Displacement And Wavelength In Non-Inertial Reference Frame

Eric Su
eric.su.mobile@gmail.com
https://sites.google.com/view/physics-news/home
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The parity symmetry in physics connects the motions in two different reference frames. By examining the displacements in both reference frames, the length of the displacement can be shown to be conserved in both reference frames. For two frames in relative inertial motion, the displacement is conserved in all inertial reference frames. For two frames free to accelerate, the displacement is conserved in all non-inertial reference frames. The length of a displacement is conserved in all reference frames. The wavelength of a wave is conserved in all reference frames. The frequency varies with reference frame in Doppler effect. Therefore, the speed of light varies with reference frame. Light travels at different speed in different reference frame.

I. INTRODUCTION

The parity symmetry connects the physics in one reference frame to the physics in another reference frame whose motion is in the opposite direction.

To demonstrate the application of this symmetry on the displacement, two pairs of identical objects are chosen to form an isolated system. Their locations and velocities are specified according to parity symmetry. Any movement of one pair of objects ensures the movement of the other pair of objects in the opposite direction.

From the conservation of the elapsed time[1], the displacement in the rest frame of one pair of objects is shown to be related to the displacement in the rest frame of the other pair of objects. This isolated system can be configured with inertial motion or arbitrary motion. The displacement will be derived in both configurations.

II. PROOF

Consider one-dimensional motion.

A. Parity Symmetry

Let four identical objects form an isolated system in a reference frame F_0.

The first object O_1 is located at x_a and moves at the speed of -v. The second object O_2 is located at x_b and moves at the same speed of -v.

Let the third object O_3 form a parity symmetry with O_1. O_3 is located at $-x_a$ and moves at the speed of v. Let the fourth object O_4 form a parity symmetry with O_2. O_4 is located at $-x_b$ and moves at the speed of v.

The displacement from O_4 to O_1 is

$$D_{41} = x_a - (-x_b) = x_a + x_b \tag{1}$$

The displacement from O_3 to O_2 is

$$D_{32} = x_b - (-x_a) = x_b + x_a \tag{2}$$

Let the elapsed time for O_4 to reach O_1 in F_0 be T^0_{41}. Let the elapsed time for O_3 to reach O_2 in F_0 be T^0_{32}.

From equations (1,2),

$$D_{32} = D_{41} \tag{3}$$

Therefore,

$$T^0_{32} = T^0_{41} \tag{4}$$

At the time when O_4 reaches O_1 in F_0, O_3 also reaches O_2 in F_0.

B. Reference Frame

O_1 is stationary relative to O_2. Let the rest frame of both O_1 and O_2 be F_1. O_4 is stationary relative to O_3. Let the rest frame of both O_4 and O_3 be F_2.

Let the displacement from O_1 to O_2 in F_1 be D^1_{12}. Let the displacement from O_4 to O_3 in F_2 be D^2_{43}

From parity symmetry,

$$D^1_{12} = -D^2_{34} = D^2_{43} \tag{5}$$

Let the elapsed time for O_4 to reach O_1 in F_1 be T^1_{41}. Let the elapsed time for O_3 to reach O_2 in F_1 be T^1_{32}.

From the conservation of the elapsed time[1], the elapsed time is conserved in both F_1 and F_0.

$$T^1_{32} = T^0_{32} \tag{6}$$

$$T^1_{41} = T^0_{41} \tag{7}$$

From equations (4,6,7),

$$T^1_{32} = T^1_{41} \tag{8}$$

At the time when O_4 reaches O_1 in F_1, O_3 also reaches O_2 in F_1.

O_4 moves to the location of O_1 at the same time when O_3 moves to the location of O_2. The displacement from O_1 to O_2 overlaps the displacement from O_4

to O_3. Therefore, the displacement from O_1 to O_2 in F_1 is identical to the displacement from O_4 to O_3 in F_1.

Let the displacement from O_4 to O_3 in F_1 be D^1_{43}

$$D^1_{12} = D^1_{43} \tag{9}$$

From equations (5,9),

$$D^2_{43} = D^1_{43} \tag{10}$$

The displacement from O_4 to O_3 is conserved in both F_1 and F_2.

C. Inertial Motion

Let v be a constant in F_0. F_1 becomes inertial relative to F_0. F_2 also becomes inertial relative to F_0 but in the opposite direction.

Both F_1 and F_2 become inertial reference frames relative to F_0. They are also inertial relative to each other. From equation (10), the displacement from O_4 to O_3 is conserved in both F_1 and F_2.

Therefore, *the elapsed time is conserved in all reference frames which are inertial relative to F_1.*

D. Arbitrary Motion

Remove restriction on v to allow F_2 move in an arbitrary motion relative to F_1. From equation (10), the displacement from O_4 to O_3 is conserved in both F_1 and F_2.

Therefore, *the displacement is conserved in all reference frames whether they are inertial or non-inertial relative to F_1.*

E. Wavelength

Wavelength of a wave is the displacement between two adjacent wave crests. Therefore, *the wavelength is conserved in all reference frames.*

One manifestation is the standing wave in a microwave oven. The standing wave pattern is observable in all reference frames and to all moving observers. The displacement between two adjacent nodes of the pattern is conserved in all reference frames.

F. Doppler Effect

For a moving observer approaching a light source, the frequency of the light will increase. This phenomenon was discovered by Christian Doppler[2] in 1842.

The wavelength of the light is conserved in all reference frames including the rest frame of the light source and the rest frame of the observer. In the rest frame of the observer, the frequency of the light increases but the wavelength of the light is conserved. The speed of light is equal to its frequency multiplied by its wavelength.

Therefore, *the speed of light increases in the rest frame of the observer who moves toward the light source.*

III. CONCLUSION

The parity symmetry generates the conservation of the displacement. The length of displacement is conserved in all reference frames in one-dimensional space. Length contraction due to choice of reference frame is impossible in physics.

The speculation of length contraction comes from Lorentz transformation[3,4] which was inspired by an error[5] in Michelson-Morley experiment[6].

The speed of a wave varies with the rest frame of the wave detector. Doppler effect shows that a different frequency will be detected in the rest frame of the wave detector due to the relative motion between the wave detector and the source of wave. The conservation of displacement shows that the wavelength in this rest frame is identical to the original wavelength. The speed of light is different in different reference frame.

[1] Su, Eric: Time In Non-Inertial Reference Frame. viXra: Relativity and Cosmology/1902.0002 (2019). http://vixra.org/abs/1902.0002

[2] Schuster, Peter M. (2005). Moving the Stars Christian Doppler: His Life, His Works and Principle, and the World After. Pllauberg, Austria: Living Edition. ISBN 3-901585-05-2

[3] Reignier, J.: The birth of special relativity - "One more essay on the subject". arXiv:physics/0008229 (2000)

[4] 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.

[5] Su, Eric: Error in Michelson and Morley Experiment. viXra: Relativity and Cosmology/1902.0285 (2019). http://vixra.org/abs/1902.0285

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

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