Star Classification by temperature

Stefan's law and Wien's displacement law
General shape of black-body curves, use of Wien's displacement law to estimate black-body temperature of sources.
Use of Stefan's law to compare the power output, temperature and size of stars

Stefan-Boltzmann's Law

The luminosity of a star depends on the temperature of the star and its size. When heated, stars will emit EM radiation over a range of wavelengths, with a total intensity that is proportional to the fourth power of its absolute temperature. This can be written as: **$I \propto T^4$.** Where **I is the intensity**, or radiated power **per unit area**, and T is the absolute temperature in kelvin. We then obtain the Stefan–Boltzmann law, or Stefan's law as it is more commonly known:

$P = \sigma AT^4$ (remember for a spherical star of radius R, the surface area is **$4\pi R^2$**). So: **$P = \sigma 4\pi R^2T^4$**

Where **P is the total power** in **Watts** radiated by an object of **surface area A**, and **σ is a constant of proportionality** called the **Stefan–Boltzmann constant**, which is equal to **5.67×10^{-8} W m^{-2} K^{-4}**.

$$\sigma = 5.67 \times 10^{-8} \frac{W}{m^2 \cdot K^4}$$

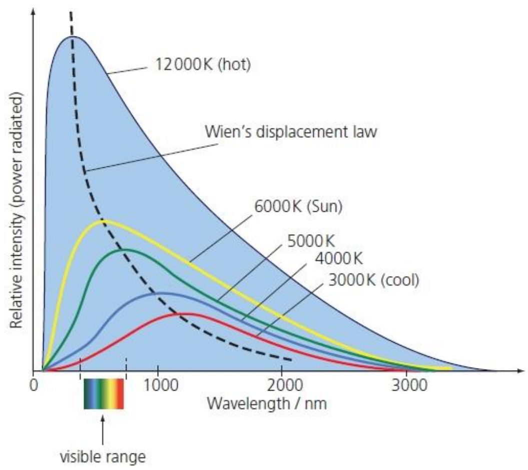
If an object is an efficient absorber of radiation at a given wavelength, then it will also be an efficient radiator at that wavelength. It was shown by Boltzmann that Stefan's law is valid only for a body that is a perfect absorber of energy. Such an object is known as a **black body**, because it does not reflect any light.

> Its radiated energy flux depends only on its temperature and not on its surface composition, in accordance with Stefan's law.

Wien's displacement law

A black body emits electromagnetic radiation over a wide range of wavelengths, but there will be one wavelength, called the peak wavelength, for which the emission of radiation has its maximum intensity. The wavelength of the peak emission intensity is inversely proportional to the absolute temperature of the object.

$\lambda_{max}T$ = constant = 2.90×10^{-3}m K (This relationship is known as Wien's displacement law or sometimes simply Wien's law. Note that 'm K' is metre kelvin, **not** millikelvin).



It shows that the dominant wavelength of a black-body radiator decreases as its gets hotter.
Notice that the higher the temperature, the shorter the wavelength of maximum intensity, just as we would expect from Wien's law.

These curves are called black-body curves. It is important to realise that when you see a black-body curve you know that the processes that give rise to the emission of radiation depend only on temperature and not on any other property, such as the chemical composition of the object.

Spectral class	Intrinsic colour	Temperature / K
O	Blue	25 000–50 000
B	Blue	11 000–25 000
A	Blue-white	7500–11 000
F	White	6000–7500
G	Yellow-white	5000–6000
K	Orange	3500–5000
M	Red	< 3500

Stellar Spectral Classes

Stars are classified by their temperature using letters of the alphabet. There are seven main types of stars denoted, in order of decreasing temperature, O, B, A, F, G, K and M (**O**nly **B**right **A**strophysicists **F**ight **G**reen **K**iller **M**artians).