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Speed and Aberration of Light and Redshift

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ABSTRACT

Relativistic constancy of speed of light, makes lightspeed a constant c for all observers stationary or moving. This is despite discoveries of Aberration of Light in 1784 and Doppler Shift in 1842, which showed relativity of lightspeed. If the speed were constant, relative to everything, it would have been found as infinitely large. But it was measured as very high and finite. Light adjusting its speed, to be the same c for every moving observer, is untenable. This paper shows that, due to radiation reaction force, c is terminal speed of charged particle accelerated by an electric field. Invoking aberration of light, it is shown that speed of light depends on motions of source and observer and that speed of light, relative to the source, is a constant c. It gives rise to Doppler Shift in light. Redshift of starlight is ascribed to small reduction in speed of light, due to refractions in intergalactic pathlength L for reaching the Earth. Hubble-Lemaître law, in physical cosmology, is deduced without an expanding Universe.

Keywords: Acceleration, Aberration Angle, Doppler Shift, Expanding Universe, Light Ray, Redshift, Relative Velocity. Radiation, Special Relativity, Speed, Vector, Velocity.

1. Introduction

A great scientist of 19th Century, J. C. Maxwell, derived speed of light c, in a vacuum, as [1, 2]:

$$c = \sqrt{\frac{1}{\mu_O \varepsilon_O}} = \pm 299\ 792\ 458 \text{ meters per second} \quad (1)$$

where μ_o is the permeability and ε_o permittivity of electric field occupying a vacuum. A vacuum, a void, has no property. The constants μ_o and ε_o are properties of an electric field in a vacuum. This c is the speed at which an electrical effect is transmitted, along the direction of an electric field. It is the maximum speed to which a charged particle is accelerated by an electric field, at constant mass as rest mass m_o, with radiation [3]. Radiation is the difference between change in potential energy and change in kinetic energy. Radiation reaction force, a kind of frictional force, limits the speed of a charged particle, on acceleration by electric field, to a terminal speed equal to c in a vacuum. Like a meteorite falling through the Earth's atmosphere, at the terminal speed, radiation reaction force becomes equal and opposite to the accelerating force, and the particle moves with constant speed.

There is no reason or benefit in making speed of light a constant for all observers, stationary or moving. Unfortunately, the relativistic cardinal principle of constancy of speed of light, has acquired the devotion of a religious doctrine. This may be so because of the reputation of the enunciator, in 1905, the celebrated physicist, Professor Albert Einstein [4, 5]. If the speed of light were that constant for everybody, it would cover any length of displacement at the same time, even in zero time. The actual speed of light c would be constant, for all observers, only if it were infinitely high, and there would have been no Doppler Shift. Speed of light in space, a vacuum, given by equation (1), is high, but finite. It is the most accurately measured quantity in the world. It is the highest attainable and the same everywhere in the Universe, establishing time as a real variable quantity.

The discovery of aberration of light in 1728 by English astronomer, James Bradley, one of the most significant discoveries in science, clearly demonstrated the relativity of speed of light for a moving observer [6, 7, 8]. Now, aberration of light has been relegated to the background by the theory of special relativity in favor of its cardinal principle of constancy of speed of light. According to aberration of light, if you move with speed u in the direction of transmission of a light ray, your relative speed is $A = (c - u)$. If you move in the opposite direction of transmission of a light ray, relative speed is $B = (c + v)$. If you move perpendicular to the direction of a light ray, relative speed becomes $C = \pm\sqrt{(c^2 + u^2)}$. The theory of special relativity makes: $A = B = C = c$. This could only be possible if the speed were not c but infinitely large or if time, taken by light, in any displacement, were always zero.

This paper also deals with Doppler Shift and the issue of Expanding Universe, where Stars in Galaxies are supposed to be receding in all directions from the Earth [9-12]. This is reminiscent of geocentric model of the structure of Universe, in the Ptolemy of Alexandria (200 BCE) system, where the Earth was assumed to be at the centre of all. Stars in the Galaxies, receding with increasing speeds from all sides of the Earth, is physically impossible.

2. Aberration of Light and Aberration Angle

Aberration of light was discovered, in 1728, by English astronomer, James Bradley. This was one of the most significant discoveries in science, but now relegated to background in favour of constancy of speed of light, a cardinal principle of the theory of special relativity. Aberration of light, illustrated in Figure 1, is independent of distance between source at S and observer at P. Aberration of light clearly shows nonconstancy of velocity of light, a vector **c**, of magnitude (speed) c.

