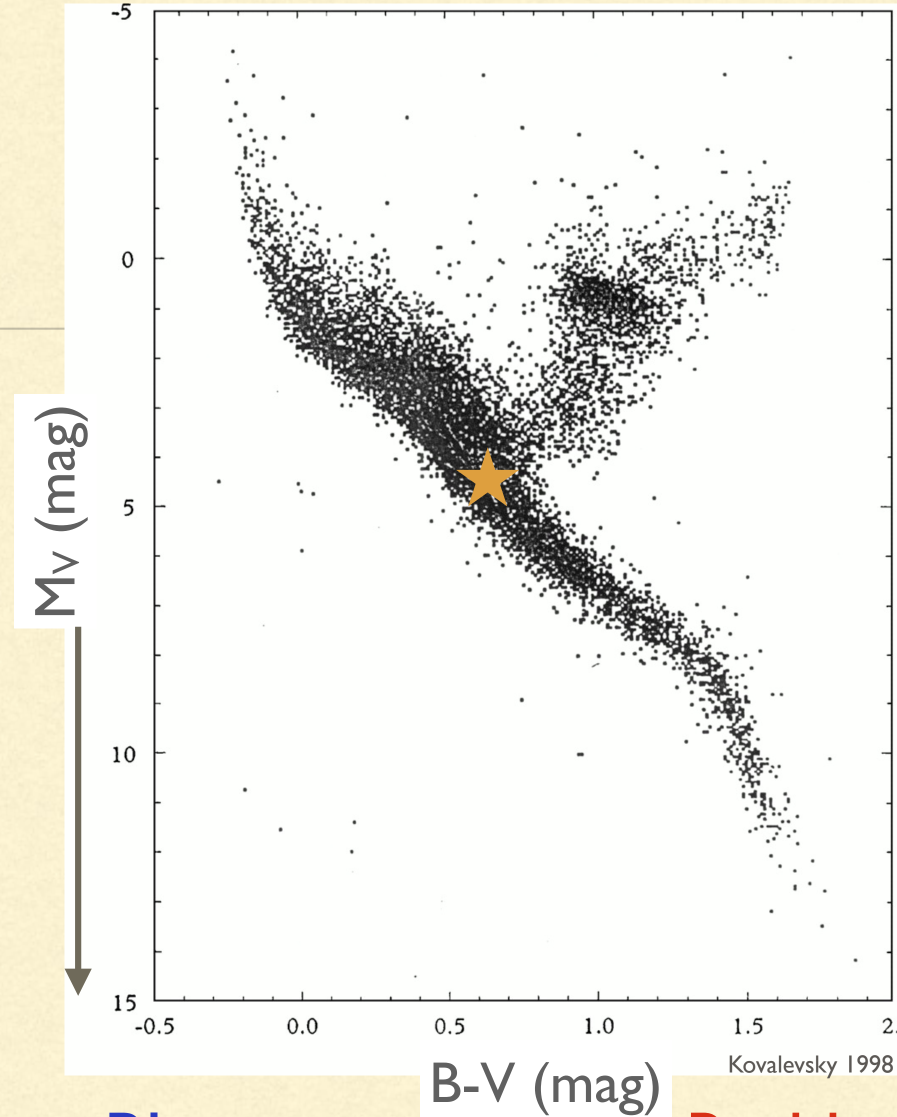
COLORS

Bluer

Redder





Luminosity

Bluer ⟷ Redder

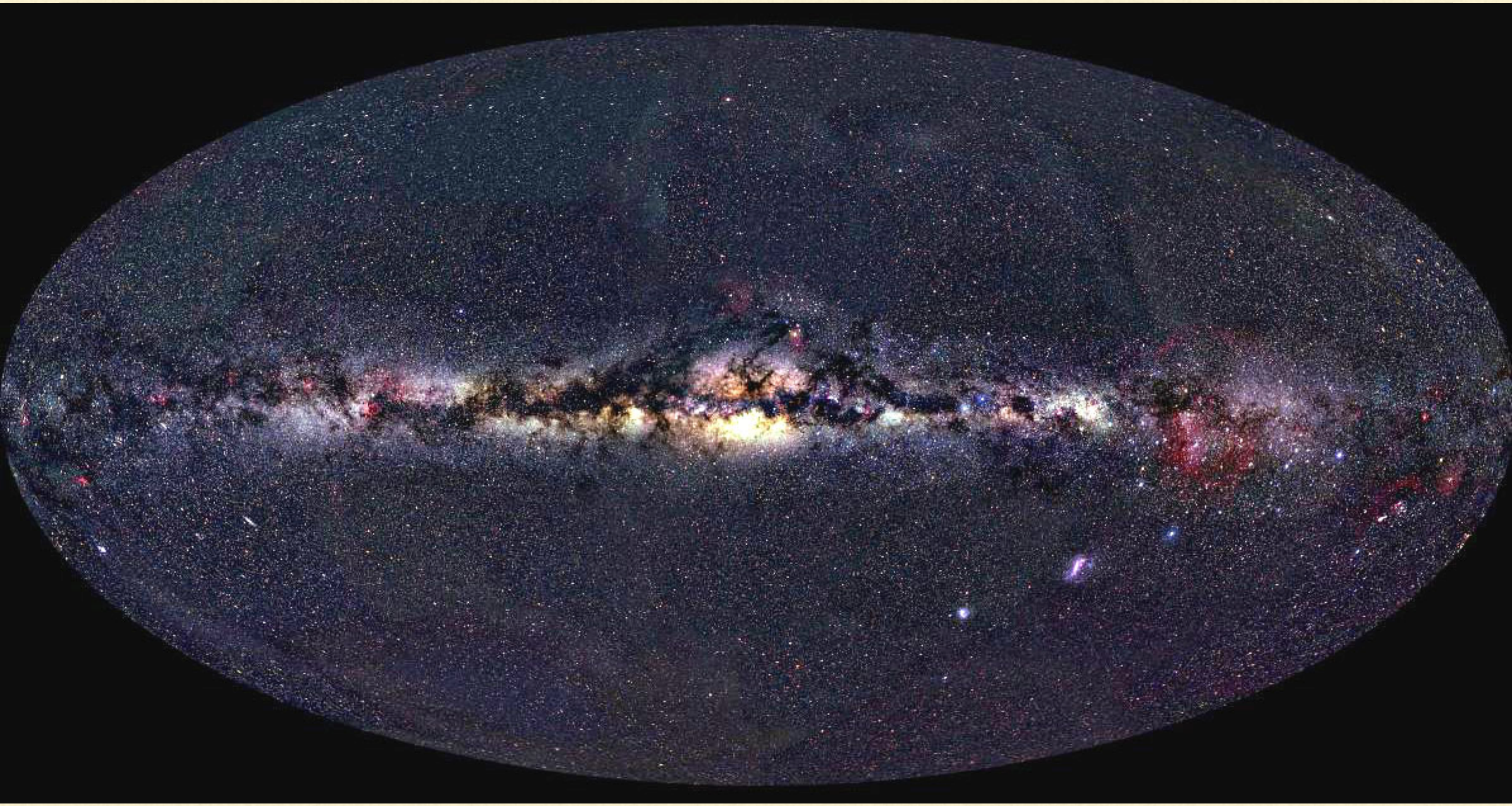
Hotter ⟷ Cooler

