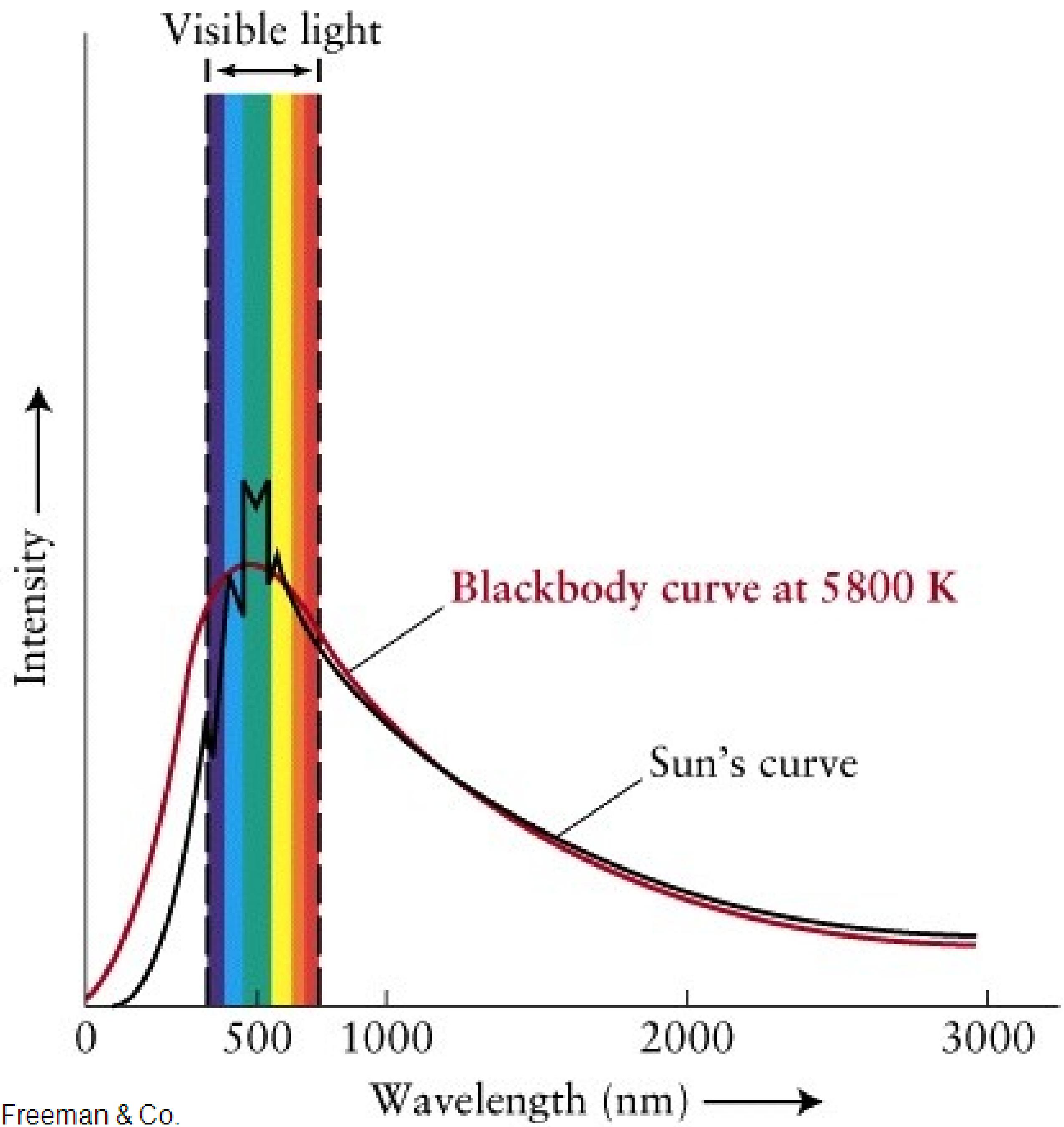
Starlight

- Continuum spectrum
- Blackbody radiation
- Wien's Displacement Law
- Luminosity and Flux

Continuum Spectrum

- The intensity of light from the Sun peaks at a wavelength λ=500nm
- Falls off rapidly towards the blue and more steadily to the red
- Continuum spectrum is approximately that of a perfect blackbody with T=5800 K


Visible light
Intensity
Blackbody curve at 5800 K
Sun's curve
0
500
1000
2000
3000
Wavelength (nm)

