Acceleration of Electromagnetic Radiation

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Experimental evidences together with theoretical proofs are presented in a single paper. The evidences confirm that the speed of light and electromagnetic radiation can be accelerated by a moving reflector. For the first time since 1902, both evidences and proofs are available to remove any doubt that the assumption from the theory of special relativity is invalid in physics. The experimental evidences include radar speed gun, FG5 gravimeter, and spectral shift in astronomy. The theoretical proofs include double-slit interference, conservation of elapsed time, microwave resonance, and Fizeau's cogwheel experiment.

I. INTRODUCTION

The speed of electromagnetic radiation can be altered by a moving reflector. The evidence are present in the gravimeter, radar speed gun and astronomical spectral shift.

The FG5 gravimeter records the time when the interference pattern changes color. The data proves that light reflected by a falling mirror becomes faster in time.

The radar speed gun for traffic police records the frequency of the radio wave reflected by a moving vehicle. The speed of radio wave is proportional to the frequency while the wavelength stays intact. Higher frequency corresponds to faster radio wave.

The redshift and blueshift in astronomy are the result of the relative motion between the earth and the remote star. Blueshift is observed on an approaching star. The frequency increases while the wavelength stays intact. Higher frequency corresponds to faster light.

A concise summary of experimental evidences and theoretical proofs is presented in the next section. It consists of excerpt and fragmented proof from 7 publications. Further details and rigorous proof are available in each individual publication from the reference section.

II. EXPERIMENTAL EVIDENCE

A. Radar Speed Gun[1]

Radar speed gun is widely used by the traffic police to measure the speed of an approaching car. It demonstrates how the detected frequency depends on the reference frame.

By keeping wavelength constant, the equation is

$$f_2^r - f_2^i = 2v\frac{1}{\lambda_i} \tag{1}$$

The formula used by common radar speed gun according to Doppler effect is

$$f_r - f_i = 2v\frac{f_i}{c} \tag{2}$$

FIG. 1. A radar speed gun in action

Equation (1) is equivalent to equation (2). The wavelength of the detected radio signal is exactly the speed of radio signal divided by the frequency detected by the radar speed gun.

Therefore Doppler radar provides an excellent experimental verification that the radio wave accelerates upon reflection by an approaching car.

B. FG5 Gravimeter[2]

The time data from FG5 gravimeter contradict the theory of mechanics. This discrepancy is the source of puzzle and difficulty experienced by most researchers on absolute gravimeter.

The mistake by most research teams is to assume that the speed of light remains constant upon reflection off a moving object. As x increases, the phase shift decreases.

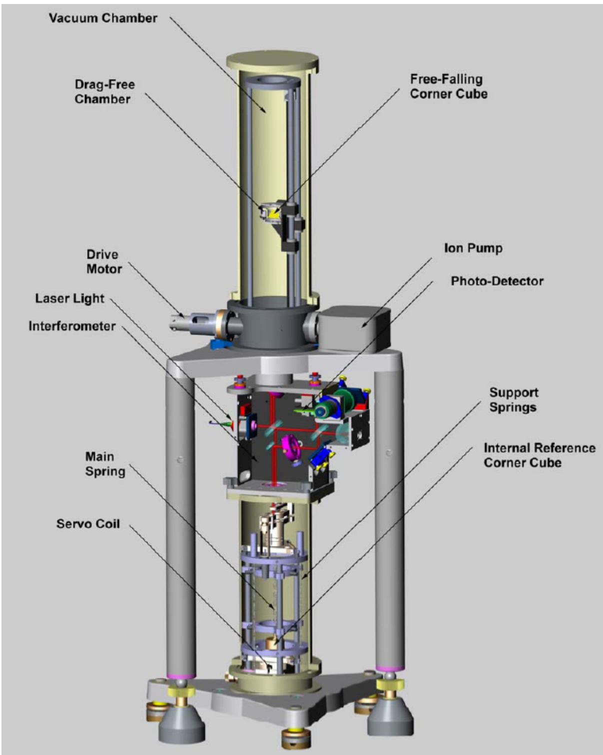

FIG. 2. FG5 gravimeter

n decreases by an integer i.

$$n + A = 2\frac{Z_2 + Z_1}{\lambda_1} - i \quad (3)$$

$$x_i = i\frac{\lambda_1}{2} \quad (4)$$

Most research teams recognize that equation (4) does not match the data collected by FG5 gravimeter. Few realize that the assumption of constant speed of light upon reflection from a moving mirror is invalid and is the source of problem.

