Isotropy Of Light In Reference Frame

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The speed of light is identical in all directions in the rest frame of the light source. In a different inertial reference frame, the direction of light may change due to the motion of the light source. The speed of light in the longitudinal direction of the motion of the light source is compared to the speed of light in the transverse direction. The result shows that these two speeds are equal only if the speed of the light source is greater than the speed of light.

I. INTRODUCTION

An isotropic light source radiates the same intensity of radiation in all directions. This is possible only if the light source is stationary. The light from a moving source may have a different velocity due to the motion of light source. Such velocity can be determined with the transformation of reference frame from the rest frame of the light source to another inertial reference frame.

The velocities from two different reference frames are related by the relative motion between reference frames. For reason of simplicity, only light in two particular directions are transformed. One direction is parallel to the motion of the light source. The other direction is vertical to the motion of the light source.

The speed of light in each direction is calculated based on transformation rules. The comparison of two speeds generates the required condition for them to be identical to each other. For light that is in a new direction in the new reference frame, its direction will show how the distribution of the light intensity should be for a moving light source.

II. PROOF

Consider two-dimensional motion.

A. Reflection Symmetry

Let an observer P_1 be stationary at the origin of a reference frame F_1. Let another observer P_2 be at a position (x,0) in F_1.

Let the rest frame of P_2 be F_2. P_2 is stationary at the origin of F_2. From the relative reflection symmetry, P_1 is at the position of (-x,0) in F_2.

Let P_2 move at the velocity of (v,0) relative to F_1. From the relative reflection symmetry, P_1 is moving at the velocity of (-v,0) relative to F_2.

B. Elapsed Time

P_1 is equipped with a light source to radiate light in all directions. The light in the x-direction reaches P_2. Let T_1 be the elapsed time for light to reach P_2. The speed of light is C_1 in F_1.

$$C_1 * T_1 = x + v * T_1 \tag{1}$$

$$x = (C_1 - v) * T_1 \tag{2}$$

The light in the y-direction travels the distance L for the duration of T_1.

$$L = C_1 * T_1 \tag{3}$$

In F_2, the elapsed time for the light from P_1 to reach P_2 is T_2. Let the speed of light in the x-direction be C_2.

$$C_2 * T_2 = | -x | \tag{4}$$

C. Speed Of Light

The light in the y-direction in F_1 is in a new direction in F_2. Let the speed of light in this direction be C_3.

$$(C_3 * T_2)^2 = L^2 + (v * T_2)^2 \tag{5}$$

$$C_3 = \frac{\sqrt{L^2 + (v * T_2)^2}}{T_2} \tag{6}$$

From equations (2,4),

$$C_2 = \frac{(C_1 - v) * T_1}{T_2} \tag{7}$$

From equations (3,6),

$$C_3 = \frac{\sqrt{(C_1 * T_1)^2 + (v * T_2)^2}}{T_2} \tag{8}$$

D. Isotropy

From equations (7,8),

$$\frac{C_3}{C_2} = \frac{\sqrt{(C_1 * T_1)^2 + (v * T_2)^2}}{(C_1 - v) * T_1} \tag{9}$$

The condition for $C_2 = C_3$ is

$$\sqrt{(C_1 * T_1)^2 + (v * T_2)^2} = (C_1 - v) * T_1 \tag{10}$$

$$(v * T_2)^2 = (v^2 - 2C_1 v) * T_1^2 \tag{11}$$

$$T_2 = T_1 \sqrt{1 - 2\frac{C_1}{v}} \tag{12}$$

The condition breaks down if

$$1 - 2\frac{C_1}{v} < 0 \tag{13}$$

C_2 is equal to C_3 only if

$$v > 2C_1 \tag{14}$$

Equation (12) indicates that C_2 is equal to C_3 only if the time dilation from Lorentz transformation[1,2] is false.

E. Intensity

The direction of transverse light in F_1 changes by an angle θ in F_2. From equation (5),

$$sin(\theta) = \frac{v * T_2}{L} \tag{15}$$

From equations (2,3,4,15),

$$sin(\theta) = \frac{v * \frac{x}{C_2}}{C_1 * \frac{x}{C_1 - v}} \tag{16}$$

For v much smaller than C_1, $sin(\theta)$ is proportional to

$$\frac{v}{C_2} \tag{17}$$

The angle increases if the light source moves faster.

III. CONCLUSION

The speed of light depends on the choice of reference frame. The motion of the light source not only changes the direction of light but also the speed of light.

The direction of light becomes closer to the direction of the movement of the light source. The movement of the light source causes its light to be concentrated toward the direction of its movement. The intensity of light in front of the light source increases upon acceleration of the light source.

For a slow moving light source, the speed of its longitudinal light is different from the speed of its tranverse light.

[1] 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.

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