Blackbody Radiation

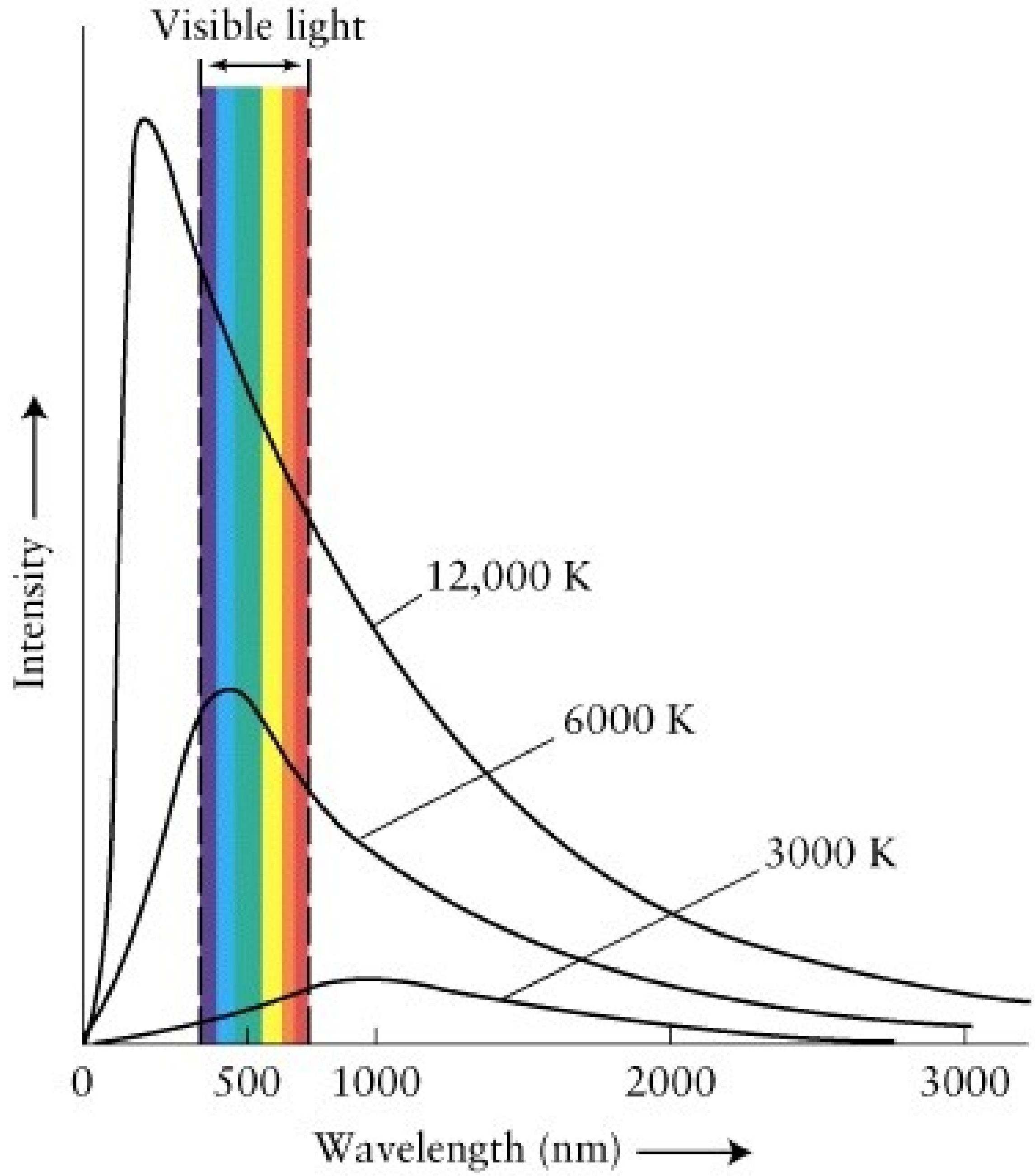
- A perfect absorber and emitter of radiation is called a blackbody
- Intensity of radiation is described by the Planck function

Wien Displacement Law

- The wavelength of the peak of the emission from a blackbody of temperature *T* is given by

$$\lambda_{\max} = \frac{3.10^{-3}}{T}$$

- The hotter the blackbody the shorter the wavelength of the peak emission



Visible light
Intensity
12,000 K
6000 K
3000 K
0
500
1000
2000
3000
Wavelength (nm)

Luminosity of a Blackbody

- The total power in the radiation from a sphere of radius *R* emitting blackbody radiation with temperature *T* is

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

where σ is the Stefan-Boltzmann constant

Effective Temperature

- The *effective* temperature of a star is the surface temperature that a spherical blackbody with the star's radius would have to provide the star's luminosity. i.e.

$$L = 4\pi R^2 \sigma T_{eff}^4$$

Luminosity and Flux

- We can also determine the luminosity of the Sun (or any star) by finding the total flux of radiation reaching Earth as long as we also know the distance
- When we observe the spectrum of a star we are measuring the flux of radiation as a function of wavelength

Monochromatic Flux

- monochromatic flux of radiation f_λ is defined as the amount of energy crossing a unit area per unit time per unit wavelength interval (Js^{-1}m^{-2}m^{-1} or Wm$^{-2}\mu$m^{-1})

Total Flux

- The flux of radiation, *f*, is defined as the amount of energy crossing a unit area per unit time ($Js^{-1}m^{-2}$ or Wm^{-2})
- It is the sum of the monochromatic fluxes over all wavelengths

$$f = \int_0^\infty f_\lambda d\lambda$$

- At a distance, *d*, from the Sun it is given by

$$f = \frac{L}{4\pi d^2}$$

- Note that flux falls with the inverse square of the distance
- Hence, the luminosity can be found from

$$L = 4\pi d^2 f$$

Summary

- The Sun and stars radiate from their surfaces very much like a blackbody
- The effective temperature of a star can be found using Wien’s law
- The luminosity of a star can be found by measuring its flux and using the inverse square law