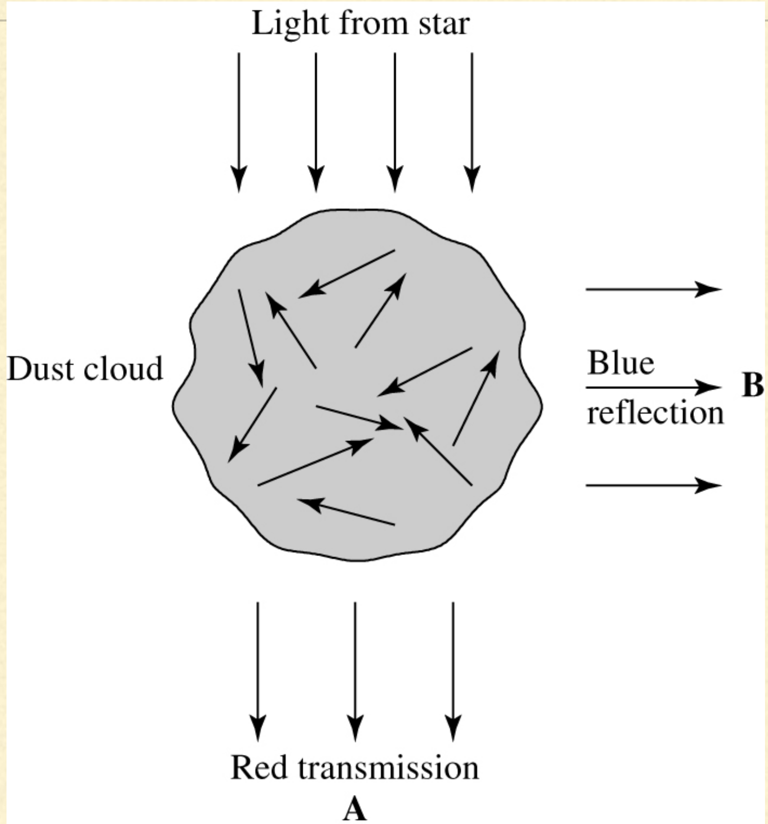
Bluer ⟷ Redder

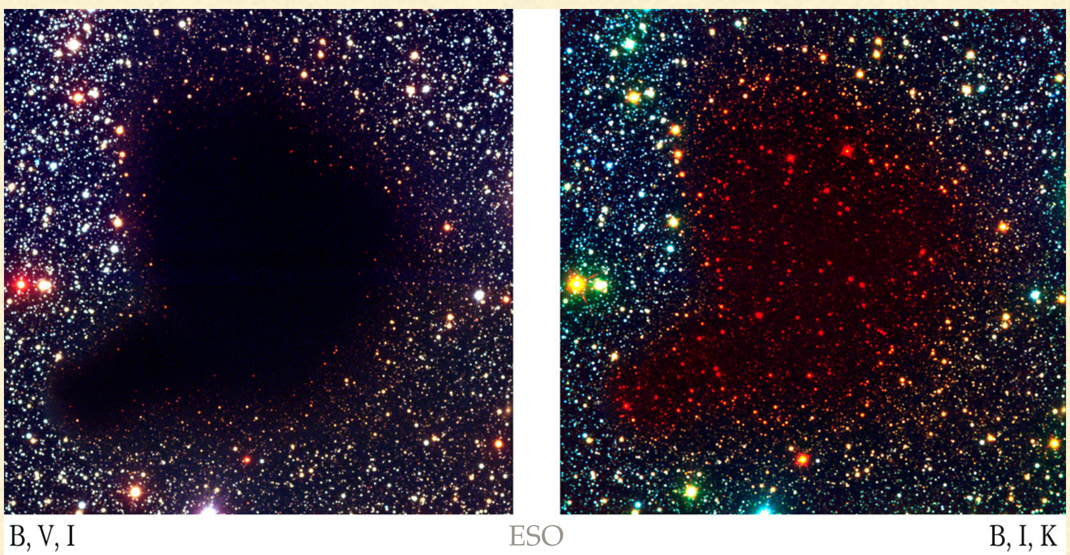
Hotter ⟷ Cooler

(Hipparcos data for stars within 100 pc)

