The constant relationships between heat, temperature and mass

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Abstract

A closer look at the mass-energy equivalence reveals details of constant relationships between heat, temperature and mass. Not only does heat emission\(T^4\) have a constant relationship to mass via the speed of light, but temperature does as well.

Results

Quote from “Does the inertia of a body depend upon its energy-content?":

“If a body gives off the energy \(L\) in the form of radiation, its mass diminishes by \(L/c^2\).”

The relationship between thermal radiation and mass is according to Einstein \(L = mc^2\), where \(L = \sigma T^4\). There are several constant relationships here that appears to have been overlooked.

Since \(L = \sigma T^4\), it means that:

\[
\frac{T^4}{m} = \frac{c^2}{\sigma} = 1.58500147 \times 10^{24} K^4/kg \quad (1)
\]

The definition of the Stefan-Boltzmann constant:

\[
\sigma = \frac{2\pi^5 k^4}{15c^2 h^3} = \frac{\pi^2 k^4}{60 h^3 c^2} = 5.67037442 \times 10^{-8} W/m^2/K^4
\]

When including it in its entirety, we can now see that:

\[
\frac{T^4}{m} = \frac{c^2}{2\pi^5 k^4/15c^2 h^3} = \frac{c^4 15h^3}{2\pi^5 k^4} = \frac{c^4 60h^3}{\pi^2 k^4} \quad (2)
\]

Where:

Planck’s constant \(h = 6.62607015 \times 10^{-34} J/Hz\)

Boltzmann’s constant \(k = 1.380649 \times 10^{-23} J/K\)

Planck’s reduced constant \(\hbar = 1.054571817 \times 10^{-34} J/s\).

Which leads to:

\[
T^4 2\pi^5 k^4 = mc^4 15h^3 \quad (3)
\]

And with Planck’s reduced constant:

\[
T^4 \pi^2 k^4 = mc^4 60h^3 \quad (4)
\]

Now we can reduce it to a constant relationship to mass for both \(T^4\) and temperature.

Here I’ll use \(k\=konstant\.

\[
k_1 = \frac{T^4}{mc^4} = \frac{15h^3}{2\pi^5 k^4} = \frac{60h^3}{\pi^2 k^4} = 1.9622162 \times 10^{-10} K^4/kg/m^4/s^4 \quad (5)
\]
Instead of $L = mc^2$ we now have:

$$T^4 = mc^4 k_1 \quad (6)$$

where $c^4 k_1 = 1.58500147 \times 10^{24} K^4/\text{kg} \quad (7)$

Then, with the fourth root of $k_1$, we get another constant:

$$k_2 = \sqrt[4]{k_1} = 3.742714625 \times 10^{-3} K/\text{kg/m/s} \quad (8)$$

And now we can get a constant relationship also between temperature and mass:

$$T = mck_2 \quad (9)$$

References

e_mc2.pdf (fourmilab.ch)