At turn of 20th century, many thought that all the principles of physics were understood, and only the detailed applications remained to be worked out!

From the 1898–99 University of Chicago catalogue:

“While it is never safe to affirm that the future of the Physical Sciences has no marvels in store even more astonishing than those of the past, it seems probable that most of the grand underlying principles have been firmly established and that further advances are to be sought chiefly in the rigorous application of these principles to all the phenomena which come under our notice . . . . An eminent physicist has remarked that the future truths of Physical Science are to be looked for in the sixth place of decimals.”

WRONG!
Radiation from a hot body (classical)

‘Blackbody’ reflects no light, so its only radiation is due to its temperature.

Classical physics calculates the number of emitters in a blackbody box or ‘cavity’ by counting the number of ways that a full wave can be fit into the box. (putting an integer number of wavelengths between points on the box surface).

Number of waves that can be fit grows as frequency squared.

Classical theory says each such wave contributes energy $kT$ ($k$ is Boltzmann constant; $T$ is temperature in Kelvin (from absolute zero)).

Total radiation energy at some frequency = number of waves fitted in times energy per wave.

Energy radiated grows rapidly as frequency increases (wavelength decreases), leading to infinite total energy radiated!

Ultraviolet catastrophe
Planck hypothesis (1900):

The wave frequencies are ‘quantized’. For waves of frequency $f$, the energy is $hf$ ($h$ is a constant now known as Planck’s constant). The probability for a wave of high frequency to occur is not constant, but decreases when $hf$ exceeds the available ‘thermal energy’ of $kT$.

Thus the number of high frequency waves (small wavelength) is diminished and the ultraviolet catastrophe is averted.

Planck calculation agrees with observation the intensity vs. wavelength of hot black bodies.

Note that the intensity peaks at a certain wavelength, $\lambda_M$.

No one knew why the oscillators in the blackbody should be quantized. It was completely new (non-classical) physics.
Properties of Planck blackbody formula

1. Wein’s Law

Product of wavelength at maximum intensity $\lambda_M$ and the temperature (Kelvin absolute scale) $T$ is constant.

$$\lambda_M T = \text{constant}$$

Thus as temperature increases, the spectrum of radiation shifts to smaller wavelength. The peak is in the middle of the visible light range for $T \sim 6000 \text{K}$

2. Stefan’s Law

The total radiated energy per second (summing the radiation at all wavelengths) grows in proportion to $T^4$

$$\text{Intensity } I_{\text{TOT}} = \text{constant} \times T^4$$