Doppler Shift Reveals Light Speed Variation

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Light speed variation relative to a moving observer occurring according to classical velocity composition is demonstrated using Doppler Shift. This directly contradicts the light speed invariance postulate of special relativity and confirms ether drift.

Keywords: Doppler shift, Special relativity theory, Light speed invariance postulate, Light Speed Variation, Ether drift

1. Introduction

The Special Theory of Relativity was introduced by Albert Einstein 100 years ago and is the accepted theory of space and time [1-4]. It enjoys considerable experimental support [5] and its ideas have had a profound effect on modern physics. However despite its acceptance, from the time of its introduction in 1905 up to today, the theory has faced a continuous stream of criticism from many researchers [6-12] who have pointed to problems in the theory and raised doubts about its validity.

One of the foundation ideas of the theory is light speed invariance according to which light travels at a constant speed c in all inertial frames. Proponents of the theory argue that this light speed isotropy results from a direct variation of space and time, a notion that many find difficult to accept. Numerous experiments have been performed in order to test this postulate [13-20] but an inability to achieve clock synchronization appears to have prevented the measurement of one-way light speed [5]. Fifty years ago Ives [6] argued that the postulate is invalid and recently Gift demonstrated light speed variation in the Doppler [21], Roemer [21, 22] and Bradley [23] experiments directly contradicting the postulate.

In further support of these findings, we again focus in this paper on the issue of light speed variation in the Doppler Effect. Specifically we show that the well-established Doppler Shift or frequency change of electromagnetic radiation that occurs for a moving observer is accompanied by a change in wave or light speed relative to the moving observer and that this wave or light speed change (for low-speed observer movement) accords with classical velocity composition.

2. Doppler Shift

Consider a fixed transmitter from which light or other electromagnetic radiation is emitted at frequency f_o and speed c. A receiver mounted on a vehicle is located such that the radiation from the transmitter can be detected and the frequency of the received signal determined. For a stationary vehicle, wave fronts of electromagnetic radiation travel to the receiver and arrive at speed c

and frequency f_o. The distance λ_o between successive wave fronts can be found using the relationship $distance = speed \times time$ giving

$$\lambda_o = c \times 1/f_o = c/f_o \tag{1}$$

where $1/f_o$ is the time between successive wave fronts. When the vehicle moves toward the transmitter at speed v, the receiver intercepts an increased number of wave fronts per unit time compared with the stationary situation. As a result the frequency f_H of the received wave fronts is observed to be higher than f_o by some value Δf such that $f_H = f_o + \Delta f$. This observed increase in frequency of the electromagnetic radiation arriving at the moving receiver is referred to as the Doppler Shift [24] and is a well-known and well established phenomenon. The wave fronts arrive at the moving receiver at a speed c_R relative to the receiver that can be determined by considering the fixed distance λ_o traveled by a wave front and the elapsed time $1/f_H$ between successive wave fronts measured at the receiver. It is given by

$$c_R = \frac{distance}{time} = \frac{\lambda_o}{1/f_H} \tag{2}$$

Using (1) in (2) gives the wave speed relative to the receiver as

$$c_R = \frac{\lambda_o}{1/f_H} = \frac{cf_H}{f_o} = \frac{c(f_o + \Delta f)}{f_o} \tag{3}$$

(3) reduces to

$$c_R = c + \frac{c\Delta f}{f_o} = c + \Delta c \tag{4}$$

where Δc is a change in wave speed given by

$$\Delta c = \frac{c\Delta f}{f_o} \tag{5}$$

From equations (4) and (5) we see that a change in frequency $\Delta f \neq 0$ arising from the movement of the receiver corresponds to a change in wave speed $\Delta c \neq 0$ relative to the moving receiver resulting in a relative wave speed c_R not equal to c. Therefore the observed Doppler Shift or frequency change in the light or other electromagnetic radiation resulting from movement of the receiver toward the transmitter indicates a change in light speed relative to the moving receiver.

