Conservation of Wavelength In Reference Frame

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Parity symmetry maps one object to another object as inverse image. It shows that a displacement and its inverse image are of the same length. The length of a displacement is conserved in all reference frames. The wavelength of a wave is the length of the displacement between two adjacent crests. Therefore, the wavelength is conserved in all reference frames. However, Doppler effect shows that the frequency of light is not conserved in all inertial reference frames. As a result, the speed of light is not conserved in all inertial reference frames.

I. INTRODUCTION

For two identical objects in motion, a reference frame can be chosen so that these two objects form parity symmetry in this reference frame. The object can be a displacement. While two displacements form the parity symmetry, they are of the same length in their own rest frame.

However, these two displacements may not be of the same length in the same reference frame. This can be resolved with the properties of parity symmetry.

By applying the result to the wavelength which is the length of a displacement, the speed of light can also be determined from parity symmetry since the speed of a wave is equal to the product of its wavelength and its frequency

II. PROOF

Consider one-dimensional motion.

A. Parity Symmetry

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

The location of first object O_1 is $\vec{r_a}$. Its velocity is $\vec{v}$. Let the location of second object O_2 be $-\vec{r_a}$. Its velocity is $-\vec{v}$. O_2 and O_1 form a parity symmetry in F_0.

Add two more objects to F_0 to form another parity symmetry. The location of third object O_3 is $\vec{r_b}$. Its velocity is $\vec{v}$. Let the location of fourth object O_4 be $-\vec{r_b}$. Its velocity is $-\vec{v}$. O_3 and O_4 form a parity symmetry in F_0.

Let the rest frame of both O_1 and O_3 be F_1. In F_1, the displacement vector from O_1 to O_4 is $\vec{D_{14}}$. The displacement vector from O_3 to O_2 is $\vec{D_{32}}$.

If a displacement vector is 0 in one reference frame, it is also 0 in all reference frames.

$\vec{D_{14}}$ becomes 0 when O_4 moves into the location of O_1 in F_1.

$$\vec{D_{14}} = 0 \tag{1}$$

In F_0, the displacement vector from O_1 to O_4 also becomes 0.

$$(-\vec{r_b}) - \vec{r_a} = 0 \tag{2}$$

From equation (2),

$$(-\vec{r_a}) - \vec{r_b} = 0 \tag{3}$$

$(-\vec{r_a}) - \vec{r_b}$ is the displacement vector from O_3 to O_2 in F_0. Therefore, $\vec{D_{32}}$ is also 0 in F_1.

$$\vec{D_{32}} = 0 \tag{4}$$

In F_1, the position vectors for these four objects are specified as:

$\vec{R_1}$ is the position vector of O_1.
$\vec{R_2}$ is the position vector of O_2.
$\vec{R_3}$ is the position vector of O_3.
$\vec{R_4}$ is the position vector of O_4.

From equation (1),

$$\vec{D_{14}} = 0 = \vec{R_4} - \vec{R_1} \tag{5}$$

From equation (4),

$$\vec{D_{32}} = 0 = \vec{R_2} - \vec{R_3} \tag{6}$$

From equations (5,6),

$$\vec{R_4} - \vec{R_1} = 0 = \vec{R_2} - \vec{R_3} \tag{7}$$

$$\vec{R_3} - \vec{R_1} = \vec{R_2} - \vec{R_4} \tag{8}$$

Let the length of displacement vector from O_1 to O_3 in F_1 be L_{13}.

$$L_{13} = \mid (\vec{R_3} - \vec{R_1}) \mid \tag{9}$$

Let the length of displacement vector from O_4 to O_2 in F_1 be L_{42}.

$$L_{42} = \mid (\vec{R_2} - \vec{R_4}) \mid \tag{10}$$

From equations (8,9,10),

$$L_{13} = L_{42} \tag{11}$$

L_{42} is the distance between O_4 and O_2 in F_1. L_{13} is the distance between O_1 and O_3 in F_1.

Let the rest frame of both O_4 and O_2 be F_2. From parity symmetry, the distance between O_1 and O_3 in F_1 is identical to the distance between O_4 and O_2 in F_2. Therefore, L_{13} is also the distance between O_4 and O_2 in F_2.

From equation (11), L_{42} is the distance between O_4 and O_2 in both F_1 and F_2.

The length of a displacement vector is conserved in both F_1 and F_2. The distance is conserved in all reference frames.

B. Wavelength

The wavelength of a wave is the length of 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 length of the displacement between two adjacent nodes of the pattern is conserved in all reference frames.

C. 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 which include 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 length 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].

Doppler effect shows that the frequency detected in the rest frame of the wave detector is different from the original frequency in the rest frame of the wave emitter. The conservation of the length of displacement shows that the wavelength in the rest frame of the wave detector is identical to the original wavelength in the rest frame of the wave emitter.

With different frequency but same wavelength, the speed of light is different in different reference frame.

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