The blackbody radiation rate in terms of wavelength is

\[ B_\lambda (T) = \frac{2hc^2}{\lambda^5 \left(e^{hc/\lambda k_B T} - 1\right)} \]  

(1)

For very short wavelengths (high energies), \( e^{hc/\lambda k_B T} \gg 1 \) so we can approximate the rate by

\[ B_\lambda \approx \frac{2hc^2}{\lambda^5} e^{-hc/\lambda k_B T} \]  

(2)

This form matches the empirical formula obtained by Wien, which is

\[ B_\lambda = \frac{a}{\lambda^5} e^{-b/T} \]  

(3)

where \( a \) and \( b \) are constants determined by fitting the curve to experimental data.

For long wavelengths, we can use the first order Taylor expansion for the exponential

\[ e^{hc/\lambda k_B T} = 1 + \frac{hc}{\lambda k_B T} + O\left(\frac{1}{\lambda^2}\right) \]  

(4)

\[ B_\lambda \approx \frac{2ck_B T}{\lambda^4} \]  

(5)

This is the classical Rayleigh-Jeans law. Notice that Planck’s constant has dropped out of the formula, and that if applied to all wavelengths it predicts that \( B_\lambda \to \infty \) as \( \lambda \to 0 \). This is the ultraviolet catastrophe which was rectified with the introduction of the quantization of energy.

To compare the three curves for the Sun, where \( T = 5777 \) K, we have the following plot:
The green curve is Planck’s formula, the blue curve is the Rayleigh-Jeans formula and the red curve is Wien’s empirical formula. The Rayleigh-Jeans formula predicts twice the actual radiation at around $\lambda = 2000$ nm which is in the infrared region.

We’ve already derived [Wien’s displacement law](#) for the wavelength at which the blackbody curve is maximum:

$$\lambda_{\text{max}} = \frac{2.901 \times 10^{-3}}{T} \text{ m}$$  \hspace{1cm} (6)