DUST AND REDDENING







- Dust makes stars fainter:

$$m_V - M_V = 5\log_{10}(d/10\text{pc}) + A_V$$

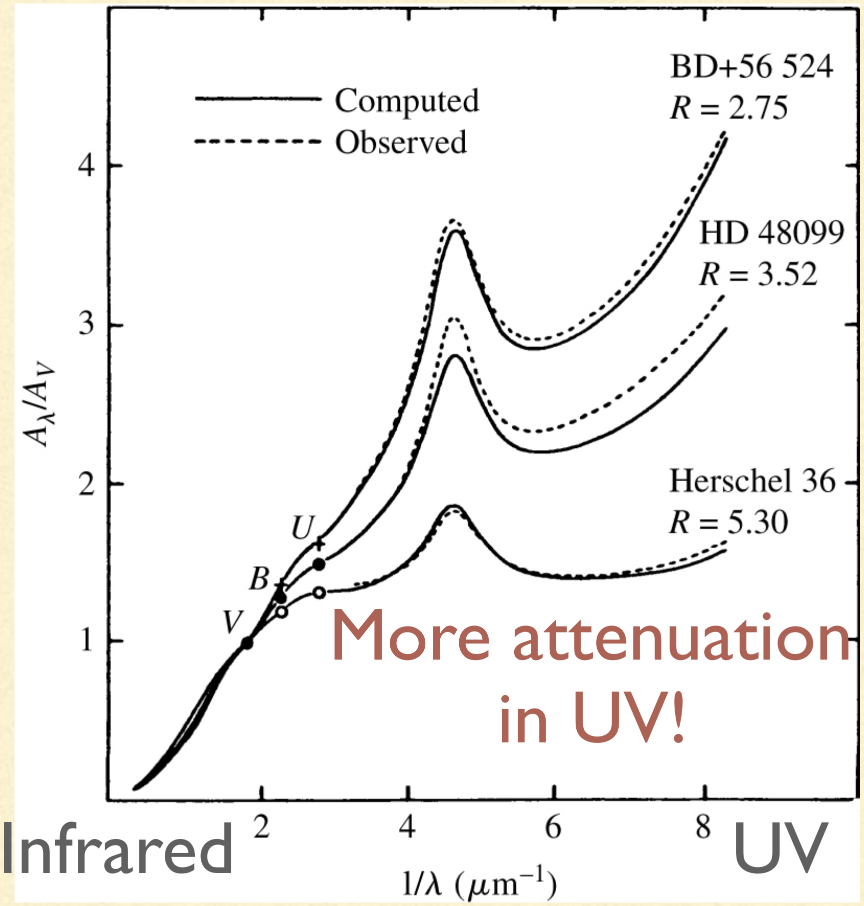
- Dust makes stars redder:

