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DOES THE INERTIA OF A BODY DEPEND UPON ITS ENERGY CONTENT?

by A. Einstein

[*Annalen der Physik* 18 (1905): 639-641]

The results of an electrodynamic investigation published by me recently in this journal[1] lead to a very interesting conclusion, which shall be derived here.

There I based myself upon the Maxwell-Hertz equations for empty space along with Maxwell's expression for the electromagnetic energy of space, and also on the following principle:

The laws governing the changes of state of physical systems do not depend on which one of two coordinate systems moving in uniform parallel translation relative to each other these changes of state are referred to (principle of relativity).

Based on these fundamental principles[2], I derived the following result, among others (*loc. cit.*, §8):

Let a system of plane waves of light, referred to the coordinate system (x,y,z), possess the energy ℓ; let the direction of the ray (the wave normal) form the angle φ with the x-axis of the system. If we introduce a new coordinate system (ξ,η,ζ), which is uniformly parallel-translated with respect to the system (x,y,z), and whose origin is moving along the x-axis with velocity v, then the above-mentioned quantity of light—measured in the system (ξ,η,ζ)—possesses the energy

$$\ell^* = \ell \frac{1 - \frac{v}{V}\cos\varphi}{\sqrt{1 - \left[\frac{v}{V}\right]^2}},$$

where V denotes the velocity of light. We will make use of this result in the following.

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[1] [1]A. Einstein, *Ann. d. Phys.* 17 (1905): 891.

[2]The principle of the constancy of the velocity of light used there is of course contained in Maxwell's equations.