

The Principle of Equivalence of Physical Laws, Empirical Calculations, Experiments, etc., in the Universe

Gh. Saleh

Saleh Research Centre, Netherlands

The principle of equivalence states that, where several methods exist for calculating a given parameter in physics, equal results must be obtained by all of them. For example, in the case of energy, the first method of calculation proceeds via the kinetic energy formula, in which the energy of any object is given by one-half the mass of the matter multiplied by the square of its speed ($E_k = \frac{1}{2} mv^2$). The second method, applicable to electromagnetic waves, is Planck's law, which states that the energy of a given wave is equal to the Planck constant multiplied by the frequency of that wave ($E = hf$).

Separately, in experiments conducted some years ago at the University of Michigan and at MIT, the energy of waves in near distance from their sources was measured using methods of their own. If the principle of equivalence is applied to these three methods for electromagnetic waves, the following relation is obtained:

Kinetic energy of the particle $\equiv$ Planck's law $\equiv$ the energy value obtained from the University of Michigan and MIT experiments

But the result of the University of Michigan and MIT experiments shows 10 times of the calculation by Plank formula.

It may indeed be said that, by any correct method, any precise experiment, any empirical calculation, or even the general law of kinetic energy, a particle or wave can and must yield an equal, identical, and consistent value. For example, energy may be calculated by the three methods referred to above for green, red, or violet light, demonstrating that, whichever method or law is applied — provided it is precise and correct — the resulting values must coincide. Here we calculate for green wave with frequency $\vartheta = 600 THz$ as at this frequency the linear and rotational part of energy is equal so it is more simply to calculate and also insert 3.3C for the speed of photon as it is the true speed.

$$E_{Total} = E_{Linear} + E_{Rotational}$$

$$\frac{1}{2}mv^2 = h\vartheta + \frac{1}{2}mr^2\omega^2$$

$$\text{at } \vartheta = 600THz \quad E_{Linear} = E_{Rotational} \Rightarrow E_{Total} = 2 E_{Linear}$$

$$E_{GreenTotal} = \frac{1}{2}m_{photon} v_{Green}^2 = \frac{1}{2}(1.64 \times 10^{-36})(3.3 \times 3 \times 10^8)^2 = 8 \times 10^{-19} j$$

$$E_{GreenLinear} = h \vartheta_{Green} = 6.62 \times 10^{-34} \times (6 \times 10^{14}) = 3.98 \times 10^{-19} j$$

$$E_{GreenTotal} \cong 2E_{GreenLinear}$$



Note: it may be concluded from the foregoing that, whatever form the laws in question take, and whatever form the correct scientific methods employed may take, these must necessarily yield equal values for the parameter under consideration.

Conclusion: in effect, equivalence, signifies that all correct methods, precise calculations, and physical laws must be mutually consistent. However, in this derivation, equivalence among the three methods referred to is not achieved unless the true speed of the photon — which is $3.3c$ — is substituted into it; it may therefore be said that a puzzle existed here, one resolved simply and fluently once the correct information is introduced.

References:

- [1] Taylor, Barry N., and Chris E. Kuyatt. *Guidelines for evaluating and expressing the uncertainty of NIST measurement results*. Vol. 1297. Gaithersburg, MD: US Department of Commerce, Technology Administration, National Institute of Standards and Technology, 1994.
- [2] Mohr, Peter J., et al. "CODATA recommended values of the fundamental physical constants: 2022." *Journal of Physical and Chemical Reference Data* 54.3 (2025): 033105.
- [3] Bokulich, Alisa, and Peter Bokulich. "Bohr's correspondence principle." (2010).

