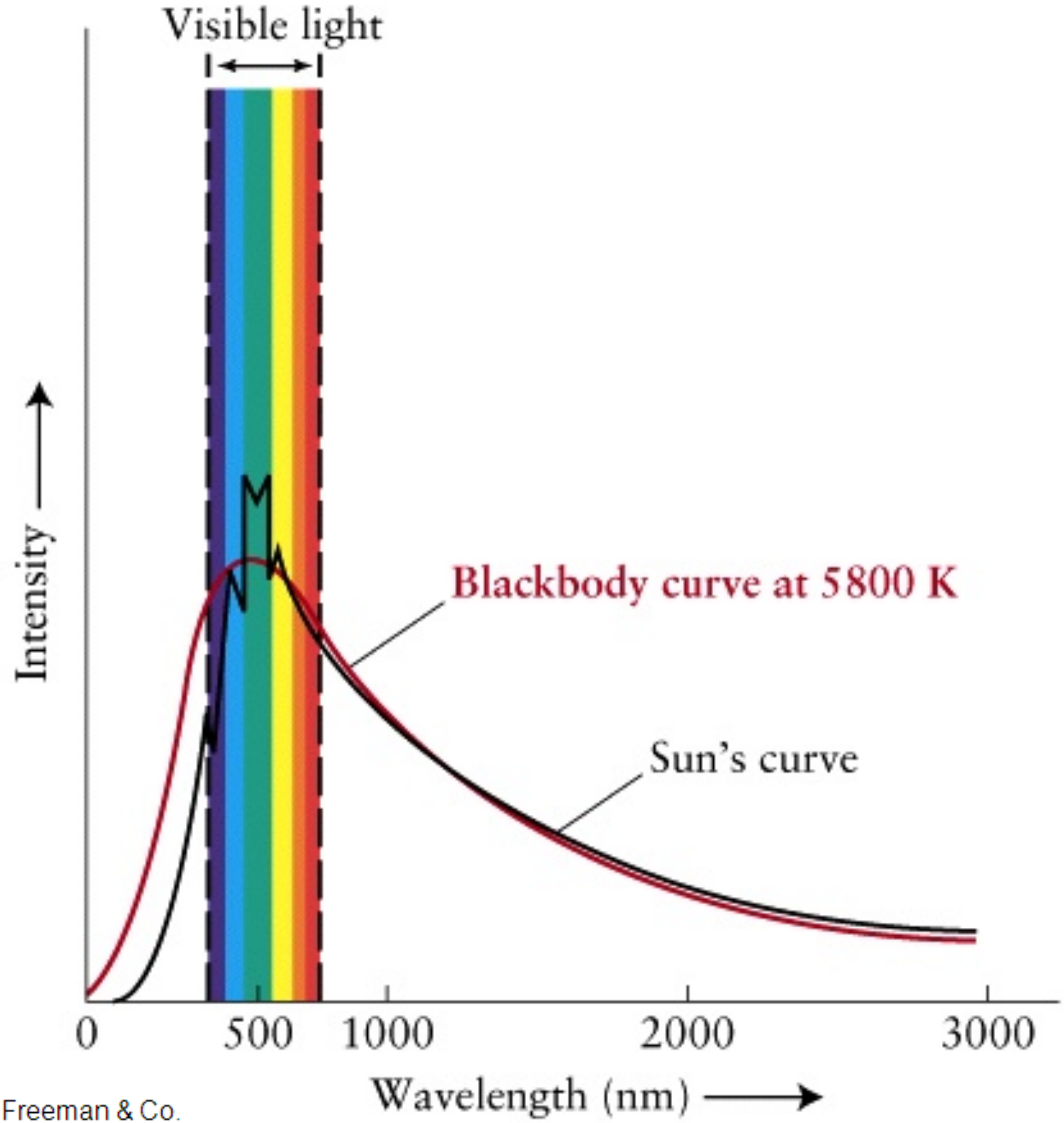
Starlight

- 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=500 nm
- 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



