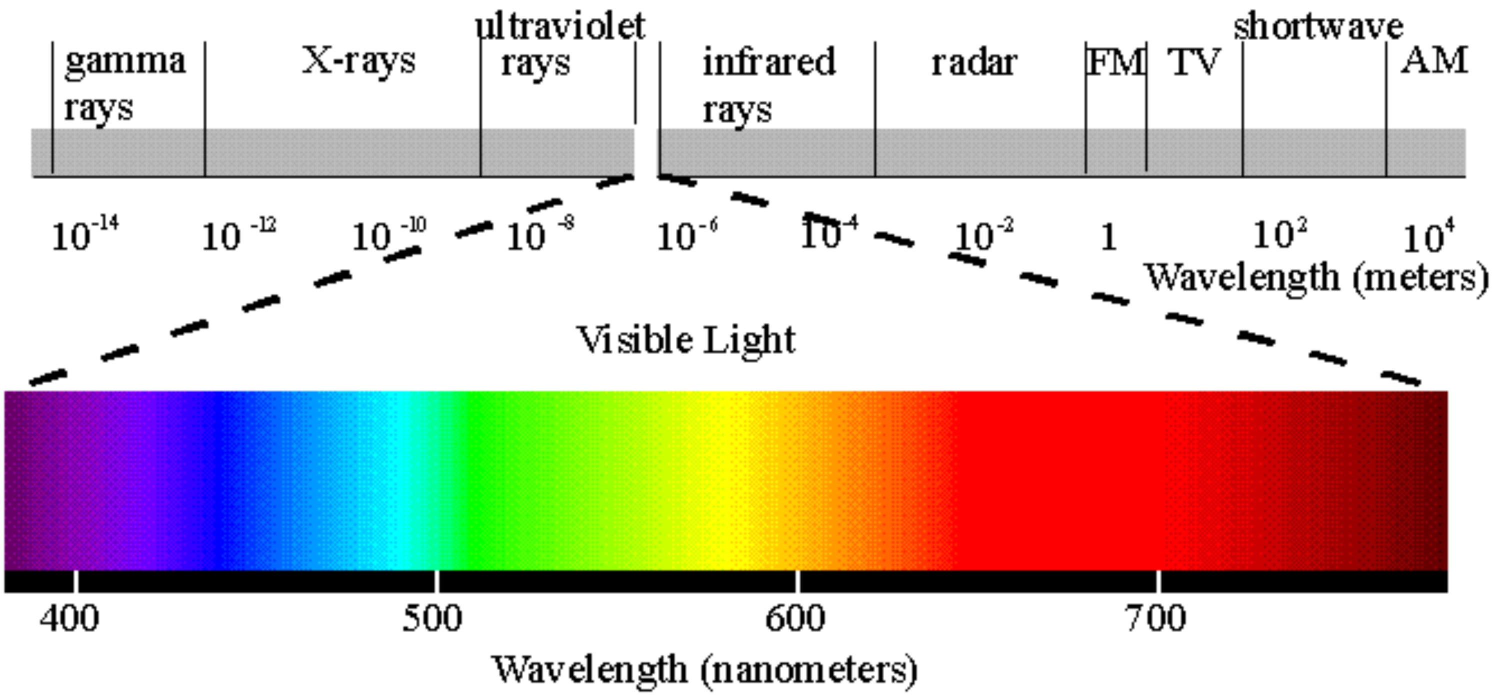
# Solar Heating & Energy Transport

## Electromagnetic Spectrum

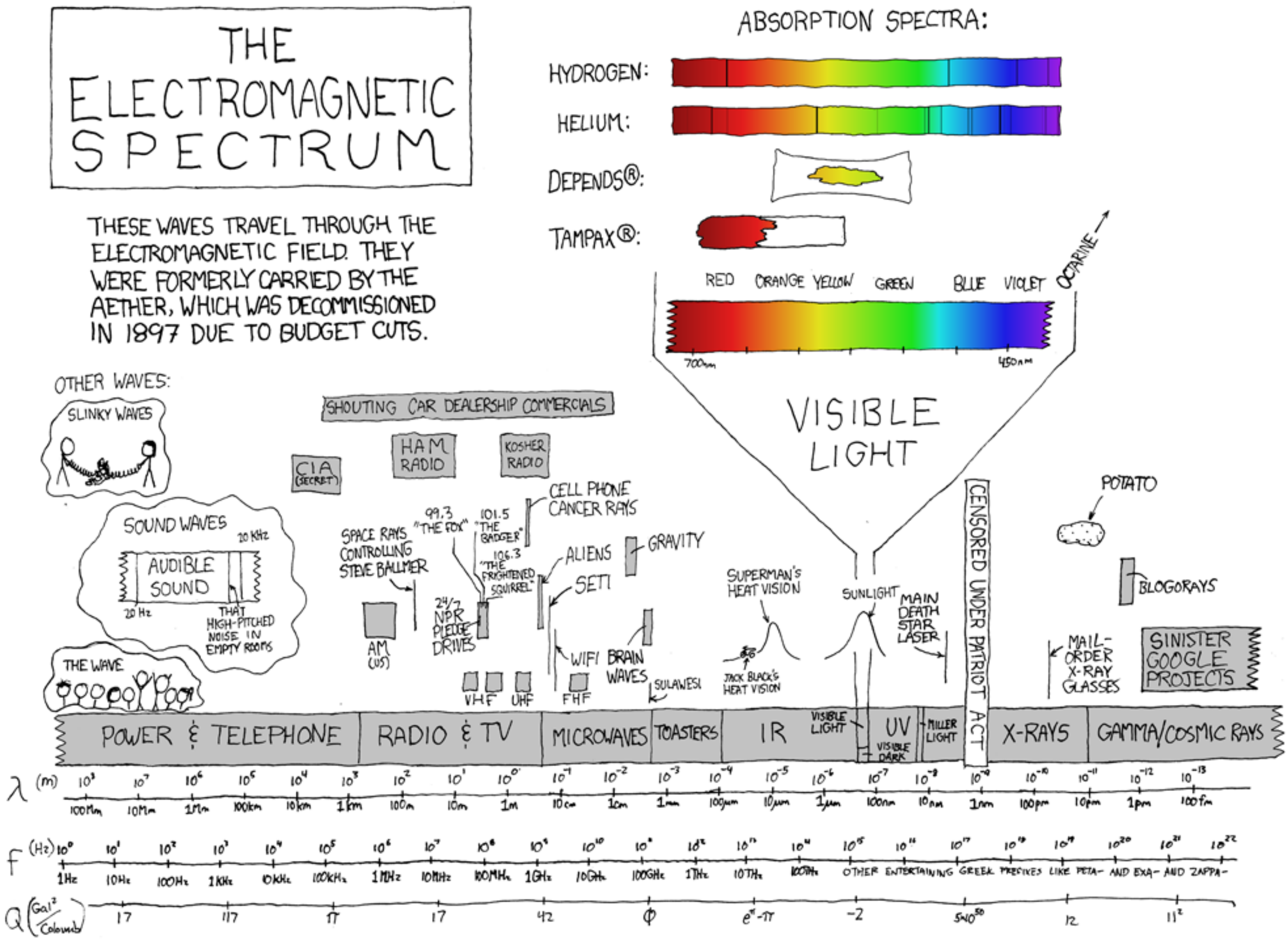