$$(B-V)_{obs} = (B-V)_{true} + E(B-V)$$

- E(B-V) is *color excess*

CO pg. 402 has a sign error in this eqn

EXTINCTION CURVES



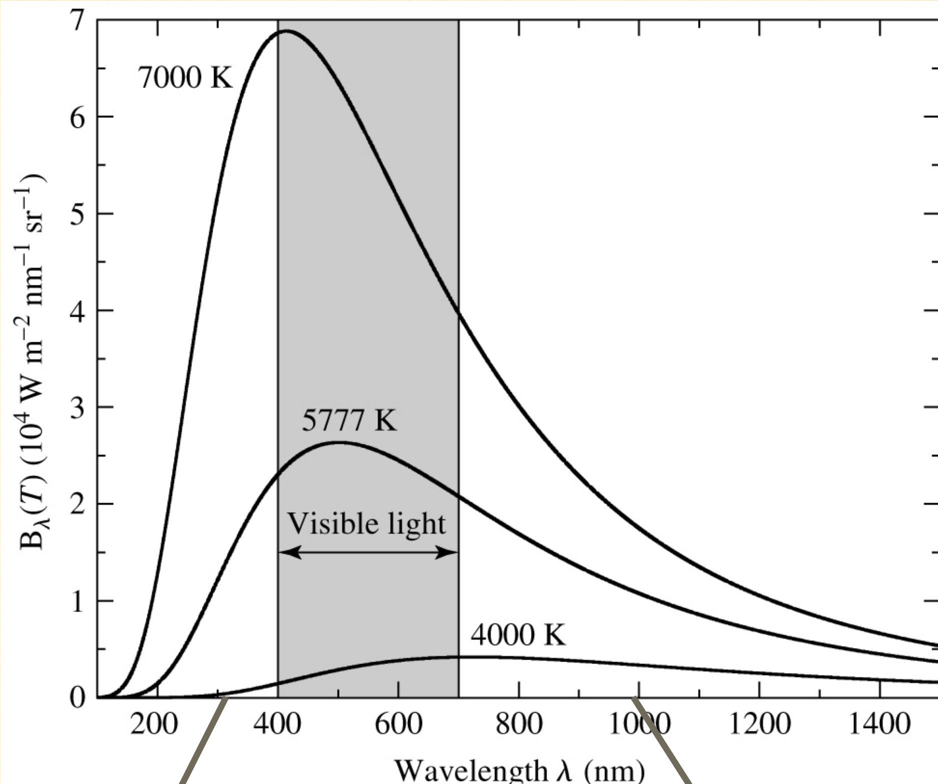
- Dust makes stars fainter:

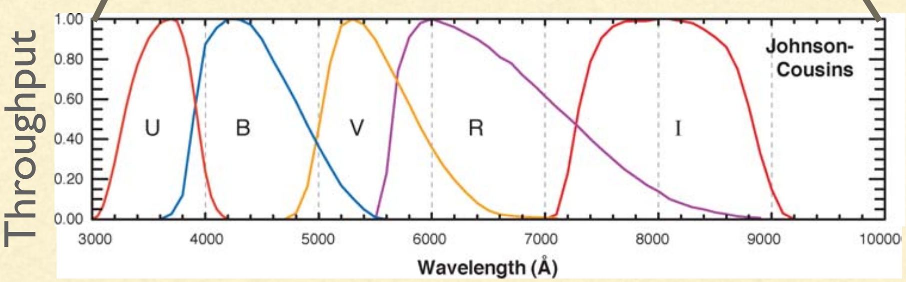
  $m_V - M_V = 5\log_{10}(d/10pc) + A_V$

- Dust makes stars redder:

  $(B-V)_{obs} = (B-V)_{true} + E(B-V)$

- $R_V = A_V / E(B-V)$
- Standard value for Galactic lines of sight is $R_V = 3.1$





FILTERS AND COLORS

- We only measure part of the light when we observe through a filter. For example:

  $$V = -2.5\log_{10}\left(\int_0^\infty F_\lambda S(V)\, d\lambda\right) + \text{Constant}(V)$$

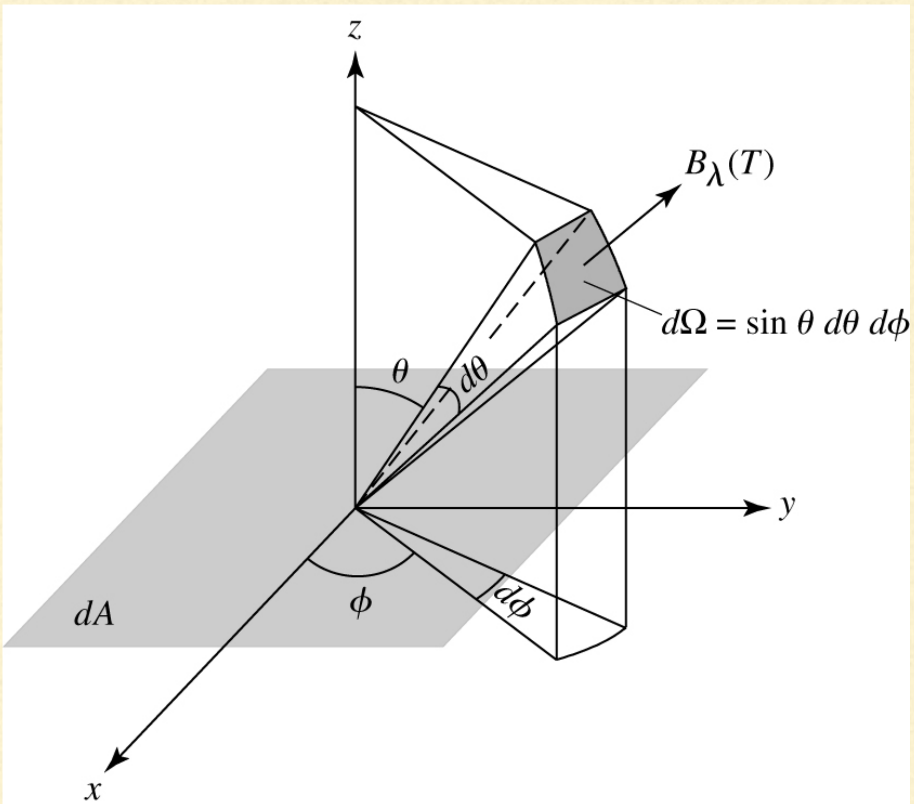
- The bolometric correction is a conversion factor:

