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Was Einstein Right or Wrong?

António Saraiva -- 2006-09-15
ajps2@hotmail.com

Abstract – Everyone thinks they know Einstein's mass variation formula, but he never wrote it. In his famous 1905 paper "On the electrodynamics of moving bodies" (A. Einstein, Ann. Phys. 17, 891) he derived another formula that happens to be correct and he was near to discovering that the electric charge is also variable with the speed.

Mass variation formula

The well-known formula for mass variation with speed is:

$$m = \frac{m_0}{\sqrt{1 - v^2 / c^2}} \qquad (1)$$

But this formula is not correct and Einstein never wrote it. In his paper "On the electrodynamics of moving bodies", Einstein derived two formulas about two types of mass, which he calls:

Longitudinal mass: $m = \frac{m_0}{\left(1 - v^2 / c^2\right)^{3/2}}$ (2) and

Transverse mass: $m = \frac{m_0}{1 - v^2 / c^2}$ (3)

The longitudinal mass formula is the true one for mass variation with speed and the second formula, if we change mass to electric charge, is the true one for charge variation with speed.

What do the experiments really say?

All experiments and all knowledge about particles accelerators are related to electrically charged particles: electrons, protons or ions, so what we really know is:

$$\frac{m}{q} = \frac{m_0}{q_0} \frac{1}{\sqrt{1 - v^2 / c^2}} \qquad (4)$$

As no one thinks that charge is also variable, if $q = q_0$ we get the classically wrong formula. But we are going to prove that the true formula is the Einstein 1905 one.

$$\begin{cases}(2)\\(4)\end{cases} \quad \Leftrightarrow \quad q = \frac{q_0}{1 - v^2 / c^2}$$

Derivation of the true Einstein's mass variation formula

From the formulas for space contraction and time dilatation:

$$\begin{cases} x = x_0\sqrt{1 - v^2 / c^2} \\ t = \dfrac{t_0}{\sqrt{1 - v^2 / c^2}} \end{cases} \quad \Leftrightarrow \quad xt = x_0 t_0 = A \qquad (\text{A = constant})$$

Doing $w = x / t$ and $f = 1 / t$ $\Leftrightarrow$ $w = Af^2$

The wave energy is given:

$E = mw^2$ and $E = hf$ $\Leftrightarrow$ $mw^2 = hf$ $\Leftrightarrow$

$\Leftrightarrow$ $f^3 = \dfrac{h}{mA^2}$ and $f_0{}^3 = \dfrac{h}{m_0 A^2}$

As $f = f_0\sqrt{1 - v^2 / c^2}$ $\Leftrightarrow$

$$\Leftrightarrow \quad m = \frac{m_0}{\left(1 - v^2 / c^2\right)^{3/2}}$$

This formula is coherent with the two equations of time dilatation and space contraction. The wrong formula can only be derived from the space formula by denying the time one.

So, the electric charge is variable with relative speed:

$$q = \frac{q_0}{1 - v^2 / c^2}$$