# Representation of Momentum

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The inelastic collision between two identical particles shows that the ratio of the momentum to the mass includes an extra term in addition to the velocity. An extra function independent of the speed of the particle is part of the momentum. This function can be determined empirically from the parameters of Large Hadron Collider at CERN.

## I. INTRODUCTION

Two identical particles 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. The vanishing momentum prohibits the conservation of mass from being observed. Another inertial reference frame is needed to show that the total momentum exists and the mass stays constant during collision.

An inertial reference frame moving transversely to the longitudinal direction of the collision is chosen to simplify the calculation of the total momentum In this reference frame, the speed changes after the collision while the total momentum remains constant. The ratio of the momentum to the mass is found to include an extra term in addition to the velocity.

## II. PROOF

Consider two-dimensional motion.

### A. Conservation of Momentum

The momentum of the particle is proportional to its mass and velocity. A general representation of momentum can be

$$\vec{p} = m(v) * \vec{v} = m_0 * f(v) * \vec{v} \tag{1}$$

$m_0$ is the rest mass of the particle. Assume f(v) is a function of the speed of the particle.

Let two identical particles make inelastic collision in a reference frame $F_1$. One particle moves at the velocity of (0,V) while the other particle moves at the velocity of (0,-V). The conservation law of momentum requires the total momentum before the collision to be equal to the total momentum after the collision.

$$m_0 * (0, V) * f(V) + m_0 * (0, -V) * f(V) \tag{2}$$

$$= m_0 * (0, 0) * f(0) + m_0 * (0, 0) * f(0) \tag{3}$$

Let another reference frame $F_2$ move at the velocity of (-v,0) relative to $F_1$. The velocity (0,V) in $F_1$ is represented by (v,U) in $F_2$.

The collision is represented in $F_2$ by

$$m_0 * (v, U) * f(\sqrt{v^2 + U^2}) \tag{4}$$

$$+m_0 * (v, -U) * f(\sqrt{v^2 + (-U)^2}) \tag{5}$$

$$= m_0 * (v, 0) * f(v) + m_0 * (v, 0) * f(v) \tag{6}$$

Cancel $m_0$ from both sides.

$$(2v, 0) * f(\sqrt{v^2 + U^2}) = 2 * (v, 0) * f(v) \tag{7}$$

$$f(\sqrt{v^2 + U^2}) = f(v) \tag{8}$$

### B. Representation of Momentum

Apply differentiation to equation (8),

$$\frac{d}{dv} f(\sqrt{v^2 + U^2}) = \frac{d}{dv} f(v) \tag{9}$$

Let $x = \sqrt{v^2 + U^2}$ and apply chain rule.

$$\frac{dx}{dv} \frac{d}{dx} f(x) = \frac{d}{dv} f(v) \tag{10}$$

$$\frac{v}{\sqrt{v^2 + U^2}} \frac{d}{dx} f(x) = \frac{d}{dv} f(v) \tag{11}$$

Replace dummy variable 'x' with 'v',

$$\frac{v}{\sqrt{v^2 + U^2}} \frac{d}{dv} f(v) = \frac{d}{dv} f(v) \tag{12}$$

$$\frac{d}{dv} f(v) = 0 \tag{13}$$

f can not be a function of the speed.

The momentum of the particle is represented by the mass, velocity and an extra function.

$$\vec{p} = m_0 * \vec{v} * f \tag{14}$$

### C. Synchrotron

f can be determined empirically by lorentz force. Let the particle move in a circular orbit. The force on the particle is

$$\frac{d\vec{p}}{dt} = m_0 * f * \frac{d\vec{v}}{dt} \tag{15}$$

At CERN, the lorentz force is used by Large Hadron Collider to keep the proton in a curved orbit.

$$m_p * f * \frac{d\vec{v}}{dt} = q * \vec{v} \times \vec{B} * Q(v) \tag{16}$$

TABLE I. Parameters of Large Hadron Collider

| Symbol | Description | Value |
|---|---|---|
| $m_p$ | proton mass | $1.67 * 10^{-27}$ kg |
| q | proton charge | $1.6 * 10^{-19}$ C |
| v | proton speed | $2.997 * 10^{8}$ m/s |
| B | magnetic field | 8.33 Tesla |
| r | bending radius | 2804 m |

$$\frac{f}{Q(v)} = \frac{q * r * B}{m_p * v} = 7460 \tag{17}$$

CERN believes the proton has become 7460 times more massive after acceleration[1]. This erroneous claim allows CERN to declare the energy of the proton to reach a maximum of 7 Tev in Large Hadron Collider.

$$E_p = 7460 * m_p * c^2 = 7 \tag{18}$$

From equation (16),

$$q\frac{Q(v)}{f}\vec{v} \times \vec{B} = m_p \frac{d\vec{v}}{dt} \tag{19}$$

The lorentz force from equations (17,19) is

$$F_B = \frac{q}{7460}\vec{v} \times \vec{B} \tag{20}$$

The force is not linearly proportional to the speed of the particle.

## III. CONCLUSION

The mass of an particle is conserved in all inertial reference frames. The conservation of mass is a direct property of the conservation law of momentum. The motion of the particle does not alter its mass but its momentum and energy.

The representation of momentum consists of three terms: mass, velocity, and a function independently of the speed.

The theory of special relativity[2,3,4] claims that the mass of an particle will increase due to its motion. 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.


[1] CERN: "Taking a closer look at LHC". http://www.lhc-closer.es/taking_a_closer_look_at_lhc/0.relativity

[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

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