3. Relative Light Speed

The actual value of the relative light speed c_R can be directly deduced from experimental data. Let the speed v of the vehicle be say 67 mph giving $v << c$. Since c is approximately 670 million mph, then $v^2 / c^2 \approx 10^{-14}$ and therefore second-order (relativistic) effects are completely insignificant. For movement of the vehicle towards the transmitter, the experimentally observed frequency increase or Doppler Shift for a moving receiver is given by [24]

$$f_H - f_o = \frac{v}{c} f_o, v << c \tag{6}$$

Doppler shift has also been experimentally verified for the case of light from a stationary star on the ecliptic observed from the revolving Earth. Here relation (6) holds when the Earth is directly advancing towards the star and is now routinely used to determine the speed of the Earth as it revolves around the Sun [25]. It is sometimes stated as a rule involving the fractional change $\Delta f / f_o$ (which to first order is equal to the fractional change in wavelength): The fractional change of the frequency of a spectrum line of a star lying on the ecliptic plane is the ratio of the Earth's orbital speed to the speed of light [26,p244].

Re-arranging equation (6) leads to

$$v = \frac{c(f_H - f_o)}{f_o} = c\frac{f_H}{f_o} - c \tag{7}$$

from which

$$c\frac{f_H}{f_o} = c + v \tag{8}$$

Now from (1), c / f_o is the fixed distance λ_o between successive wavefronts of the transmitted wave i.e. $\lambda_o = c / f_o$. Hence equation (8) can be written as

$$\lambda_o f_H = c + v \tag{9}$$

From (2), the light speed c_R relative to the approaching receiver is given by

$$c_R = \frac{dis\tan ce}{time} = \frac{\lambda_o}{1/ f_H} = \lambda_o f_H \tag{10}$$

Using the experimentally deduced result for $\lambda_o f_H$ in (9) in light speed equation (10) yields

$$c_R = \lambda_o f_H = c + v \tag{11}$$

We have therefore established the following result: **The Doppler Shift or frequency change for light or other electromagnetic radiation detected by an observer moving at speed $v << c$ directly towards a stationary source corresponds to an increased**

light speed $c_R = c + v$ relative to the moving observer. It can similarly be shown that movement of the observer away from the source results in a reduced light speed $c_R = c - v$. Analogous effects occur for sound waves in a fluid medium [24].

4. Discussion and Conclusion

This experimentally established light speed variation relative to a moving observer contradicts the light speed invariance postulate of special relativity which requires light speed constancy in all inertial frames. Edwards [27] has argued that two-way light speed invariance, which has been experimentally confirmed [5], is sufficient to maintain the validity of the equations of special relativity in the presence of one-way light speed variation. This however is not true since the velocity addition formula of special relativity predicts one-way light speed invariance: Light speed variation is strictly prohibited in special relativity. Thus for light traveling in a frame *S* at speed *c* in the direction *x*, the speed c' in a frame S´ moving along *x* at speed *v* relative to S is from the velocity addition formula given by [2-4]

$$c' = \frac{c - v}{1 - cv/c^2} = c \tag{12}$$

If the light direction is reversed such that its speed in *S* is –*c*, then the speed c' in frame S´ is [2-4]

$$c' = \frac{-c - v}{1 + cv/c^2} = -c \tag{13}$$

This one-way light speed invariance demanded by the velocity addition formula of special relativity is directly contradicted by the one-way light speed variation occurring in the Doppler shift phenomenon.

The relative light speed $c \pm v$ occurring in the Doppler phenomenon in accordance with classical velocity composition confirms ether drift arising from movement through a preferred reference frame. Ether drift was first demonstrated by Sagnac for rotation of a disc [28, 29] and later by Michelson and Gale [30] for the rotating Earth. It has been recently reported by Gift using the Doppler and Roemer effects for the approximately linear motion of the Earth around the Sun [31]. The Doppler frequency-shift experiment therefore succeeds where the celebrated Michelson-Morley ether-drift experiment of 1887 [32] and many other similar experiments have failed.

In conclusion, a change in radiation frequency or Doppler Shift occurs when an observer moving at speed $v << c$ towards or away from a stationary source intercepts electromagnetic waves from that source. This frequency change arises because the observer intercepts the electromagnetic radiation at a relative speed $c \pm v$ that is different from the light speed *c*. Though special relativity predicts the Doppler Shift, this light speed variation $c \pm v$ occurring in this situation directly contradicts the light speed invariance requirement of special relativity.

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