Solar Heating & Energy Transport



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Planck's Law for Black Body Radiation



Figure modified from Eric W. Weisstein

Specific Brightness:

$$B_{\nu}(T) = \frac{2h\nu^3}{c^2} \frac{1}{e^{\frac{h\nu}{kT}} - 1}$$

Limits for Planck's Law

Specific Brightness:
$$B_{\nu}(T) = rac{2h\nu^3}{c^2} rac{1}{e^{rac{h
u}{kT}} - 1}$$

 Rayleigh-Jeans Law: In the limit where hv << kT, most applicable for long wavelengths (such as in the radio part of the spectrum) and temperatures in the range of planetary bodies.

$$B_{\nu}(T) \approx \frac{2\nu^2}{c^2} kT$$
 where $e^{h\nu/(kT)} - 1 \approx h\nu/(kT)$

2. The Wien Law: When $h_V \gg kT$

$$B_{\nu}(T) \approx \frac{2h\nu^3}{c^2} e^{-h\nu/(kT)}$$

Wien's Displacement Law



Setting the derivative of Planck's Law with respect to λ (wavelength) equal to zero, we determine the peak wavelength with respect to temperature.

$$v_{max} = 5.88 \times 10^{10} T$$
, where v_{max} is in Hz

Solar Spectrum, Variability, and Atmospheric Absorption



Luminosity

A useful way to describe the amount of energy emitted by an object is the luminosity (often used in astronomy to relate the energy, size and temperature of stars and intercompare their properties).

Luminosity (L) = Energy flux x Area and has units J/s or W

Hertzsprung-Russell (H-R) diagram

60 M_{Sun} 106 30 Ms. β Centauri 105 SUPERGIANTS **Betelgeuse** Spica Lifetime 10 *M*. Canopus Antares 104 10⁷ yrs Polaris MAIN 10³ GIANTS ENCE Lifetime cturus 10⁸ yrs 10² Pollux Sirius (solar units) 10 Lifetime ntauri A 10⁹ yrs luminosity (0. entauri B Lifetime 1010 yrs 99.50 ese 725 A Sirius B WHITE 10.2 Gliese 725 B 0.1 M_{Sut} Lifetime DWARFS Barnard's Sta Ross 128 10¹¹ yrs 10-3 Wolf 359 Proxima Centauri Procyc DX Cancri 10-4 10-5 0 F G в A Μ ĸ 30,000 10,000 6,000 3,000 increasing temperature decreasing surface temperature (Kelvin) temperature

The Sun in Perspective