← 'Bluer' 'Redder' →

← Shorter Wavelength Longer Wavelength →

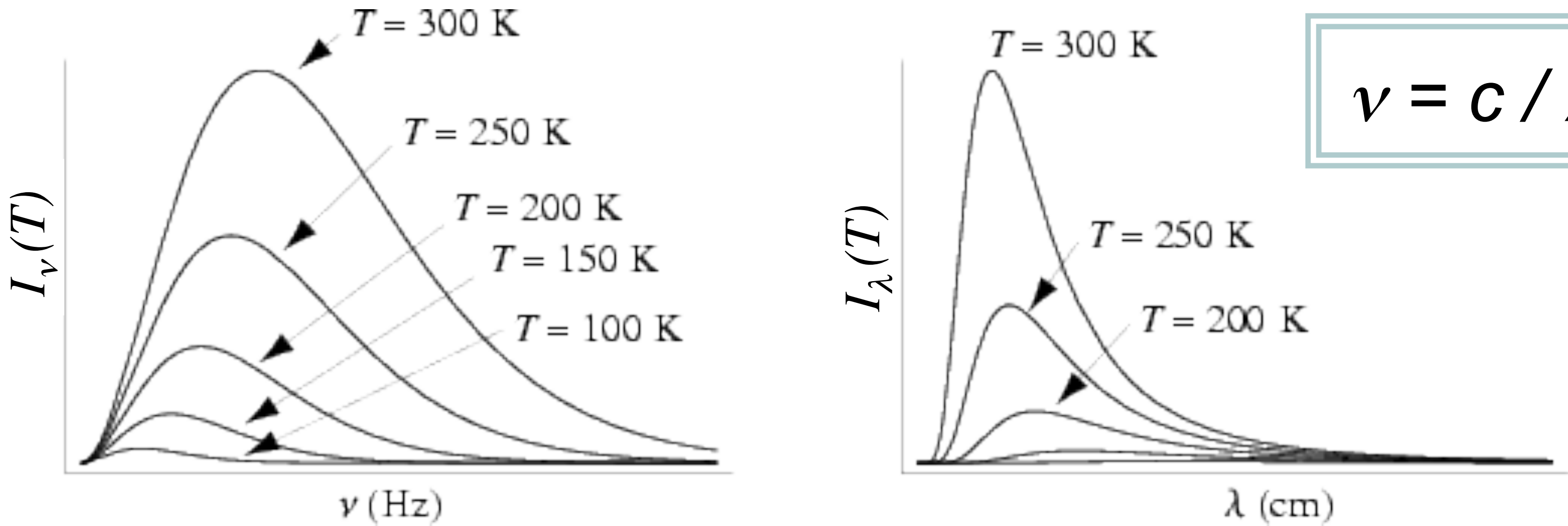
← Higher energy photons Lower energy photons →

