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Relativistic Doppler Effect versus Time Dilation: Critical Inconsistency

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Abstract

The period of a light wave emitted by an oscillating electron in a "stationary" reference frame was determined in a relatively moving frame using the Lorentz transformation applied on different event intervals; one being between two events on the wave propagation path, and the other between two co-local events on the oscillating source path. A critical inconsistency in the Special Relativity was revealed.

Keywords: *Special Relativity, Relativistic Doppler shift, Time Dilation*

Introduction

In his 1905 paper,[1] Einstein derived the Lorentz transformation (LT) equations for the space and time coordinates on the basis of the relativity principle and the constancy of the speed of light. These equations resulted in the time dilation and length contraction. In addition, transformation equations for the electric and magnetic forces were then deduced from the Maxwell-Hertz and the LT equations. The obtained electrodynamics transformations applied on the wave equations for light led to the general relativistic Doppler shift formula.

It follows that the coherence of the Doppler shift formula is vital for the Special Relativity reliability. In this paper, it is shown that when the LT time equation was applied on the propagation of a light wave, the result will be the relativistic Doppler formula in terms of the wave periods. Whereas, if the same LT transformation was applied on the wave source, the result will be the relativistic time dilation in terms of the source periods. Since the wave and its source have the same period, inconsistency in the foresaid results is obvious.

Relativistic Doppler Shift

In §3 of the above cited paper,[1] the time transformation equation converting event time between two inertial frames in relative motion of velocity v, having the coordinate systems $K(x, y, z, t)$ and $k(\xi, \eta, \zeta, \tau)$ associated with what's considered as "stationary" and "moving" frame, respectively, is obtained as

$$\tau = \gamma\left(t - \frac{vx}{c^2}\right), \tag{1}$$

where

$\gamma = \left(\sqrt{1 - v^2/c^2}\right)^{-1}$, and $c =$ speed of light in empty space.

In §7 of the same paper, a light (electrodynamics waves) source, with given wave characteristics, is considered in the stationary system at a sufficiently far distance from the origin. The characteristics of these waves were to be determined when observed from the moving frame. We quote the following passage:

> *From the equation for ω' it follows that if an observer is moving with velocity v relatively to an infinitely distant source of light of frequency ν, in such a way that the connecting line "source-observer" makes the angle ϕ with the velocity of the observer referred to a system of co-ordinates which is at rest relatively to the source of light, the frequency ν' of the light perceived by the observer is given by the equation*
>
> $$\nu' = \nu \frac{1 - \cos\phi \ . \ v / c}{\sqrt{1 - v^2/c^2}}. \qquad (2)$$
>
> *This is Doppler's principle for any velocities whatever. When $\phi = 0$ the equation assumes the perspicuous form*
>
> $$\frac{\nu'}{\nu} = \frac{\sqrt{1 - v/c}}{\sqrt{1 + v/c}}. \qquad (3)$$

Equation (3) can be written in the form

$$\nu' = \gamma\nu\left(1 - \frac{v}{c}\right), \qquad (4)$$

or in terms of the wave periods

$$T' = \gamma T\left(1 + \frac{v}{c}\right). \qquad (5)$$

Relativistic Doppler Effect Contradiction with Time Dilation

A critical inconsistency in the Special Relativity is the fact that the relation

$$T' = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} T, \qquad (6)$$

where T and T' are the light wave periods in the "stationary" source frame and the "moving" observer's frame, respectively, is a Special Relativity result.

In fact, consider an electron oscillating with a period T across the origin of the "stationary" frame coordinate system along the Y- axis. Let λ be the wavelength of the emitted light wave, with respect to the "stationary" frame, while the wave period must be equal to the oscillating electron period T. The observer rest frame is moving at speed v relative to the "stationary" frame. We are to determine the wave period T' relative to the observer.

Consider two consecutive events $E1$ and $E2$ occurring at two consecutive wave peaks. These two events are separated by the spatial interval $\Delta x = \lambda = cT$, and the temporal interval $\Delta t = T$. From the perspective of the moving observer, the corresponding spatial interval is $\Delta x' = \lambda' = cT'$, and the temporal interval is $\Delta t' = T'$.

Applying the Lorentz transformation

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

between these two events, from the observer's perspective (the source is "moving" with the velocity $-v$), we get

$$T' = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} T\left(1+\frac{v}{c}\right), \quad (7)$$

in accordance with SR Eq. (5)

Now, consider another two consecutive events, $E3$ and $E4$, occurring when the electron is at its maximum Y- coordinate for two consecutive times. Therefore, the temporal interval separating these events is the period of the oscillating electron, which is the same as the wave period T. The spatial interval separating these two events is zero.

Applying the Lorentz transformation

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

between these two events, we get

$$T' = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\left(T-0\right);$$

$$T' = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} T. \quad (8)$$

Hence, the above equation is ascertained to be for the wave period as observed from the moving frame, relative to its proper period. Yet, it contradicts the previous equation obtained as

$$T' = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} T\left(1+\frac{v}{c}\right);$$

both obtained under the Special Relativity predictions.

Conclusion

A critical contradiction in the Special Relativity is revealed when the Lorentz transformation time equation is applied between two events on a light wave propagation path, from one part, and between two events on the light wave emitting source (oscillating electron) path, from the other part.

References

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