A level Physics Component 2.7 Using radiation to investigate stars

Stellar spectrum:

Stars emit light as a continuous spectrum of radiation from the gasses at the stars surface.

Continuous spectrum

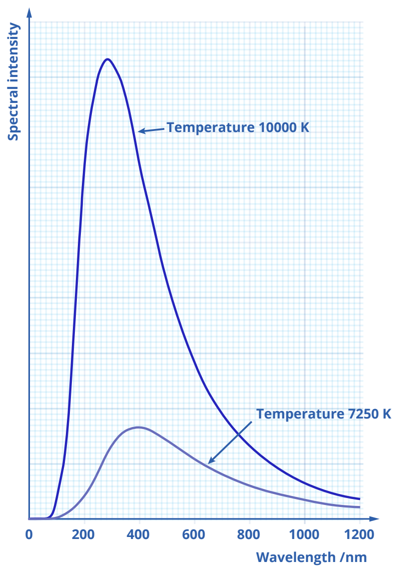
However, the light must pass through the gasses in the star's atmosphere where the atoms in the gas absorb some wavelengths of light (see Unit 2.7) leaving absorption lines to be superimposed on the spectrum.

Absorption spectrum

Black bodies:

Stars can be considered **black bodies**. A black body **absorbs all radiation** that falls on it. Although it is strange to think of a star as a black body, they are also very good emitters of radiation.

Black body spectrum:



Key aspects to notice and remember;

- The shape of the curve is always similar but the peak can be shifted and higher due to different temperatures. You must be able to sketch this curve.
- The peak intensity wavelength is inversely proportional to the temperature of the star.
- The higher the temperature, the higher the peak intensity.
- The gradient of the curve is 0 at a wavelength of 0.

Wien's Law, Stefan's law and the inverse square law can all be used to investigate the properties of stars.

Wien's Law:

Wien's Law states that the wavelength of peak emission from a black body is inversely proportional to the absolute (kelvin) temperature of the body.

$$\lambda_{max} = \frac{W}{T}$$

Remember that T must be in kelvin;

$T/\mathrm{K} = \theta/°\mathrm{C} + 273{\cdot}15$

Stefan's law:

Stefan's law states that the total electromagnetic radiation energy emitted per unit time by a black body is given by this equation:

$$power = P = A\sigma T^4$$

Where A is the body's surface area and σ is a constant called the Stefan constant.

Luminosity is the energy released per second from a star, it is equivalent to the power of the star.

Inverse square law:

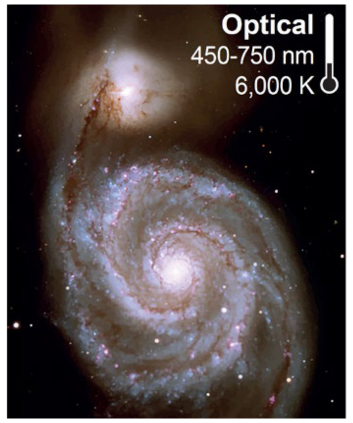
Inverse square law states that the intensity of radiation from a star per m^2 is inversely proportional to the distance from the star squared.

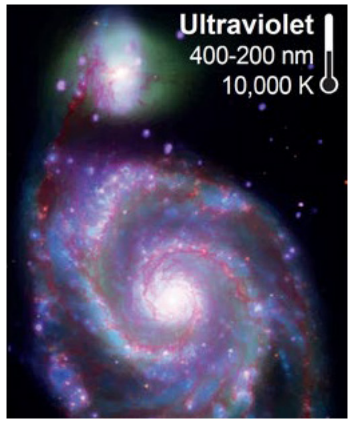
$$I = \frac{P}{4\pi R^2}$$

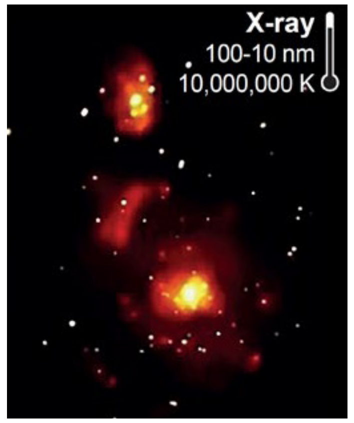
Multiwavelength astronomy:

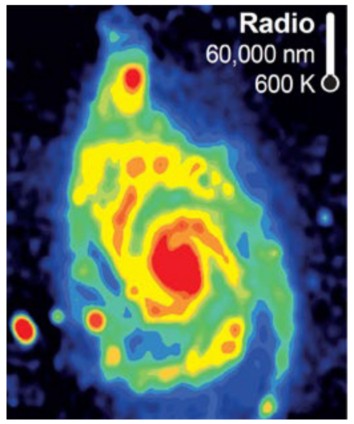
Studying stars and space by making observations outside of the visible light spectrum can **give more information about the processes which took place**. For example, observing using the microwave region of the spectrum revealed the cosmic microwave background radiation.

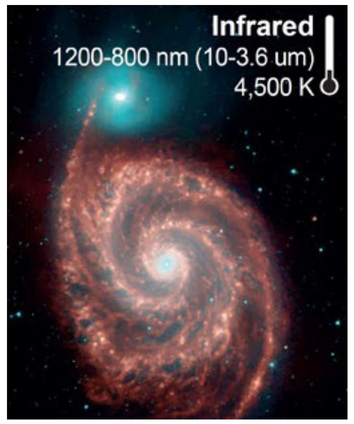
This image shows the visible light from a galaxy. The images below are of the same galaxy but taken using different regions of the electromagnetic spectrum.











W = Wien's constant = 2.90×10^{-3} m K

T = temperature in K

λ_{max} = peak wavelength in m

I = intensity in W m^{-2}

σ = Stefan constant = 5.67×10^{-8} W $m^{-2} K^{-4}$

P = power in W

A = surface area in m^2

R = distance to the star in m