Special Relativity for Beginners Part III

(The Invariance of the Relativistic Mass Multiplied by the Relativistic Length)

In this paper I derive the invariance of the product: relativistic mass times relativistic length.

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September 29, 2015

Keywords: *rest mass, relativistic mass, proper length, relativistic length, relativistic mass law, Fitzgerald-Lorength length contraction formula.*

1. The Invariance of the Product *Relativistic mass* times *Relativistic length*

Let us consider Einstein's relativistic mass law

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} \tag{1.1}$$

and also the Fitzgerald-Lorentz length contraction formula

$$l = l_0\sqrt{1-\frac{v^2}{c^2}} \tag{1.2}$$

Multiplying equation (2.1) by equation (2.1) we get

$$m\,l = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}\, l_0\sqrt{1-\frac{v^2}{c^2}} \tag{1.3}$$

After simplification we get

$$m\,l = m_0 l_0 \tag{1.4}$$

this result means that

Invariance of the product: relativistic mass times relativistic length

The product of the relativistic mass of a given body (or particle) times its relativistic length is the same for all observers in uniform relative motion.

Appendix 1
Nomenclature

The following are the symbols used in this paper

c = speed of light in vacuum
v = speed of a body or particle of mass m
m_0 = rest mass of a body or particle
m = relativistic mass of a body or particle
l_0 = proper length of a body or particle
l = relativistic length of a body or particle
p = momentum of a body or particle
E = total relativistic energy (or simply relativistic energy) of a body or particle
K = relativistic kinetic energy of a body or particle
$K_{classical}$ = classical kinetic energy of a body or particle
SR = Special Relativity (Einstein's theory of special relativity)

FURTHER READING

(1) A. Einstein, *On the Electrodynamics of Moving Bodies*, Annalen der Physik, (1905).
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