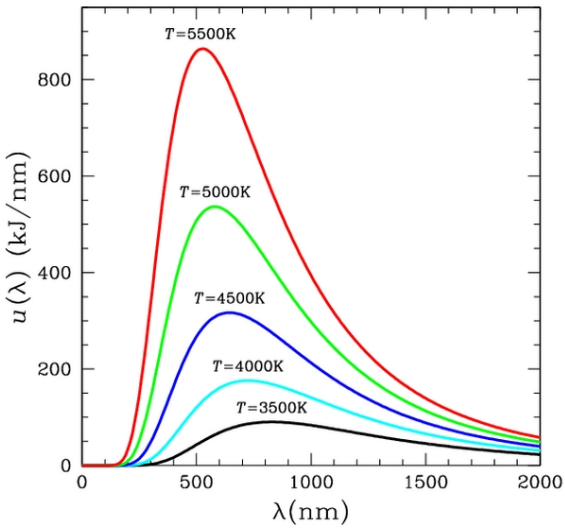
Measuring Star Temperatures

Careful measurements of a star's light spectrum gives astronomers clues about its temperature. For example, incandescent bodies that have a red glow are 'cool' while bodies with a yellow or blue color are 'hot'. This can be made more precise by measuring very carefully exactly how much light a star produces at many different wavelengths.

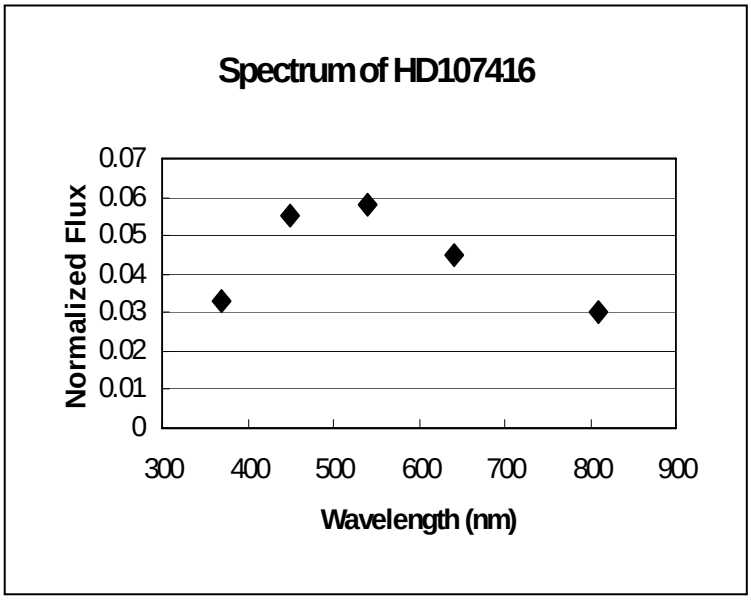
In 1900, physicist Max Planck worked out the mathematical details for how to exactly predict a body's spectrum once its temperature is known. The curve is therefore called a Planck 'black body' curve. It represents the brightness at different wavelengths of the light emitted from a perfectly absorbing 'black' body at a particular temperature.



From the mathematical properties of the Planck Curve, it is possible to determine a relationship between the temperature of the body and the wavelength where most of its light occurs - the peak in the curve. This relationship is called the Wein Displacement Law and looks like this:

$$\text{Temperature} = \frac{2897000 \text{ Kelvins}}{\text{Wavelength}}$$

Where the temperature will be in units of Kelvin degrees, and the wavelength will be in units of nanometers.



The lower plot shows measurements of the spectrum of the star HD107146. The horizontal axis is in units of nanometers (nm).

Problem 1 - Based on the overall shape of the curve, and the wavelength where most of the light is being emitted, use the Wein Displacement Law to determine the temperature of HD107146.

Problem 2 - What would be the peak wavelengths of the following stars in nanometers.

A) Antares ..... 3,100 K
B) Zeta Orionis..... 30,000 K
C) Vega ..... 9,300 K
D) Regulus..... 13,000 K
E) Canopus..... 7,300 K
F) OTS-44 brown dwarf... 2,300 K
G) Sun..... 5,770 K

Answer Key:

Problem 1 - The peak of the curve is **near 500** nanometers. The temperature is 2897000 / 500 = **5,794 K**.

Problem 2 - What would be the peak wavelengths of the following stars in Angstroms:

Answer:

A)	Antares occurs at…….	2897000/3100 K	=	934 nanometers
B)	Zeta Orionis is at……..	2897000/30,000 K	=	97 nanometers
C)	Vega ……..	2897000/9,300 K	=	311 nanometers
D)	Regulus……..…..	2897000/13,000 K	=	223 nanometers
E)	Canopus……	2897000/7,300 K	=	397 nanometers
F)	OTS-44 brown dwarf…	2897000/2,300 K	=	1260 nanometers
G)	Sun…….	2897000/5770Ak	=	502 nanometers

Figure Credits:

The spectrum of HD 107146 is adapted from a paper by Williams et al. published in the Astrophysical Journal, 2004 vol. 604 page 414. The graph of Planck curves is from Wikimedia and is copyright-free.