

## STEFAN-BOLTZMANN CONSTANT - LUMINOSITY OF A STAR AS A BLACKBODY

Link to: [physicspages home page](#).

To leave a comment or report an error, please use the auxiliary blog and include the title or URL of this post in your comment.

Post date: 9 Jun 2023.

The blackbody radiation rate in terms of wavelength is

$$B_{\lambda}(T) = \frac{2hc^2}{\lambda^5 (e^{hc/\lambda k_B T} - 1)} \quad (1)$$

$B_{\lambda}$  is the rate at which a blackbody at temperature  $T$  radiates in watts per unit area, per unit wavelength band, per steradian. The amount of radiation emitted in a wavelength span  $[\lambda, \lambda + d\lambda]$  is therefore  $B_{\lambda}d\lambda$ . As we saw earlier, the total rate of emission of energy per unit area, integrated over all wavelengths and over solid angle is

$$j = \frac{2\pi^5 k_B^4}{15h^3 c^2} T^4 \quad (2)$$

The constant multiplying  $T^4$  is the Stefan-Boltzmann constant, defined as

$$\sigma \equiv \frac{2\pi^5 k_B^4}{15h^3 c^2} \quad (3)$$

The value of  $\sigma$  is

$$\sigma = \frac{2\pi^5 (1.3806488 \times 10^{-23})^4}{15 (6.62606957 \times 10^{-34})^3 (2.99792458 \times 10^8)^2} \quad (4)$$

$$= 5.670373 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4} \quad (5)$$

This value agrees with the currently accepted value of the constant.

If the star radiates uniformly over its entire surface, then the luminosity of the star is  $j$  times the surface area, so

$$L = 4\pi R^2 j = \frac{8\pi^6 R^2 k_B^4}{15h^3 c^2} T^4 = 4\pi R^2 \sigma T^4 \quad (6)$$

PINGBACKS

Pingback: [Sirius binary star system](#)

Pingback: [Spectroscopic, eclipsing binary stars - mass, radius and temperature](#)