Coordinate Transformation between Inertial Reference Frames

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Two inertial reference frames moving at identical velocity can be seperated if one of them is put under acceleration for a duration. The coordinates of both inertial reference frames are related by the acceleration and its duration. An immediate property of this coordinate transformation is the conservation of distance and length across reference frames. Therefore, the concept of length contraction from Lorentz Transformation is impossible in reality and physics.

I. INTRODUCTION

Two inertial reference frames moving at identical velocity can be considered a single reference frame. In order to seperate these two reference frames, one of them must be put under acceleration for a duration. Once the acceleration is removed, these two inertial reference frames will move relatively to each other and are considered two seperate inertial reference frames.

The acceleration relates the coordinates of both inertial reference frames. It and its duration determine how the coordinates can be transformed between two reference frames.

One example of such transformation is derived in this paper. The acceleration is chosen to be constant in time so that the derivation is simple and concise. Any acceleration dependent of time can be considered if the reader desires.

II. TRANSFORMATION

Consider one-dimensional motion.

A. Acceleration

Based on the definition of acceleration, a stationary object put under constant acceleration A for a duration T will move a distance D and increase its velocity to V.

$$D = X_f - X_i \tag{1}$$

$$V = A * T \tag{2}$$

$$X_f = X_i + \frac{A*T^2}{2} \tag{3}$$

X_i is the initial position of the object before application of constant acceleration A.

X_f is the final position of the object after application of constant acceleration A for a duration T.

T is the total elapsed time for the application of acceleration

V is the final velocity of the object.

Place two identical objects at two different locations, $X1_i$ and $X2_i$. Both objects are at rest initially. Put both objects under identical constant acceleration A at the same time for a duration T.

Their final locations, $X1_f$ and $X2_f$, can be calculated according to the definition of acceleration.

$$X1_f = X1_i + \frac{A*T^2}{2} \tag{4}$$

$$X2_f = X2_i + \frac{A*T^2}{2} \tag{5}$$

Both objects will move at the same velocity of V at the end of duration T.

$$V = A * T \tag{6}$$

The distance between these two objects is R

$$R = X2_f - X1_f = X2_i - X1_i \tag{7}$$

R remains constant during acceleration.

The acceleration is terminated at the end of duration T. Therefore, for any time t greater than T,

$$X1_f = X1_i + (t - T) * V + \frac{A*T^2}{2} \tag{8}$$

$$X2_f = X2_i + (t - T) * V + \frac{A*T^2}{2} \tag{9}$$

R remains constant after acceleration.

B. Reference Frame

Both objects are stationary to each other at all time. They form a reference frame F_2 that moves at the velocity V relative to a reference frame F_1 in which both objects are initially at rest.

Let the initial location of object 1 be the origin of both F_1 and F_2. The location of object 2 becomes a representation of the coordinate in both F_1 and F_2.

Let x' be the location of object 2 in F_2. Let x be the location of object 2 in F_1.

$$x' = X2_i \tag{10}$$

$$x = X2_f \tag{11}$$

Therefore, the coordinate transformation between F_1 and F_2 is:

$$x = x' + (t - T) * V + \frac{A * T^2}{2} \tag{12}$$

C. Conservation of Length

Place a stationary object of length L in F_2. The positions of both ends of this object in F_2 are x'_a and x'_b.

$$L = x'_b - x'_a \tag{13}$$

Based on coordinate transformation between F_1 and F_2,

$$x_a = x'_a + (t - T) * V + \frac{A * T^2}{2} \tag{14}$$

$$x_b = x'_b + (t - T) * V + \frac{A * T^2}{2} \tag{15}$$

x_a and x_b are the positions of both ends of this object in F_1. The length of this object in F_1 is x_b-x_a.

$$x_b - x_a = x'_b - x'_a = L \tag{16}$$

The length of this object is L in both F_1 and F_2.

III. CONCLUSION

Coordinate transformation between two inertial reference frames depends on the acceleration and its duration. A direct property of such transformation is the conservation of distance and length across reference frames. Consequently, the length of an object is independent of inertial reference frame.

Therefore the concept of length contraction based on Lorentz Transformation[1] is impossible in physics. Lorentz Transformation is a proposal based on the assumption that the speed of light is independent of inertial reference frame[2]. It fails to produce the property of the conservation of distance and length. By violating this fundamental property of physics, it can not be a proper coordinate transformation between two inertial reference frames in physics.

For more than a century, Lorentz Transformation has confused physics community with its consistency in mathematics. There is a popular misunderstanding that consistent mathematics means reality. This is, of course, not true.

Consequently, any theoriy based on Lorentz Transformation can not describe reality correctly.

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