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Additional Supporting Evidence to "Unveiling the Conflict of the Speed of Light Postulate"

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Further mathematical evidences of the unviability of the special relativity's constancy of the speed of light postulate are presented.

Introduction

Beside the relativity principle, the constancy of the speed of light postulate forms the basis of the mathematical formulation of the special relativity theory. It provides the mathematical foundation for the Lorentz transformation derivation. This principle, as well as the Lorentz transformation, has been the subject of an analytical study [1, 2] by the author, in which mathematical contradictory results, attributed to the Lorentz transformation and the speed of light postulate, have been unveiled. This communication provides a supplementary material to the said work. Further elaboration on the constancy of the speed light principle equations, providing additional evidences of their unviability, is carried out.

Previous Finding

It has been shown in one part of a previous study[1, 2] that for the two inertial reference frames $\mathrm{K(x,y,z,t)}$ and $\mathrm{K'(x',y',z',t')}$ moving relative to each other with a uniform velocity v, the Lorentz transformation equations can lead to

$$x^2 = c^2 t^2 \; ; \tag{1}$$

$$x'^2 = c^2 t'^2 ; \tag{2}$$

under no restriction imposed on the Lorentz transformation domain of application in the reference coordinate systems.

On the other hand, since the constancy of the speed of light principle is expressed as [3, 4]

$$x^2 + y^2 + z^2 = c^2t^2 \tag{3}$$

in K, converted in K' to

$$x'^2 + y'^2 + z'^2 = c^2t'^2; \tag{4}$$

leading to

$$x^2 - x'^2 = c^2t^2 - c^2t'^2, \tag{5}$$

equations (1) and (2) become the basic, unique solution for the constancy of the speed of light equation (5). In other words, the light sphere equations (4) and (5) become straight line equations.

Verification

To verify the above finding, a simple particular case will be examined, from which a general conclusion can be drawn.

The speed of light postulate indicates that any point (x, y, z), in the reference frame K, on the light sphere defined by equation (3), traveling with the expanding sphere at the speed of light c, will be transformed in K' to point (x', y', z') traveling at the same speed of light c on the expanding light sphere described by equation (4). For instance, if we select the points on the light sphere of equation (3), satisfying the following relations

$$x^2 = \frac{1}{3}c^2t^2;\ y^2 = \frac{1}{3}c^2t^2;\ z^2 = \frac{1}{3}c^2t^2; \tag{6}$$

or

$$x = \pm\frac{1}{\sqrt{3}}ct;\ \ y = \pm\frac{1}{\sqrt{3}}ct;\ z = \pm\frac{1}{\sqrt{3}}ct\,; \tag{7}$$

then, according to the constancy of the speed light principle, the transformed coordinates x', y', and z' in K' must satisfy the sphere equation (4). However, it will be demonstrated below that this could not be achieved, unless the reference frame K and K' are at rest with respect to each other (i.e. $v = 0$).

Now, according to the constancy of the speed of light principle, if $x = ct$ is the equation of the distance travelled by a light ray tip point in the stationary frame K, the corresponding travelled distance in the relatively moving frame K' is governed by the same equation with respect to K'coordinate systems:

$x' = ct'$. Accordingly, for a light ray with a tip point satisfying equations (7), i.e. the x-projected distance travelled by the ray tip point in the stationary frame is given by $x = ct/\sqrt{3}$, then the x'-projected distance must be $x' = ct'/\sqrt{3}$, because as c is constant in both frames, $c/\sqrt{3}$ remains constant as well. Indeed, this result can be deduced from the Lorentz transformation as follows.

The Lorentz transformation is given in the following expressions[3].

$$x' = \gamma(x - vt);$$
$$y' = y\,;$$
$$z' = z\,;$$
$$t' = \gamma\left(t - \frac{vx}{c^2}\right);$$
$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}.$$

For our particular case of the defined points on the expanding light sphere, with the coordinates satisfying equations (7), let

$$x = \pm c\tau; y = \pm c\tau; z = \pm c\tau$$

Where,

$$\tau = \frac{t}{\sqrt{3}}.$$

The Lorentz transformation can then be written for this particular case as

$$x' = \gamma(x - v\tau);$$
$$y' = \pm c\tau\,;$$
$$z' = \pm c\tau;$$
$$\tau' = \gamma\left(\tau - \frac{vx}{c^2}\right);$$

Therefore, the above Lorentz transformation equations lead to

$$x'^2 = c^2\tau'^2 = \frac{1}{3}c^2t'^2; \tag{8}$$

$$y'^2 = c^2\tau^2 = \frac{1}{3}c^2t^2\,; \tag{9}$$

$$z'^2 = c^2\tau^2 = \frac{1}{3}c^2t^2; \tag{10}$$

and, as anticipated above, $x = ct/\sqrt{3}$ in K corresponds to $x' = ct'/\sqrt{3}$ in K'.