  $$BC = m_{bol} - V = M_{bol} - M_V$$

- For Sun: $M_{\odot,bol} = 4.74$ mag $M_{\odot,V} = 4.82$ mag

  So BC = -0.08 mag

PLANCK FUNCTIONS

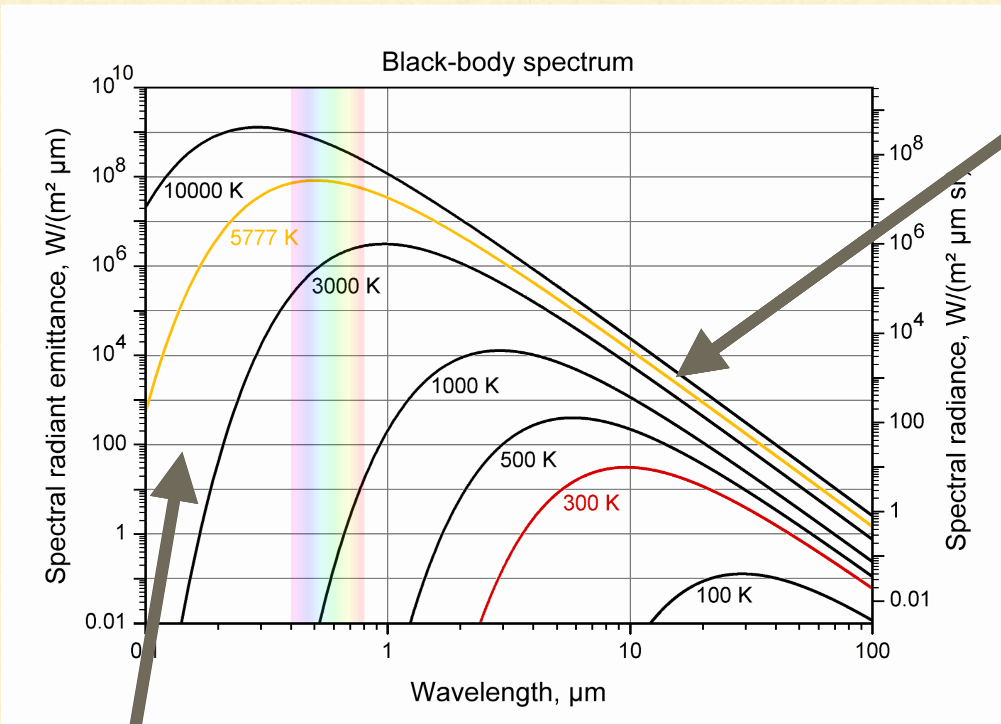


- B_λ is a specific intensity:

