Solar Heating & Energy Transport

Electromagnetic Spectrum

- Gamma rays
- X-rays
- Ultraviolet rays
- Infrared rays
- Radar
- FM
- TV
- Shortwave
- AM

Visible Light

- Wavelength (nanometers): 400 to 700
- ‘Bluer’ → Shorter Wavelength → Higher energy photons
- ‘Redder’ → Longer Wavelength → Lower energy photons
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**THE ELECTROMAGNETIC SPECTRUM**

These waves travel through the electromagnetic field they were formerly carried by the aether, which was decommissioned in 1897 due to budget cuts.

**OTHER WAVES:**

- Slinky waves
- Sound waves
- Visible light

**VISIBLE LIGHT**

- Hydrogen
- Helium
- Tampax®
- Red
- Orange
- Yellow
- Green
- Blue
- Violet

**POWER & TELEPHONE**

- HAM
- Radio
- CIA

- SHOUTING CAR DEALERSHIP COMMERCIALS
- THE WAVES
- THE HIGH ENERGIZED STATE OF THE BOOM

- Flickr
- Blogorays
- POTATO

**SINISTER GOOGLE PROJECTS**

- MAIN DEATH STAR LASER
- K-MAL ORDER X-RAY GLASSES

- THE HIGH ENERGIZED STATE OF THE BOOM
- THE BLOGORAYS
- THE HIGH ENERGIZED STATE OF THE BOOM

**X-RAYS**

- 300 BUCKS FOR A TATTOO

- MAIN DEATH STAR LASER
- K-MAL ORDER X-RAY GLASSES

**Q (Electron)**

- 17

http://xkcd.com
Planck’s Law for Black Body Radiation

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

Specific Brightness:

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

Figure modified from Eric W. Weisstein
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 \( h\nu \ll kT \), most applicable for long wavelengths (such as in the radio part of the spectrum) and temperatures in the range of planetary bodies.

\[
B_\nu(T) \approx \frac{2\nu^2}{c^2} kT \quad \text{where} \quad e^{\frac{h\nu}{kT}} - 1 \approx \frac{h\nu}{kT}
\]

2. **The Wien Law**: When \( h\nu \gg kT \)

\[
B_\nu(T) \approx \frac{2h\nu^3}{c^2} e^{-\frac{h\nu}{kT}}
\]
Setting the derivative of Planck’s Law with respect to $\lambda$ (wavelength) equal to zero, we determine the peak wavelength with respect to temperature.

$$\nu_{\text{max}} = 5.88 \times 10^{10} T$$, where $\nu_{\text{max}}$ is in Hz.
Solar Spectrum, Variability, and Atmospheric Absorption

TOTAL Irradiance = ∫ SPECTRAL Irradiance ~ 1366 Wm⁻²

Spectral irradiance

Solar variability

WAVELENGTH (nm)

N₂, O₂, O, O₂, O₃, H₂O & CO₂

11-YR CYCLE RATIO

(Max−Min)/Min
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).

\[
\text{Luminosity } (L) = \text{ Energy flux } \times \text{ Area}
\]
and has units J/s or W
Hertzsprung-Russell (H-R) diagram

The Sun in Perspective