Conservation of Mass in Collision

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The conservation of mass in inertial reference frame is a property of the conservation law of momentum. The inelastic collision between two identical objects shows that the total momentum is zero in the COM frame (center of mass). In another inertial reference frame, the rest frame of one object before collision, the total momentum before the collision is equal to the total momentum after the collision. This conservation of momentum shows that the mass of an object is also conserved in all inertial reference frames. The mass of a moving object is independent of its velocity.

I. INTRODUCTION

The conservation law of momentum can be applied to the collision to determine the velocity of each object after the collision. With the velocity determined, the mass of each object after the collision can also be determined.

Two identical objects make inelastic collision. In the center-of-mass reference frame, both move at the same speed but in the opposite direction. There is no total momentum. In another inertial reference frame, the total momentum exists and stays constant during collision.

The rest frame of one object before the collision is chosen to simplify the calculation of the total momentum during the collision. In this reference frame, total momentum before the collision is from a single mass. The total momentum after inelastic collision is always from a single mass. This enables a concise calculation of mass from the total momentum.

II. PROOF

Consider one-dimensional motion.

A. Conservation of Momentum

Let two identical objects make inelastic collision in a reference frame F_1. The mass of each object is a function of the speed of the object.

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

One object moves at the speed of V while the other object moves at the speed of -V. The conservation law of momentum requires

$$m(V) * V + m(-V) * (-V) = m(0) * 0 + m(0) * 0 \tag{2}$$

Let another reference frame F_2 moves at the speed of -V relative to F_1. The collision in F_2 is represented by

$$m(U) * U + m(0) * 0 = m(V) * V + m(V) * V \tag{3}$$

$$m(U) * U = 2 * m(V) * V \tag{4}$$

According to the velocity transformation [1] between inertial reference frames,

$$U = 2V \tag{5}$$

From equations (4,5),

$$m(2V) = m(V) \tag{6}$$

$$\frac{d}{dV} m(2V) = \frac{d}{dV} m(V) \tag{7}$$

Apply chain rule to the differentiation,

$$\frac{d}{dV} m(V) = 0 \tag{8}$$

The mass of an object in motion is independent of its speed.

III. CONCLUSION

The mass of an object is conserved in all inertial reference frames. The motion of the object does not alter its mass.

The conservation of mass is a direct property of the conservation law of momentum.

The theory of special relativity[2,3,4] claims that the mass of an object will increase as the object starts to move. This is proved to be incorrect. This erroneous claim creates a common illusion in modern particle physics that the particles become more massive after acceleration.

The radio frequency cavity in the particle accelerator increases the energy of the particle if the movement of the particle happens to synchronize with the resonance frequency of the cavity. As the mass of the particle stays constant, the increase in the kinetic energy actually corresponds to the higher speed of the particle after acceleration by the cavity.

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[2] Albert Abraham Michelson, Edward Morley, 1887. https://en.wikisource.org/wiki/On_the_Relative_Motion_of_the_Earth_and_the_Luminiferous_Ether

[3] H. R. Brown (2001), The origin of length contraction: 1. The FitzGeraldLorentz deformation hypothesis, American Journal of Physics 69, 1044 1054. E-prints: gr-qc/0104032; PITT-PHIL-SCI00000218.

[4] 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

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