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Black Body Radiation

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

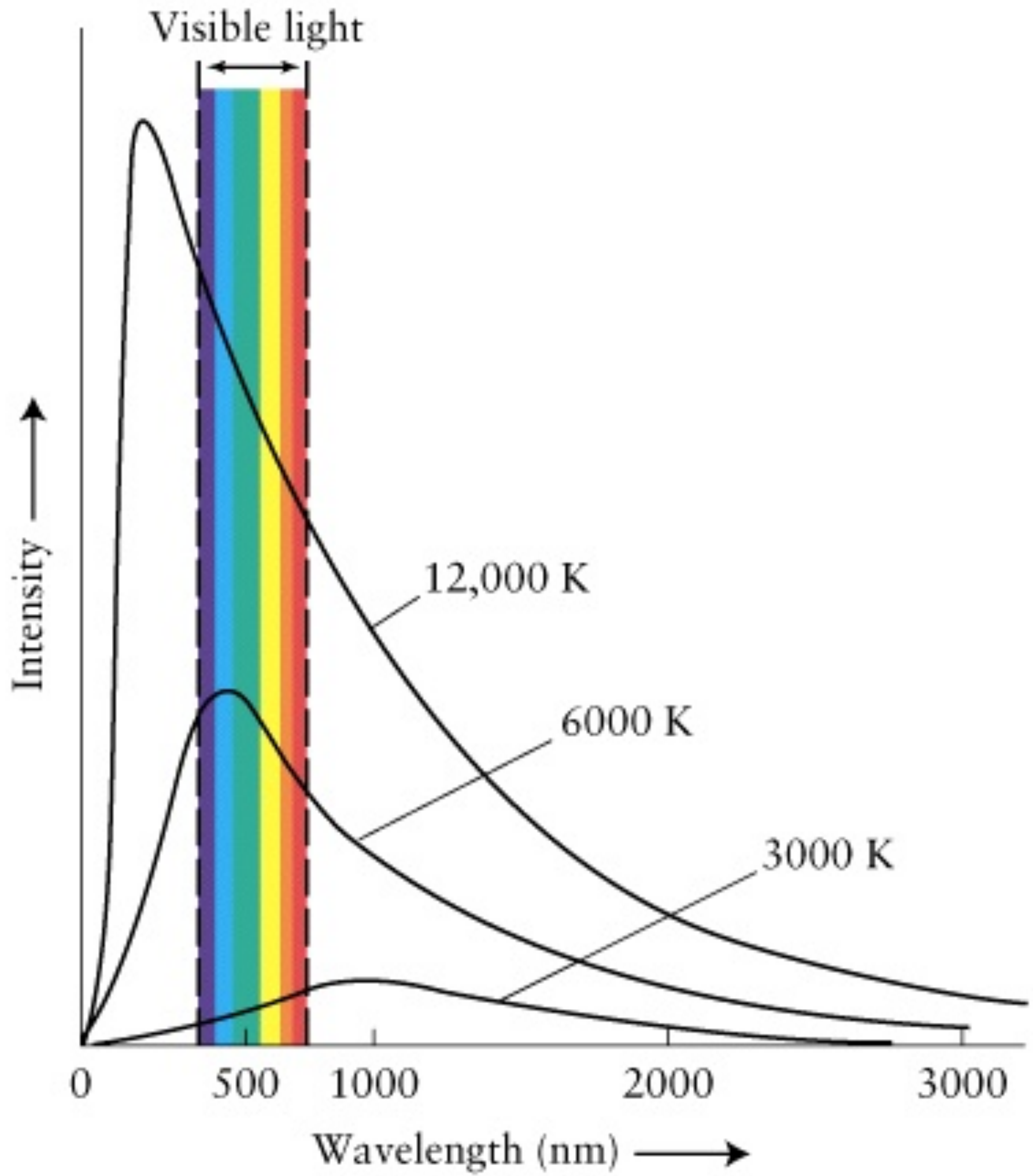
$$B_\nu = \frac{2h\nu^3}{c^2}\left(\exp\left(\frac{h\nu}{kT}\right) - 1\right)^{-1}$$

Wien Displacement Law

- The wavelength of the peak of the emission λ_{max} (in m) from a blackbody of temperature T (in K) is given by

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

- The hotter the blackbody the shorter the wavelength of the peak emission
- For the Sun, λ_{max} is about 520 nm (optical)



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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 ($J\ s^{-1}\ m^{-2}\ m^{-1}$) or some other unit, such as $W\ m^{-2}\ \mu m^{-1}$
- Can also define f_ν the *flux density* which is often written as S_ν in radio astronomy, and specified in $W\ m^{-2}\ Hz^{-1}$ or Jy

Total Flux

- The flux of radiation, *f*, is defined as the amount of energy crossing a unit area per unit time (J s^{-1} m^{-2} or W m^{-2})
- It is the sum of the monochromatic fluxes over all wavelengths or frequencies, e.g.,

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

- 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