In Figure 1, astronomer at P, moved with velocity **u** (of magnitude u) at angle θ to instantaneous line SRP of actual location of a stationary star under observation. To see the star, the astronomer had to point his telescope

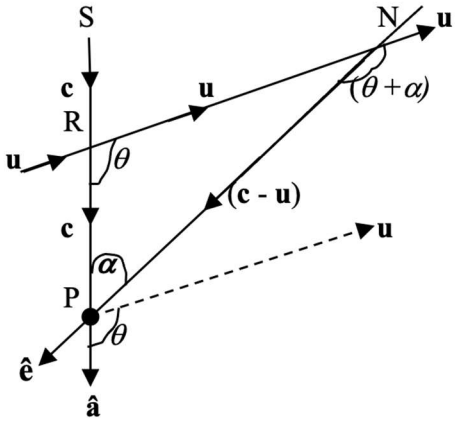

Figure 1: Aberration of light from stationary star with its light at velocity **c** along line SRP, in the direction of unit vector **â**, observed along line NP, at aberration angle α, by astronomer at P moving with velocity **u** at angle θ to instantaneous line SRP.

forwards for light to enter with velocity (**c – u**), along the line NP, in the direction of unit vector **ê**. It was as if the astronomer were given velocity -**u**, to become stationary at P, while light was propagated with velocity (**c** – **u**). He saw the star along NP, displaced through a small angle, aberration angle α, between the vectors **c** and (**c** - **u**), such that sine rule in triangle RPN, gives the equation.

$$sin\alpha = (u/c)\, sin(\theta + \alpha) \tag{2}$$

With α as a very small angle and θ is about $\pi/2$ radians, equation (2) becomes:

$$sin\alpha \approx \alpha \approx (u/c) sin\theta \approx (u/c) \tag{3}$$

James Bradley used equation (3), knowing $u = 3\times10^4$ *m/s*, as speed of revolution of the Earth round the Sun, to obtain an estimate of speed of light.

Bradley discovered aberration of light, from a visible northern Star (*Gamma Draconis, 150 light years away*), having failed to get its parallax, as it was too far away for his telescope, but he obtained an aberration angle α, in many years of observations and measurements. He obtained 3.1×10^8 *m/s* as the second estimate of speed of light in space, and confirmed the Earth's revolution round the Sun. The significance of this discovery is now submerged by the global influence of celebrated physicist, Professor Albert Einstein, and his theory of special relativity, with its principle of constancy of speed of light.

Aberration of light is a clear, but ignored, demonstration of relativity of speed of light with respect to a moving observer. Today, aberration of light is ignored or denied. Some academia relativists even claim that it does not apply on the Earth, conveniently forgetting the fact that Reverend Bradley made his significant discovery, in measurements spanning some thirty years, at a Rectory near London, in England. Aberration of light is a universal phenomenon applying well at astronomical and atomic levels. Aberration is a common phenomenon as with an observer running in the rains, with raindrops hitting him at an angle to the vertical, getting his chest wet while his back remains dry.

3. Velocity of Light from Stationary Source

In Figure 1, velocity of light **s**, in the direction of unit vector **ê**, relative to observer at P, moving with velocity **u**, is:

$$\mathbf{s} = (\mathbf{c} - \mathbf{u}) = \sqrt{c^2 + u^2 - 2cu\cos\theta}\,\hat{\mathbf{e}} \tag{4}$$

For $\theta = 0$, rectilinear motion away from source of light, equations (4) gives speed of light $s = c - u$.....(5)
For $\theta = \pi$ radians, rectilinear motion towards source of light, equations (4) gives speed $s = c + u$.....(6)
For $\theta = \pi/2$ radians, circular motion round a central source of light, equation (4) gives $s = \pm\sqrt{c^2 + u^2}$ ..(7)

3. Velocity of Light Relative to Moving Observer

Velocity of light **z** from source moving at velocity **v** relative to observer at velocity **u**, is vector:

$$\mathbf{z} = \mathbf{c} + (\mathbf{v} - \mathbf{u}) \tag{8}$$

where **c** is velocity of light, relative to the source. The vectors **c**, **v** and **u** may be in any direction, relative to a frame of reference. For rectilinear motion, speed z, in the direction of light velocity **c**, is scalar:

$$s = c + v - u \tag{9}$$

Light takes on the speed of its source. Linear speed of light, relative to source, is a universal constant c.

5. Doppler red shift and Hubble-Lemaitre law

If source moves with speed v and observer with speed u, equation (9) gives frequency f of radiation, as:

$$f = \frac{c + v - u}{c} f_o \tag{10}$$

where f_o is the stationary frequency if $v = u$. The wavelength λ is:

$$\lambda = \frac{c}{c + v - u} \lambda_o \tag{11}$$

where λ_o is the stationary wavelength if $v = u$. Equation (10) and (11) express Doppler Shift for light. For sound waves, c, in equations (10) and (11) is replaced by $(w - v)$, where w is speed of sound in air, with sonic boom ($f = \infty$ *and* $\lambda = o$) if $v = w$. For stationary observer ($u = 0$), there is increase of frequency (doubling at $v = c$) if source moves towards the observer and decrease of frequency (disappearing at $v = c$) if source moves away from observer. Redshift, decrease in frequency of light from stars in the Galaxies, observed by astronomers, in powerful telescope, was misinterpreted as due to the Galaxies receding, away from the Earth, in accordance with Doppler Shift, in an 'Expanding Universe'.

