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Simplified Interpretation for Einstein's Energy Mass Relation

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Abstract: *A simplified interpretation for equivalence of energy and mass which appear in the energy – mass relation of Einstein is presented without using Lorentz transformation and Maxwell equations. A shortest derivation of this relation is presented by using the definition of energy in terms of force and work, by assuming that no particle reaches a velocity that is greater than the velocity of light, and by using the interpretation.*

Keywords: *Energy; Mass; Velocity of Light.*

Section 1: Introduction

This short note avoids Lorentz transformation and Maxwell equations. This note does not consider the derivations of Einstein [2] and interpretation of others to explain his energy – mass relation. This note is based on the assumption that velocity of a moving particle or propagating energy cannot exceed the velocity of light in vacuum. This is the fundamental assumption in the special theory of relativity. This note assumes Newton's second law of motion in the following form: Force is equal to the rate of change of linear momentum with respect to time. This note assumes the definition of energy in terms of work and force, and the classical derivation of the kinetic energy of a particle moving in a straight line with a uniform velocity.

Section 2: Interpretation

A part of the mass of a fire-wood is converted into energy, when it is burnt. Although it is not verified, let us assume with an imagination that the sunlight energy is converted indirectly as a part of the mass of a living tree (There is an article [3] which provides an experimental evidence for energy to matter conversion). Thus, there are chances to convert a mass into energy, and energy into a mass. It should be understood that there is a conservation of "energy + mass" in a "closed" system. So, any example may be considered to derive the energy – mass relation within an "energy + mass" system. Let us consider a classical example. Consider a radioactive material which is permitted to decay and to convert mass into energy through radiation. Let us assume with an imagination that all particles are radiated, and the mass becomes nothing at some stage. Let us again assume with an imagination that each elementary mass dm of the given mass is permitted to move at the maximum possible velocity, the velocity of light in vacuum. Total emitted energy is the energy in the energy-mass formula of Einstein. This interpretation is experimentally supported in the article [4]. With these formal assumptions, let us proceed towards an elementary derivation, which is also a shortest one.

Section 3: A Derivation

Let

M = initial mass of an object at time zero,

m = mass of the object at a general time,

v = velocity of the object at a general time,

F = force applied on the object,

x = distance travelled by the object at a general time,

t = a general time,

c = velocity of light in vacuum (a constant), and

E = total energy that is to be derived from M.

Observe from the Newton's second law that
$F = \frac{d(mv)}{dt} = m\frac{dv}{dt} + \frac{dm}{dt}v$.

With v = c, a constant, this relation becomes
$F = c\frac{dm}{dt}$.

So, $F\,dx = c\,\frac{dm}{dt}\,dx = c\frac{dx}{dt}\,dm = cv\,dm = c^2\,dm$.

So, if E is the total energy emitted through radiation when the initial mass M is reduced to zero mass, the following relations are true.

$E = \int_{m=0}^{m=M} F\,dx = \int_{m=0}^{m=M} c^2\,dm = Mc^2$.

So, the following is true for an object with mass M: $E=mc^2$.

This derivation reminds us the classical derivation for kinetic energy. Let us assume again that the entire mass M is radiated simultaneously such that each elementary mass reaches the maximum possible velocity c. Then the total kinetic energy of these elementary masses is $(1/2)Mc^2$. But this kinetic energy can be obtained only when same amount of "potential energy or binding energy" hidden in the matter or mass is spent. So, Mc^2 should be the total energy hidden inside the matter or mass. Thus, there is no need to search for a derivation for the energy-mass relation, when the interpretation is understood, and when the classical derivation for kinetic energy is recalled.

Section 4: Conclusions

The energy – mass relation has been derived with the assumption that no particle can reach a velocity that is greater than the velocity of light in vacuum. All known technologies accelerate charged particles, electrons and protons, with the help of changes in electric fields and magnetic fields. Even if it is assumed that all changes happen from a single source, and these changes form a propagating wave, then its velocity cannot exceed the maximum possible velocity of electromagnetic waves. So, charged particles cannot be driven to a speed that is greater than the speed of light. If two charged particles of equal mass collide with each other, then again they cannot increase their velocities. If a proton and an electron having different masses collide with each other, then a release of energy takes place (see [1]), and again a chance of increase in velocities of these particles is missing. So, present technologies are not applicable to drive a particle so that it can get a velocity that is greater than the velocity of light. Thus, another theoretical verification of the energy – mass relation has been presented in this note, through a simplified interpretation. It is understood that interpretations are more important than any derivation for the energy-mass relation.

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