The manufacturer of FG5 gravimeter applies least-squares fit to the data and proposes a more realistic equation as equation (5) which is equivalent to equation (6).

$$x_i = \frac{1}{2}g_0 t_i^2 (1 + \gamma\frac{t_i^2}{12}) \quad (5)$$

$$x_i = i\frac{\lambda_1}{2}(1 + \gamma\frac{t_i^2}{12}) \quad (6)$$

In better agreement with recorded data from equation (7)

$$x_i = i\frac{\lambda_1}{2} - \frac{v_i}{C_1 + v_i}(Z_1 + 2Z_2 + L_2 - i\frac{\lambda_1}{2}) \quad (7)$$

under the fact that the speed of light increases upon reflection.

$$C_2 = C_1 + 2v \quad (8)$$

The fringe pattern serves as an excellent experimental evidence that the speed of light increases upon reflection off the falling corner cube retro-reflector.

C. BlueShift RedShift[3]

In modern astronomy, many galaxies are detected with redshift greater than 1 which indicates the galaxies travel faster than light. This problem arises from the assumption that the wavelength is not constant. Without any verification, modern astronomy believes the wavelength has changed from λ_1 to λ_{obs}.

The corrected equation for radial velocity is

$$v = \frac{z}{1+z}c_3 * cos(\theta_3) \quad (9)$$

The first table shows the corrected radial velocity for large z. The difference between z and z' is significant for galaxy GN-108036 which is detected with wide angle diffraction.

TABLE I. Radial Velocity and Comparison of z and z'

Galaxy	**z**	**z'**	**Radial Velocity**
GN-z11[4]	11.18	11.148	0.9179C
GN-108036[6]	9.27	7.247	0.9026C
ULAS J1120+0641[7]	7.086	7.082	0.8763C
IOK-1[8,9]	6.905	6.603	0.8735C

The second table shows the first order angle related to the wavelength.

TABLE II. Wavelength and Angle

Galaxy	**Grating** line/mm	λ_1 nm	$sin(\theta_1)$	λ_{obs} nm	$sin(\theta_{obs})$
GN-z11	30.8	121	0.00372	1470	0.0452
GN-108036	600	121	0.0726	998	0.5988
ULAS J1120+0641	32	121	0.00387	978	0.0313
IOK-1	300	121	0.0363	920	0.276

The speed of light from a galaxy is the product of the frequency and the wavelength. With higher frequency but same wavelength, the speed of light increases with the frequency in blueshift.

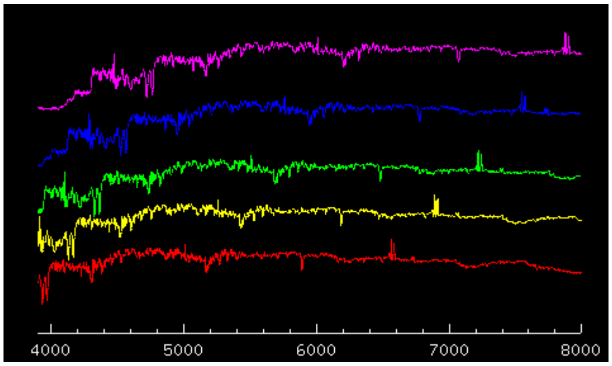

FIG. 3. A galaxy spectrum at four different redshifts

D. Michelson and Morley Experiment[4]

In 1887, Michelson and Morley carried out an experiment to verify the existence of ether. One equation in their paper is reproduced as follow

$$T_2 = \frac{D}{V+v} \tag{10}$$

T_2 is time light occupies to return from c to a.

There is an error in equation (10). T_2 is calculated with a wrong value for the speed of reflected light. In the rest frame of the stone platform, the speed of light is invariant upon reflection. However, In the rest frame of ether, the speed of reflected light depends on the motion of the reflecting mirror.

With the correct value, V-2v, to replace the incorrect value, V, for the speed of the reflected light, the elapsed time for reflected light to travel between mirrors can be calculated correctly as

$$T_2 = \frac{D}{(V-2v)+v} = \frac{D}{V-v} = T_1 \tag{11}$$

The total distance traveled by light in the rest frame of ether is

$$T_1 * V + T_2 * (V-2v) = T_1 * (2V-2v) \tag{12}$$

From equations (11,12),

$$T_1 * (2V-2v) = \frac{D}{V-v}(2V-2v) = 2D \tag{13}$$

The total distance traveled by light in the rest frame of the stone platform is

$$D + D = 2D \tag{14}$$

From equations (13,14), the distance traveled by the light is conserved in both rest frames. *The distance can not be contracted by the choice of reference frame.*

III. THEORETICAL PROOF

A. Conservation of Wavelength[3]

The double-slit interference demonstrates how the wavelength is conserved in all inertial reference frame.