  energy / area / time / solid angle / wavelength

  - $B_\lambda \neq B_\nu$

PLANCK FUNCTIONS



- Rayleigh-Jeans Tail

$$B_\nu(T) \approx (2kT/c^2)\,\nu^2$$

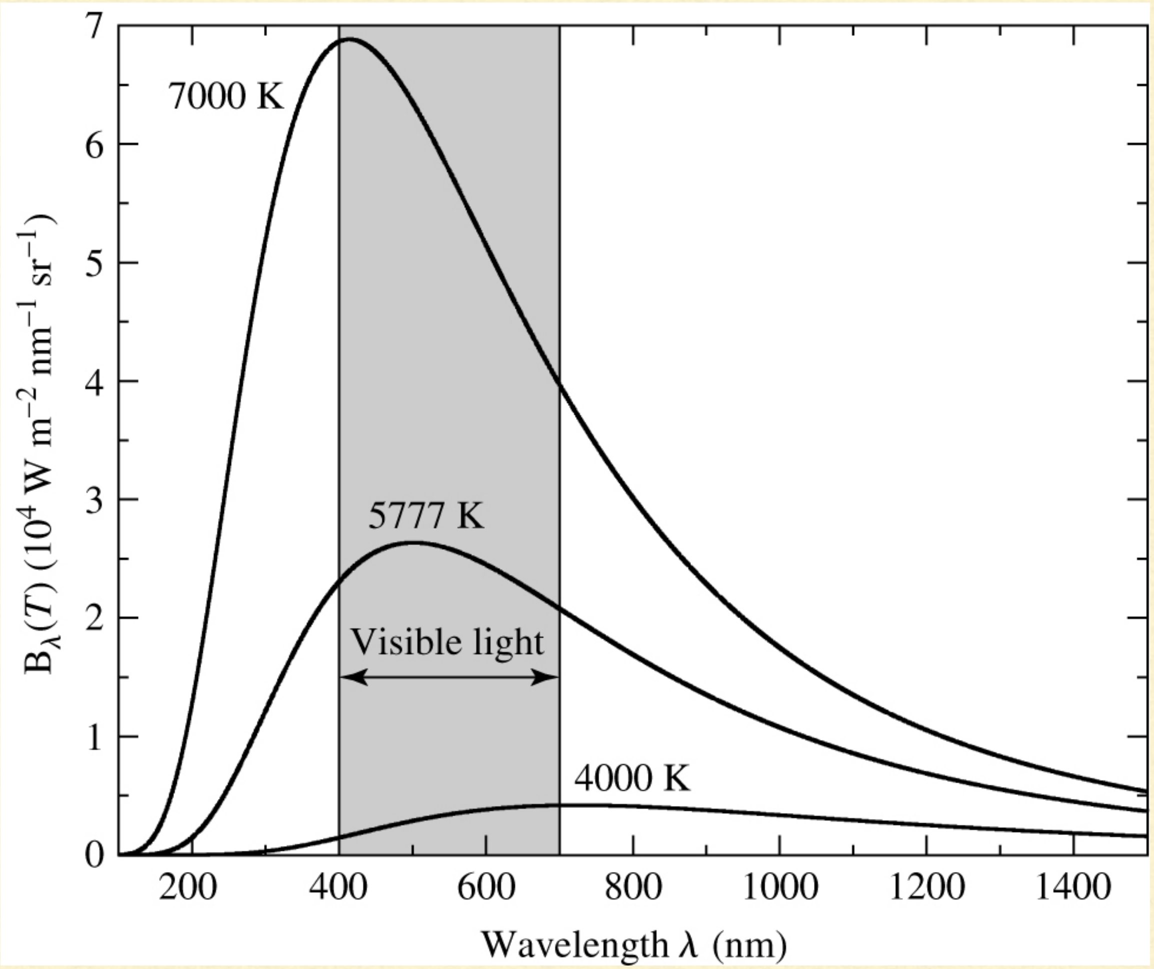
$$B_\lambda(T) \propto (T/\lambda^4)$$

- Monotonic in T:

$$B_\nu(T_1) > B_\nu(T_2) \text{ at all } \nu \text{ if } T_1 > T_2$$

Wien law: $B_\lambda(T) \propto \lambda^{-5}\, e^{(-b/\lambda T)}$

BLACKBODIES



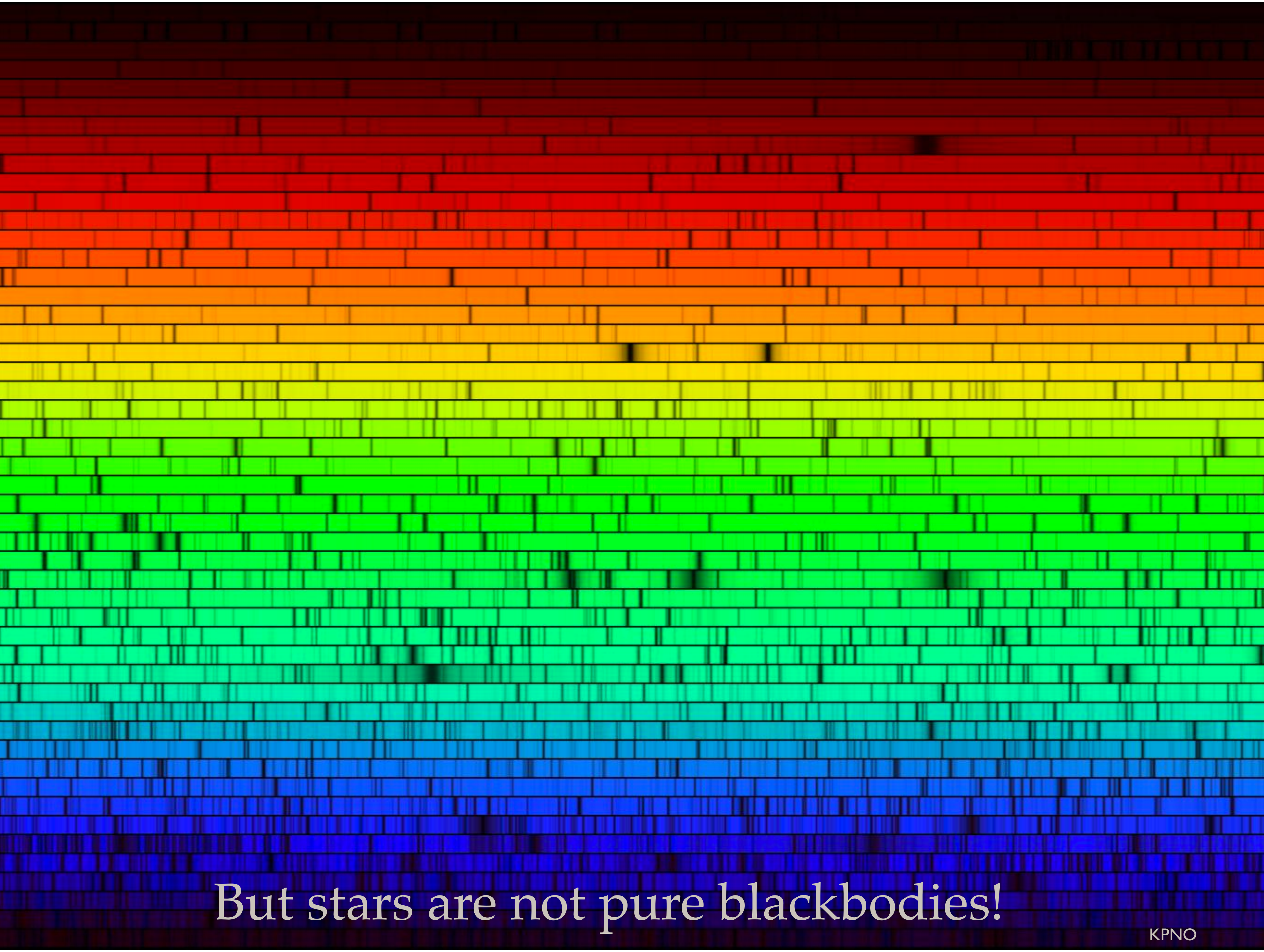
$L=(\text{surface area})\sigma T_e^4$

$L=4\pi R_\star^2 \sigma T_e^4$

$\sigma=5.67\times10^{-5}$ erg/cm^2/s/K^4

$\sigma=5.67\times10^{-8}$ W/m^2/K^4

Wien's displacement law:
$\lambda_{peak} = 0.0029$ m/T(K)