# Solar Heating & Energy Transport




http://xkcd.com

# Planck's Law for Black Body Radiation




$\nu = c / \lambda$

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

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

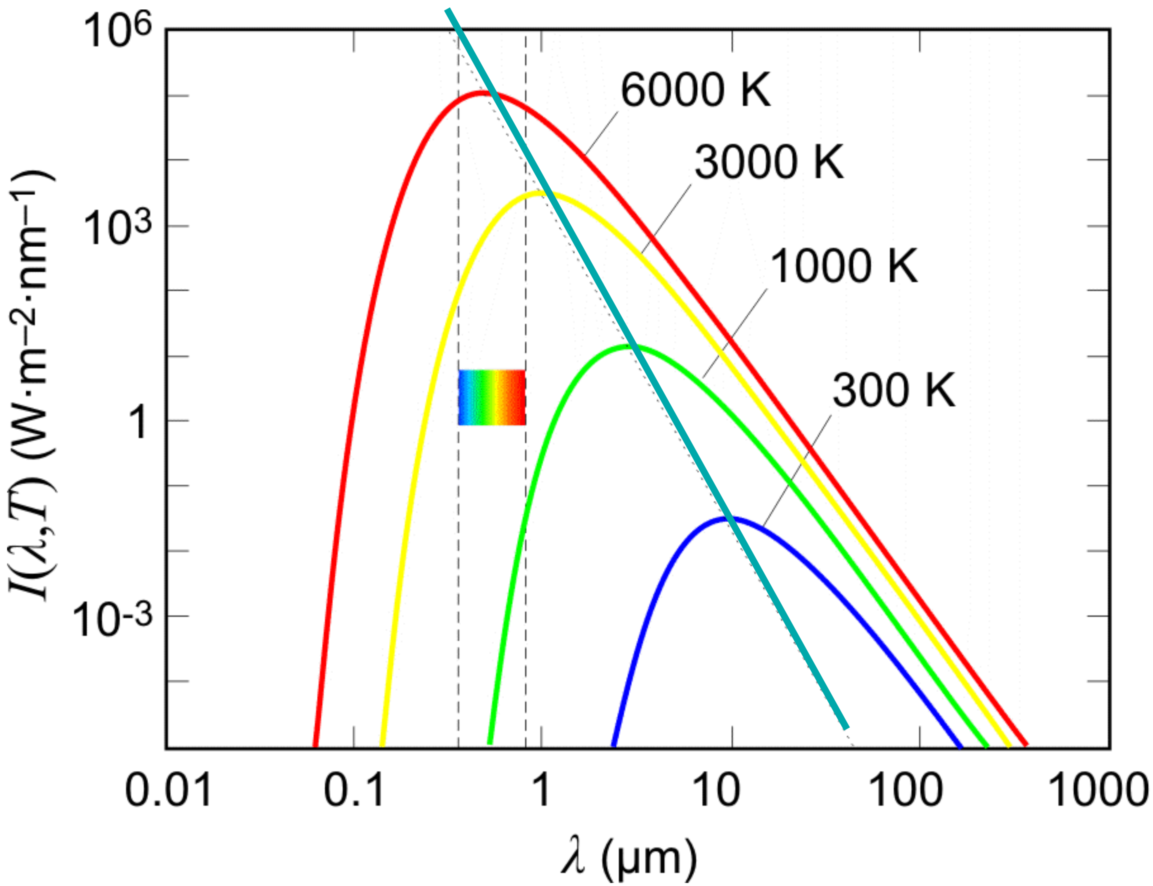
1. Rayleigh-Jeans Law: In the limit where hν << kT, most applicable for long wavelengths (such as in the radio part of the spectrum) and temperatures in the range of planetary bodies.