The used expression $\tau' = t'/\sqrt{3}$ in equation (8) is justified as follows.

The Lorentz transformation equations

$$x' = \gamma(x - vt);$$

$$t' = \gamma\left(t - \frac{vx}{c^2}\right);$$

return $x' = ct'$ for $x = ct$.

Multiply both sides of the above equations by a real number α, we get

$$\alpha x' = \gamma(\alpha x - \alpha vt);$$

$$\alpha t' = \gamma\left(\alpha t - \frac{\alpha vx}{c^2}\right).$$

Now, letting $\tau = \alpha t$ and $\chi = \alpha x = \alpha ct = c\tau$, the above expressions becomes

$$\alpha x' = \gamma(\chi - v\tau) = \chi',$$
$$\alpha t' = \gamma\left(\tau - \frac{v\chi}{c^2}\right) = \tau'.$$

Therefore, for $\tau = t/\sqrt{3}$ $\left(i.e.\ \alpha = 1/\sqrt{3}\right)$, $\tau' = t'/\sqrt{3}$ ∎

On the other hand, adding equations (8)–(10), yields

$$x'^2 + y'^2 + z'^2 = \frac{1}{3}(c^2t'^2 + c^2t^2 + c^2t^2). \tag{11}$$

Therefore, equation (11) would return the light sphere equation (4), only if $t = t'$, which implies from the Lorentz transformation that $\gamma = 1$.

This result can be equally obtained from equation (5), which results in $1/3\, c^2t^2 - 1/3\, c^2t'^2 = c^2t^2 - c^2t'^2$, or $2/3\, c^2t^2 = 2/3\, c^2t'^2$, yielding $t = t'$.

Alternative Approach

The above evidence of the unviability of the constancy of the speed of light in the three dimensional space can be also reconfirmed through the following argument.

Consider the above particular case of the light sphere points defined by equation (7). As a consequence of the Lorentz transformation, the x-coordinate expression

$$x = \frac{1}{\sqrt{3}} ct$$

can be written—by substituting $x(x', t')$ and $t(x', t')$ from the Lorentz transformation—as

$$\gamma(x' + vt') = \frac{1}{\sqrt{3}} c\gamma \left(t' + \frac{vx'}{c^2}\right);$$

which can be simplified to

$$x'\left(1 - \frac{1}{\sqrt{3}}\frac{v}{c}\right) = \frac{1}{\sqrt{3}} ct'\left(1 - \sqrt{3}\frac{v}{c}\right).$$

Squaring both sides of the above equation, we get

$$x'^2 = \frac{1}{3} c^2 t'^2 \left(\frac{1 - \sqrt{3}\, v/c}{1 - \sqrt{3}^{-1}\, v/c}\right)^2.$$

It follows that

$$x'^2 + y'^2 + z'^2 = \frac{1}{3} c^2 t'^2 \left(\frac{1 - \sqrt{3}\, v/c}{1 - \sqrt{3}^{-1}\, v/c}\right)^2 + \frac{2}{3} c^2 t^2 \qquad (12)$$

Therefore, equation (12) would reduce to the light sphere equation (4), only if $v = 0$, which implies from the Lorentz transformation that $\gamma = 1$, and $t = t'$.

It should be noted the above contradiction ($\gamma = 1$) has been obtained as a consequence of the Lorentz transformation, and not by effecting the Lorentz transformation on the given coordinates (i.e. not by plugging the given x-coordinate in the x'- and t'-equations) satisfying the light sphere equation in the K reference frame, which would return the light sphere equation in K', since the Lorentz transformation itself is derived on the basis of the light sphere transformation given by equations (3) and (4)—Arriving at the light sphere equation (4), through converting the given coordinates satisfying equation (3) via Lorentz transformation, does not necessarily verify the viability of the light sphere transformation given by equations (3) and (4).

Conclusion

The constancy of the speed of light equations (3) and (4) are unviable for the considered particular case of $x, y,$ and z coordinates satisfying the light sphere equation in the reference frame K—where x, y and z are different from zero—thus generally refuting the validity of these equations for non-zero value of y and z (i.e. for $x^2 \neq c^2t^2$), and verifying the previous finding that equations (1) and (2) are the basic, unique solution for the constancy of the speed of light equations.

References

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3 Einstein, A. "Zur elektrodynamik bewegter Körper," Annalen der Physik **322** (10), 891–921 (1905).

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