But stars are not pure blackbodies!
KPNO

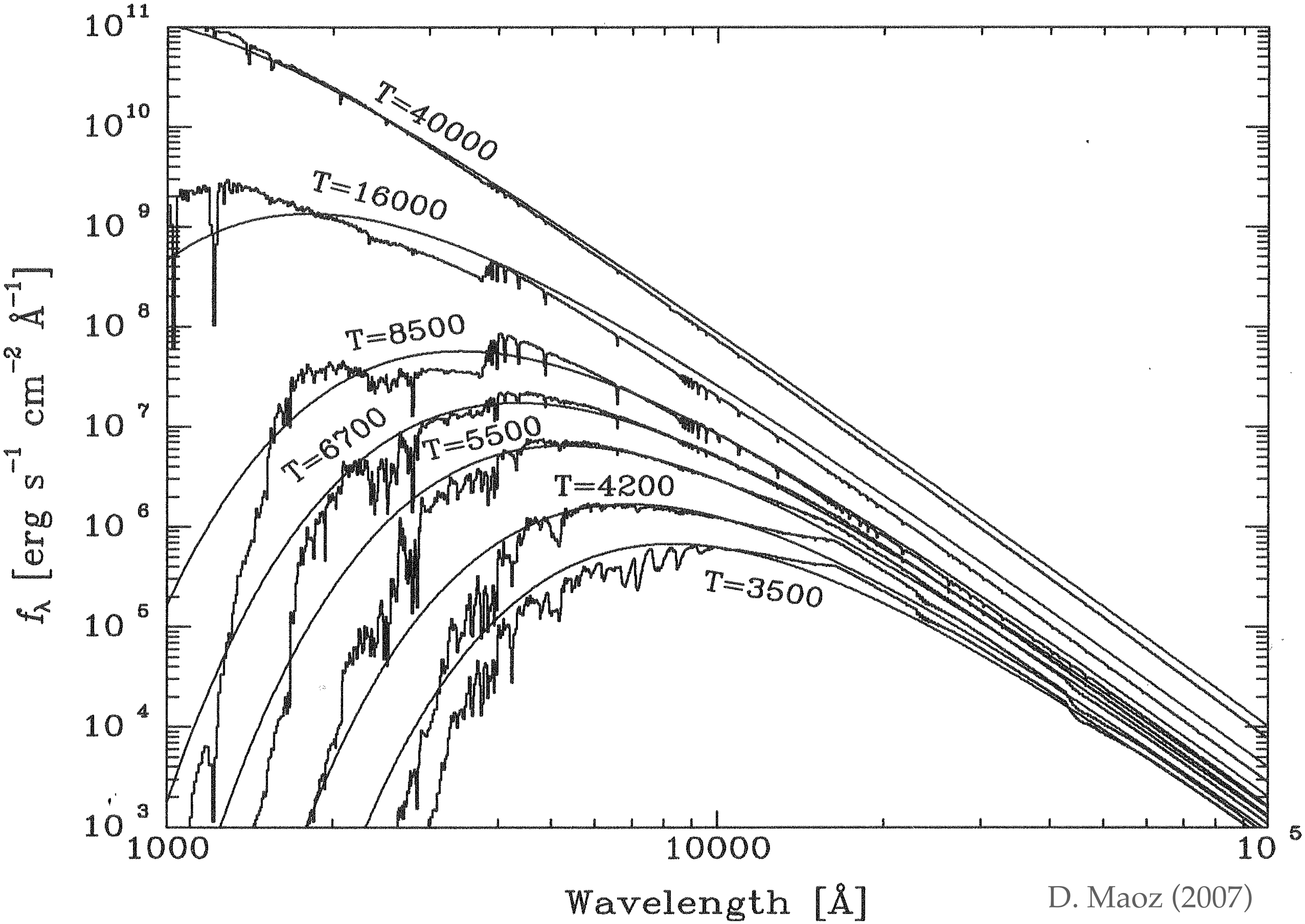
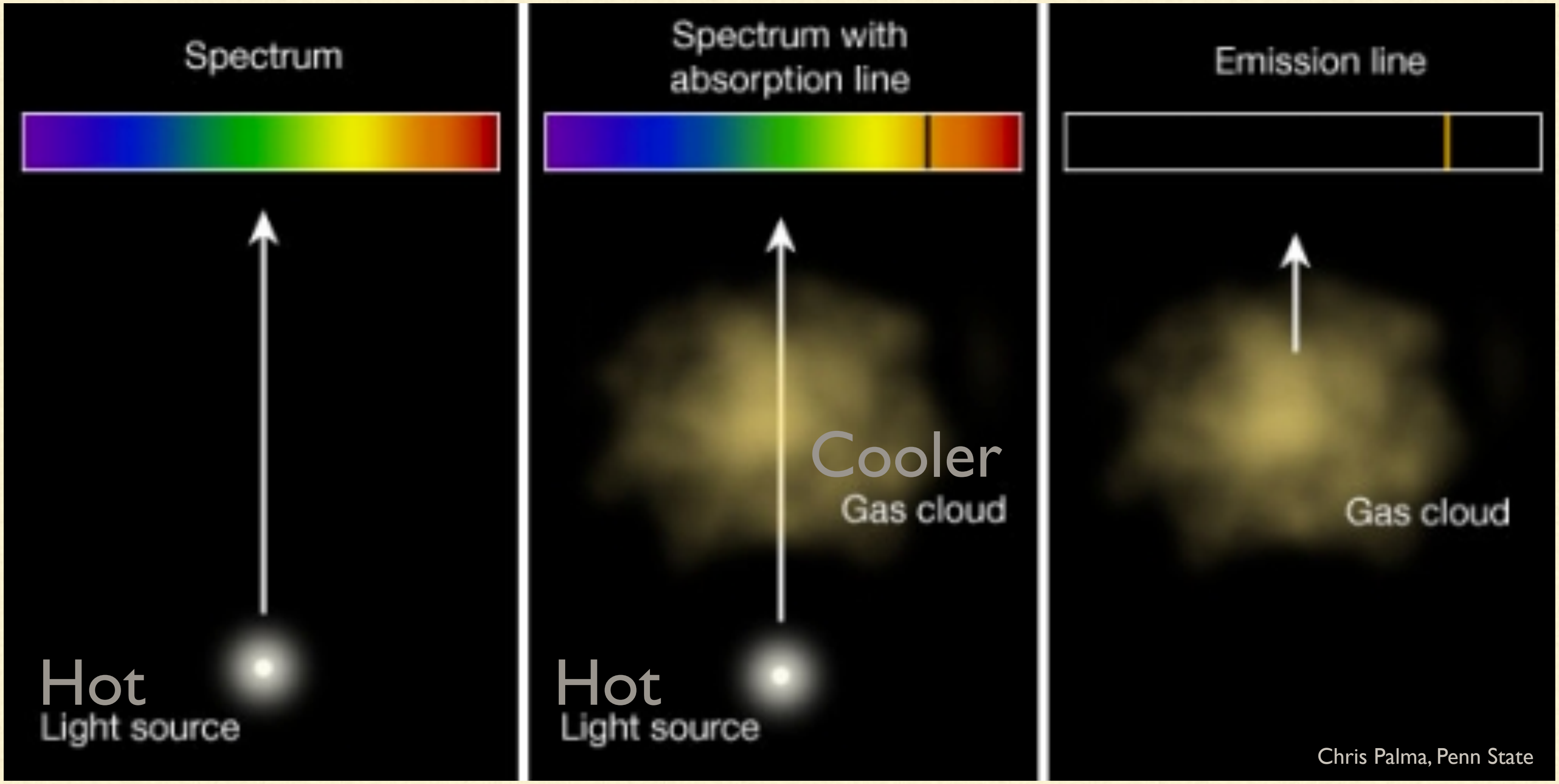


Figure 2.1 Flux per wavelength interval emitted by different types of stars, at their "surfaces," compared to blackbody curves of various temperatures. Each blackbody's temperature is chosen to match the total power (integrated over all wavelengths) under the the corresponding stellar spectrum. The wavelength range shown is from the ultraviolet (1000 Å $=0.1\ \mu$m), through the optical range (3200–10,000 Å), and to the mid-infrared (10^5 Å $=10\ \mu$m). Data credit: R. Kurucz.

KIRCHHOFF'S LAWS



UNITS

- Astronomers frequently use cgs (e.g., 10^7 erg = 1 J)
  - Note: Carroll & Ostlie use SI (so I will try to standardize on that), but RL and HKT use cgs
- $1\ M_\odot = 1.99 \times 10^{33}$ g $= 1.99 \times 10^{30}$ kg
- $1\ L_\odot = 3.8 \times 10^{33}$ erg/s $= 3.8 \times 10^{26}$ W
- $1\ R_\odot = 6.96 \times 10^{10}$ cm $= 6.96 \times 10^{8}$ m
- $T_\odot = 5777$ K