Art_2 : Inertial Property of All Forms of Energy

Source: http://sci.tech−archive.net/Archive/sci.physics/2005−12/msg00842.html

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- *Date*: 11 Dec 2005 08:00:34 −0800

Inertia is an inherent property of matter and mass is the quantitative measure of inertia. The annihilation and pair production of some of the elementary particles has shown that the elementary particles could be viewed as specially lumped up or locally entrapped forms of energy. Therefore, it is quite reasonable to deduce that Inertia must be an inherent property of all forms of energy, especially the entrapped energy. The quantitative measure of inertia of a small energy content dE may be given by its equivalent mass content dm through the well known relation

$dm = dE / c^2$ .... (1)

where c is the speed of light in vacuum.

>>From this inertial property of all forms of entrapped energy, we can derive the notion of dynamic mass and develop its quantitative relationship with the rest mass. Let a material particle P be at rest in some global inertial reference frame and let its rest mass in this frame be m_0. When at rest, the kinetic energy of this particle P will obviously be zero.

Now let us assume that the particle P is set in motion through application of a constant force F. Further, at an instant of time t, let the instantaneous velocity of P be v with corresponding kinetic energy content E. Since the energy content E will also exhibit the inertial property, let the quantitative measure of total inertia of P at the instant t be given by m, which may also be referred as the dynamic mass of the particle. If during a small interval of time dt the particle traverses a small distance ds and gains a small amount of kinetic energy dE then the following relations will hold.

$v = ds/dt$ .... (2)

$dE = F.ds$ .... (3)

>>From Newton's second law of motion

$F = d(mv) / dt = m. dv/dt + v. dm/dt$ .... (4)

>>From equations (3) and (4)

$dE = m. dv/dt . ds + v. dm/dt . ds$

$= mv . dv + v^2. dm$ .... (5)

And from equations (1) and (5) we get,

$dm = (mv/c^2) . dv + (v^2/c^2). dm$ .... (6)

Let us make a substitution $x= v/c$ in equation (6) so that $dx = dv/c$
and
$dm = mx . dx + x^2 . dm$ .... (7)
Or $(1-x^2) dm = mx . dx$
Or $dm/m = (x/(1-x^2)) . dx$ .... (8)

This on integration yields,
$m/m_0 = (1-x^2)^{(-1/2)}$
Or $m = m_0 / \sqrt{1- v^2/c^2}$ .... (9)

This is a standard relation for the dynamic mass of a particle in motion. Here it is important to note that the derivation of dynamic mass m in terms of rest mass m_0 did not involve special relativity. Instead this derivation is entirely based on the inertial property of all forms of energy, including K.E. Similarly all dynamic relations of SR can be shown to be resulting from the inertial property of all forms of energy, including K.E.

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