

Planck's radiation law

Planck's radiation law, a mathematical relationship formulated in 1900 by German physicist Max Planck to explain the spectral-energy distribution of radiation emitted by a blackbody (a hypothetical body that completely absorbs all radiant energy falling upon it, reaches some equilibrium temperature, and then reemits that energy as quickly as it absorbs it). Planck assumed that the sources of radiation are atoms in a state of oscillation and that the vibrational energy of each oscillator may have any of a series of discrete values but never any value between. Planck further assumed that when an oscillator changes from a state of energy E_1 to a state of lower energy E_2 , the discrete amount of energy $E_1 - E_2$, or quantum of radiation, is equal to the product of the frequency of the radiation, symbolized by the Greek letter ν and a constant h , now called Planck's constant, that he determined from blackbody radiation data; i.e., $E_1 - E_2 = h\nu$.

Planck's law for the energy E_λ radiated per unit volume by a cavity of a blackbody in the wavelength interval λ to $\lambda + \Delta\lambda$ ($\Delta\lambda$ denotes an increment of wavelength) can be written in terms of Planck's constant (h), the speed of light (c), the Boltzmann constant (k), and the absolute temperature (T):

$$E_\lambda = \frac{8\pi hc}{\lambda^5} \frac{1}{e^{(h\nu/kT\lambda)} - 1}$$

The wavelength of the emitted radiation is inversely proportional to its frequency, or $\lambda = c/v$. The value of Planck's constant is found to be $6.62606957 \times 10^{-34}$ joule·second, with a standard uncertainty of $0.00000029 \times 10^{-34}$ joule·second. For a blackbody at temperatures up to several hundred degrees, the majority of the radiation is in the infrared radiation region of the electromagnetic spectrum. At higher temperatures, the total radiated energy increases, and the intensity peak of the emitted spectrum shifts to shorter wavelengths so that a significant portion is radiated as visible light.