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

2. The Wien Law: When hν >> kT

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

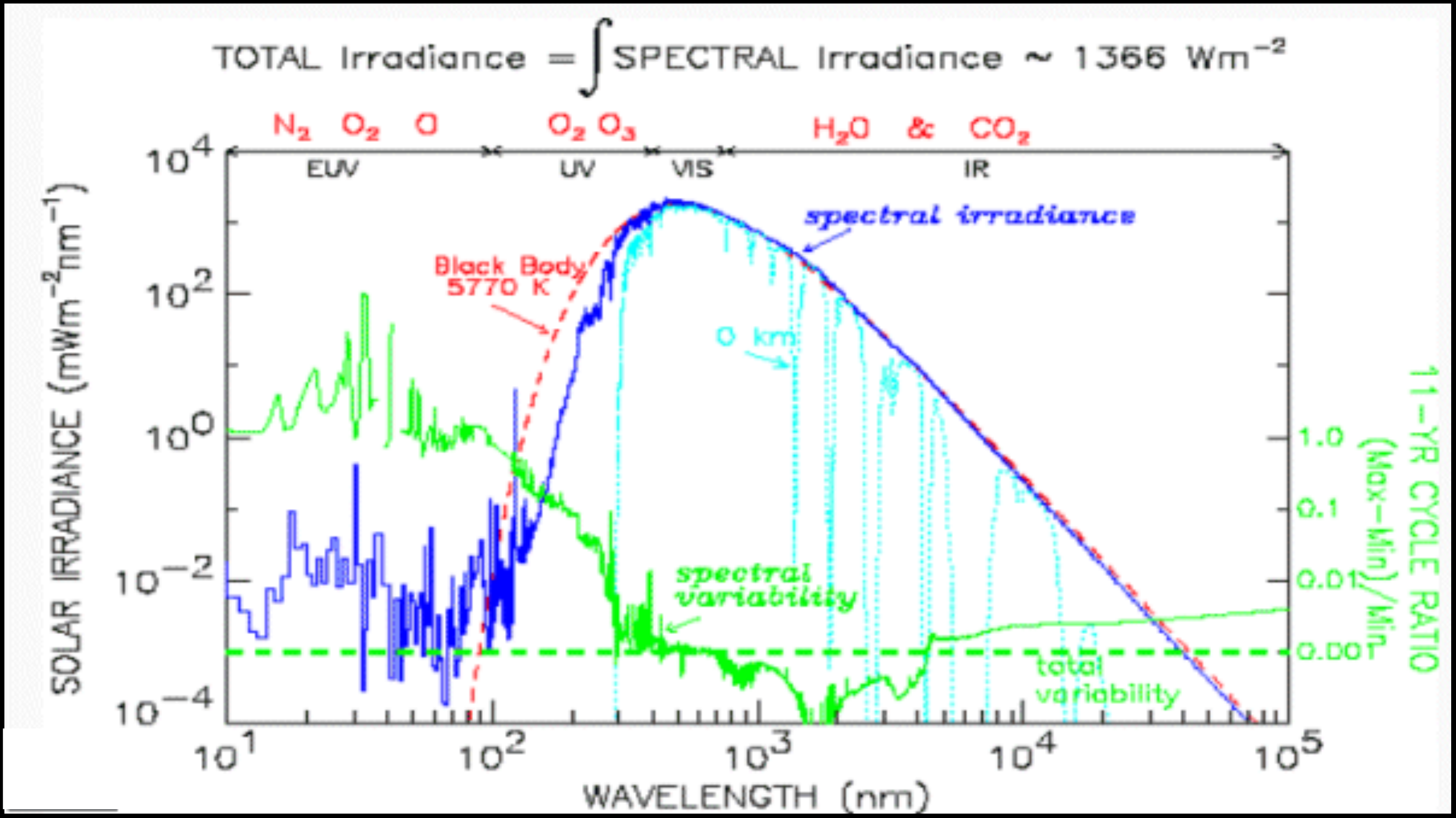
# Wien's Displacement Law




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

$\nu_{max} = 5.88 \times 10^{10} T$ , where $\nu_{max}$ 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

The Sun in Perspective