A series of alternating light and dark bands appear on the projection screen along the y-direction. Let the distance between the plate and the screen be D_1. The location of the light band is y_1. The separation between the parallel slits is d_1.

The constructive interference can be described by

$$y_1 = m * \lambda_1 * \frac{\sqrt{D_1^2 + y_1^2}}{d_1} \tag{15}$$

λ_1 is the wavelength in F_1. m is a positive integer.

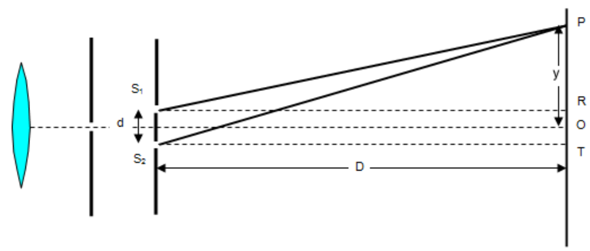

FIG. 4. Double Slit Interference

Let another reference frame F_2 move at a velocity of (-v,0) relative to F_1. The interference pattern in F_2 is represented by

$$y_2 = m * \lambda_2 * \frac{\sqrt{D_2^2 + y_2^2}}{d_2} \tag{16}$$

The choice of inertial reference frame along the x-direction has no effect on the measurement along the y-direction.

$$y_2 = y_1 \tag{17}$$

$$d_2 = d_1 \tag{18}$$

$$\lambda_{2y} = \lambda_{1y} \tag{19}$$

The choice of inertial reference frame along the x-direction may alter the measurement along the x-direction. Let γ be the proportional factor between the original measurement in F_1 and the new measurement in F_2.

$$D_2 = \gamma * D_1 \tag{20}$$

$$\lambda_{2x} = \gamma * \lambda_{1x} \tag{21}$$

From equation (15,16,17,18,19,20,21),

$$\gamma^2 - 1 = 0 \tag{22}$$

The choice of inertial reference frame along the x-direction does not alter the measurement along the x-direction.

From equations (19,21,22),

$$\lambda_2 = \lambda_1 \tag{23}$$

The wavelength is conserved in all inertial reference frames.

B. Conservation of Elapsed Time[5]

Let a person P_1 be stationary at the origin in a reference frame F_1. Let another person P_2 be at a position x 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 in F_2.

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

Let t_1 be the time in F_1. P_2 moves at the speed of v in F_1. This motion can be described by the following equation,

$$\frac{dx}{dt_1} = v \tag{24}$$

Let t_2 be the time in F_2. P_1 moves at the speed of -v in F_2. This motion can be described by the following equation,

$$\frac{d(-x)}{dt_2} = -v \tag{25}$$

From equations (24,25),

$$dt_1 = dt_2 \tag{26}$$

The elapsed time is conserved and identical in all inertial reference frames.

C. Microwave Resonance and Doppler Effect[6]

The condition for the standing wave is

$$n\frac{\lambda}{2} = d \tag{27}$$

Let another reference frame F_1 moves at a constant velocity of (v,0) relative to F_0. The standing wave in F_1 is represented by

$$n\frac{\lambda_1}{2} = d_1 \tag{28}$$

Let another reference frame F_2 moves at a constant velocity of (-v,0) relative to F_0. The standing wave in F_2 is represented by

$$n\frac{\lambda_2}{2} = d_2 \tag{29}$$

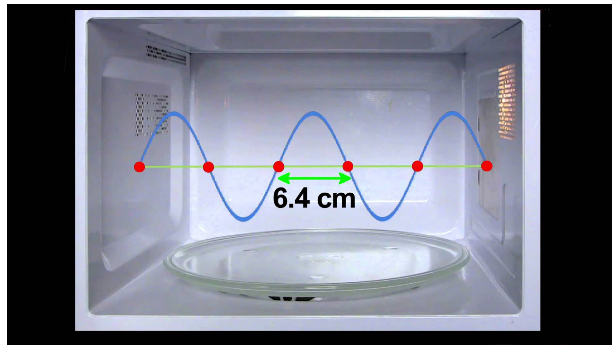

FIG. 5. The standing wave in a microwave cavity

According to Lorentz transformation, length contraction is independent of the direction of the relative motion.

$$d_1 = d_2 \tag{30}$$

From equations (28,29,30),

$$\lambda_1 = \lambda_2 \tag{31}$$

The wavelength is conserved in both F_1 and F_2.

