Mass Transformation in Reference Frame

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The total momentum of an isolated system is invariant if the system is subject to a conservative force. An isolated system of two identical objects subject to the gravitational force presents a rigorous proof that the mass of the object is independent of the direction of its motion. In an inertial reference frame moving in the transverse direction to the direction of gravitational force, the law of conservation of momentum requires the mass of an object to be independent of its speed.

I. INTRODUCTION

The total momentum of an isolated system remains constant if it is subject to a conservative force. Two identical objects attracted by the gravitational force between them will form such conservation system.

The momentum is proportional to the product of mass and velocity. For more than a century, speculation exists that the mass is also a function of the velocity. The mass-velocity relation originates from electromagnetic mass[1] in the late 19th century and mutates into relativistic mass[2] in the 20th century with unrealistic idea of longitudinal mass and transverse mass. Currently, the theory of velocity dependent mass is mostly abandoned although the theory of relativistic momentum and relativistic energy still lingers in high energy physics.

However, the mass-velocity relation can indeed be precisely determined by applying the law of conservation of momentum to two inertial reference frames. One frame is the center-of-mass frame. The other frame moves in the transverse direction of the relative motion between two identical objects.

II. PROOF

Consider two dimensional motion.

A. Conservation of Momentum

In an isolated system, two identical objects with mass of m are attracted to each other by gravity. One object moves at the velocity of (v,0). The other moves at (-v,0). Let the mass of object be a function of its velocity

$$m = m(\vec{v}) \tag{1}$$

$$\vec{v} = (v, 0) \tag{2}$$

The total momentum is

$$\vec{P} = m(\vec{v})(v, 0) + m(-\vec{v})(-v, 0) \tag{3}$$

$$= (m(\vec{v}) - m(-\vec{v}))(v, 0) \tag{4}$$

The total momentum remains constant because the gravitational force is conservative.

$$d\vec{P} = 0 \tag{5}$$

From equations (4,5),

$$(m(\vec{v}) - m(-\vec{v}))(v, 0) = \vec{K} \tag{6}$$

$\vec{K}$ is a constant vector that satisfies any value of v. Set v to zero to obtain $\vec{K}$.

$$\vec{K} = 0 \tag{7}$$

From equations (6,7),

$$m(\vec{v}) = m(-\vec{v}) \tag{8}$$

The mass of an object depends on the speed of its motion but not the direction of its motion.

$$m = m(v) \tag{9}$$

B. Mass Transformation

Let F_1 be the rest frame of the center-of-mass of this isolated system. In F_1, one object moves at the velocity of (v,0). The other moves at (-v,0).

Let F_2 be an inertial reference frame moving at the velocity of (0,-U) relative to F_1. In F_2, one object moves at the velocity of (w,U). The other moves at the velocity of (-w,U).

The total momentum in F_2 is

$$\vec{P} = m(\sqrt{w^2 + U^2})(w, U) \tag{10}$$

$$+m(\sqrt{(-w)^2 + U^2})(-w, U) \tag{11}$$

$$= m(\sqrt{w^2 + U^2})(0, 2U) \tag{12}$$

The law of conservation of momentum demands

$$d\vec{P} = 0 \tag{13}$$

From equations (12,13),

$$d(m(\sqrt{w^2 + U^2})(0, 2U)) = 0 \tag{14}$$

U is a constant.

$$d(m(\sqrt{w^2 + U^2})) = 0 \tag{15}$$

$$\frac{d}{dw} m(\sqrt{w^2 + U^2}) = 0 \tag{16}$$

The mass of the object is not a function of w. The mass of an object is independent of its speed.

III. CONCLUSION

The mass of an object is conserved in all reference frames. Mass is independent of velocity.

For more than a century, the mass-velocity relation has been the center of speculation in particle physics. The unrealistic idea of the longitudinal mass and the transverse mass eventually gives way to the unrealistic relativistic momentum and energy. However, no proof has ever been presented to resolve this speculation.

Mass is finally proved to be independent of the velocity. The theory of relativistic mass is proved to be invalid in physics.

[1] O. Heaviside (1888), The electro-magnetic effects of a moving charge Electrician 22,147148. 333345.

[2] Reignier, J.: The birth of special relativity - "One more essay on the subject". arXiv:physics/0008229 (2000) Relativity, the FitzGerald-Lorentz Contraction, and Quantum Theory

[3] Eric Su: List of Publications, http://vixra.org/author/eric_su