Einstein's Total Relativistic Energy and the Scale Principle

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Abstract

Earlier this year I wrote an article entitled Scale Factors and the Scale Principle (The Scale Law). In that article I formulated a new law which all laws of physics obey. The purpose of this article is to show that the Einstein's relativistic energy formula is a special case of the present formulation.

Keywords: *total relativistic energy, momentum, scale law.*

1. Introduction

In 2012 I formulated the scale principle or scale law [1] which I published in June this year. In summary the scale law states that the laws of physics can be written as dimensionless ratios. In other words the scale law can be expressed, mathematically, by the following relationship:

Scale Principle or *Scale Law*
$$\left(\frac{Q_1}{Q_2}\right)^n \left[< \,\middle|\, \le \,\middle|\, = \,\middle|\, \ge \,\middle|\, > \right] S \left(\frac{Q_3}{Q_4}\right)^m \qquad (1.1)$$

See reference [1] for a full description of the scale law.

2. Derivation of Einstein's Total Relativistic Energy Equation from the Scale Law

I shall derive the Einstein's total relativistic energy [2, 3] formula:

$$E^2 = p^2c^2 + m_0^2c^4 \qquad (2.1)$$

from the scale principle (scale law). To start the derivation let us consider the energy scale table given below.

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Energy	Energy	Energy	Energy
E_1	E_2	pc	pc

Table 1: *This simple scale table is used to show that Einstein's relativistic energy equation obeys the scale law.*

Where

E_1 = energy (the meaning is given below)
E_2 = energy (the meaning is given below)
p = momentum of the particle
c = speed of light in vacuum

According to the above scale table we write

$$E_1 \, E_2 = S \, pc \, pc \qquad (2.2)$$

As always we have introduced the scale factor *S*. Equation (2.2) can be rewritten in the form of the scale law:

$$\frac{E_1}{pc} = S \frac{pc}{E_2} \qquad (2.3)$$

The meaning of E_1 and E_2 is given by the following definitions

$$E_2 \equiv E + m_0 c^2 \qquad (2.4)$$

E_1 is the particle's relativistic energy ***plus*** its rest energy, and

$$E_2 \equiv E - m_0 c^2 \qquad (2.5)$$

E_2 is the particle's relativistic energy ***less*** its rest energy.

Where

E = total relativistic energy of the particle
m_0 = particle's rest mass

Substituting E_1 and E_2 in equation (2.3) with the second side of equations (2.4) and (2.5) respectively, we get

$$\frac{E + m_0 c^2}{pc} = S \frac{pc}{E - m_0 c^2} \qquad (2.6)$$

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A scale factor of 1 yields the implicit expression for the total relativistic energy:

$$\frac{E + m_0 c^2}{pc} = \frac{pc}{E - m_0 c^2} \qquad (2.7)$$

Comparing eq. (2.7) with eq. (1.1) we get the following relations

$n = m = 1$
$Q_1 = E + m_0 c^2$
$Q_2 = Q_3 = pc$
$Q_4 = E - m_0 c^2$
$S = 1$

(The value of the scale factor can be determined by experiments. Let us not forget that Einstein's relativistic energy equation was compared over and over again against experimental evidence to prove its correctness). Thus equation (2.7) corresponds to the following simple case of the scale law:

$$\frac{Q_1}{Q_2} = \frac{Q_3}{Q_4} \qquad (2.8)$$

where

$Q_2 = Q_3$

Now let us return to equation (2.7) and let us rewrite it as follows

$$\left(E + m_0 c^2\right)\left(E - m_0 c^2\right) = \left(pc\right)^2 \qquad (2.9)$$

$$E^2 - \left(m_0 c^2\right)^2 = \left(pc\right)^2 \qquad (2.10)$$

Finally

$$E^2 = p^2 c^2 + m_0^2 c^4 \qquad (2.11)$$

Thus we have derived Einstein's formula for the total relativistic energy of a particle from the scale law. It is without question that by observing equation (2.11) it is almost impossible to suspect that this equation obeys the scale law.

There is a shorter an easier way to prove that equation (2.11) obeys the scale law. We could have started from equation (2.11) (without drawing the scale table) and then we could have worked backwards through equations (2.10), (2.9), (2.8) until we get to equation (2.7). However, this backwards process cannot be applied unless we know the final equation which is not known when analyzing an unknown phenomenon.

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3. Conclusions

Critically speaking we could say that, to determine the value of the scale factor, we had to look at the experimental evidence. However this is also the case of Einstein's special theory of relativity which was based on experiments (Michelson-Morley) which proved that the speed of light in vacuum was independent of the motion of the light source (a postulate known as: the invariance of c). Einstein adopted this experimental result as one of his postulates or cornerstones to formulate his special theory of relativity. Therefore the derivation presented in this paper is as solid as any other theory based on postulates inferred from experimental results.

In summary, taking into consideration that the scale law describes all known laws of physics as I have shown in previous papers [1, 4] and in this paper, we can consider that the scale law is a more general and higher law than the specific laws it describes. In other words the scale law is a Meta-law.

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