According to the Doppler effect, the apparent frequency of the microwave decreases in F_1 but increases in F_2.

$$f_1 < f_2 \tag{32}$$

The speed of microwave in F_1 is C_1.

$$C_1 = f_1 * \lambda_1 \tag{33}$$

The speed of microwave in F_2 is C_2.

$$C_2 = f_2 * \lambda_2 \tag{34}$$

From equations (31,32,33,34),

$$C_1 < C_2 \tag{35}$$

The apparent speed of the microwave decreases in F_1 but increases in F_2.

D. Fizeau's Experiment[7]

The original Fizaeau's cogwheel experiment is adapted by replacing the cogwheel with two disks.

In order for the light to pass through the slits of both disks, the slit of D_2 can not be in the same radial direction of the slit on D_1. Let this angular difference between the slits of D_1 and D_2 be θ_0.

Let F_2 be the rest frame of D_1. Both D_1 and D_2 move at the same speed relatively to F_1. D_2 is stationary relatively to D_1. Therefore, F_2 is also the rest frame of D_2.

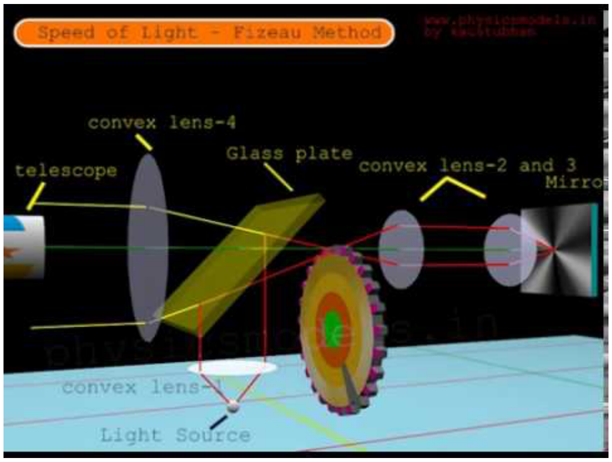

FIG. 6. The original Fizaeau's cogwheel experiment

Let F_2 be stationary relatively to F_1. The speed of light C_2 in F_2 can be calculated as.

$$C_2 = (x_2 - x_1) * \frac{\omega}{\theta_0} \tag{36}$$

Let F_2 move at the speed of v in the x direction relatively to F_1. Due to this relative motion, the angular difference θ_0 needs to be θ for the light to pass through both slits.

$$C_2 = (x_2 - x_1) * \frac{\omega}{\theta} \tag{37}$$

θ is of the same value in both F_1 and F_2. It can be determined as

$$\theta = \frac{R}{C - v} * \omega \tag{38}$$

Therefore, the speed of light C_2 in F_2 can be calculated as

$$C_2 = (x_2 - x_1) * \frac{\omega}{\frac{R}{C-v} * \omega} \tag{39}$$

$$C_2 = (x_2 - x_1) * \frac{C - v}{R} \tag{40}$$

$$C_2 = C - v \tag{41}$$

The speed of light C_2 in F_2 differs from the speed of light in F_1 by v.

IV. CONCLUSION

Faster radio signal has been detected by the traffic police on a daily basis. The radar speed gun emits radio signal toward the vehicle. The frequency and the speed of the reflected radio increase as the vehicle moves toward the radar speed gun.

In modern physics, light and all electromagnetic wave are emitted at the same speed which is commonly knows as "speed of light". The speed remains invariant until reflection. The wavelength is invariant upon reflection. However, the frequency as well as the speed depend on the relative motion. As a result, the speed changes if a different frequency is detected.

The evidence emerges in the FG5 gravimeter clearly. The time data of this scientific instrument indicates a faster light reflected by a falling mirror.

Another example in daily life to detect a faster or slower light is the motion detector. It emits signal toward any moving object and records a higher or lower frequency when the signal returns. As the signal speeds up, its frequency increases accordingly.

The common mistake in modern physics is to assume the wavelength is altered by reflection. This popular assumption has never been verified nor proved. It originates from the assumption of relativity. Unfounded but taken as granted without proof.

The experimental evidences that speed of light can change have been ignored for over a century until the theoretical proofs become available in 2017.

The simplest proof is from the standing wave in a microwave cavity. The standing wave consists of two waves with identical wavelength. The two wavelengths are identical to all moving observers. However, the two frequencies become different to all moving observers. Hence, the speeds of two waves also become different.

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