The astronomer, Edwin Hubble, discovered the extra Galaxies (like the Milky Way Galaxy in which the Solar System resides), several millions of light years apart, each containing billions of stars like the Sun, distributed in the Universe. This must be one of the most remarkable achievements in human endeavours. In 1929 Edwin Hubble published his first paper on the relationship between redshift and distance. Subsequently, he presented convincing evidence of the direct linear relationship between a galaxy's redshift and its distance from the Earth. This relationship, between redshift R and separation L, from the Earth, may be expressed as:

$$R \propto L \tag{12}$$

Hubble-Lemaitre Law gives the relationship between distance L at time t and speed $v = dL/dt$ of supposed recession of a Galaxy from the Earth, as:

$$v = HL \tag{13}$$

where H is the Hubble constant. Differentiating equation (13) with time t, gives:

$$dv/dt = H(dL/dt) = Hv \text{ and } v = Ae^{Ht} \text{ and } dv/dt = AHe^{Ht} \tag{14}$$

where A *is* the initial speed and AH the initial acceleration (at $t = 0$). Equation (14) which involves exponentially increasing acceleration and force $M(dv/dt)$ for a Galaxy of mass M, cannot physically be correct. Equation (14) conforms with the popular Big Bang Theory and Expanding Universe, which George Lemaitre expounded, but on which Edwin Hubble was noncommittal. Equation (13) could have been a misinterpretation of an observation.

The expression "Big Bank" was coined by British cosmologist, Professor Fred Hoyle, who rejected the idea of Expanding Universe, where Galaxies retreat and disappear into infinite space. An expanding universe is inconsistent with the presence of Steven Hawkin's Black Holes, supposed to be concentrated massive bodies which attract everything around them, even light. It is not consistent with observations on Andromeda Galaxy, the nearest, 2.5 million light years away from Milky Way, and on collision course. The Galaxies should consist of revolving stars and planets under gravitational forces.

Redshift may rationally be explained as due to reduction in the speed of light, by some kind of refractions and/or interactions with space, as it passes through countless atmospheres, in interstellar distances of total length L, on its way to the Earth. If the reduction in speed is proportional to distance L traversed, the Hubble-Lemaître law, equation (13) in physical cosmology, that galaxies are moving away from Earth at speeds v proportional to their distances L, may be more realistically enacted. All stars receding from the Earth, at speeds exponentially increasing with time, equally in all directions, is not tenable. The stars should have disappeared by now. Redshift is likely to be due to a reduction in speed of light from a star as it traverses the vast interstellar distance L from a Star in a Galaxy to the Earth.

Time t_1 taken by light to traverse distance L at speed c in a vacuum of refractive index $\mu = 1$, is $t_1 = L/c$. A longer time t_2 taken by light to cover distance L at average speed c/μ_s in interstellar and intergalactic "cosmic dusts" of average refractive index μ_s, is $t_2 = \mu_s L/c$. Time difference $\Delta t = t_2 - t_1 = (L/c)(\mu_s - 1)$. Fringe shift δ, equal to redshift R, (equation 12), for starlight of wavelength λ, is:

$$\delta = c(\Delta t)/\lambda = (L/\lambda)(\mu_s - 1) = R \qquad (15)$$

Redshift is not due to expanding Universe but reduction of speed of starlight, in some refractions, as intergalactic space is not entirely a vacuum of refractive index 1. The factor $(\mu_s - 1)$ may be almost zero, but vast intergalactic distance L makes R quite appreciable in equation (15), in accordance with evidence provided by Edwin Hubble (equation 12) for light of wavelength λ. The Earth's atmosphere is too thin to make a difference in equation (15).

Redshift may also be explained by assuming that white light, from a Star in an extra Galaxy at far distance L, reaches the Earth after going through many intergalactic atmospheres of refractive index $\mu_s \geq 1$. This light suffers some dispersion and attenuation depending on the distance L traversed, with the higher frequencies (the blue end) being more affected than the lower frequencies (the red end). The "old light", or "tired light" arriving at the Earth with some "wear and tear", should show a redshift, more or less depending on distance covered. Starlight, like sunlight, is white, but far-away stars appear reddish, at night, probably due to redshift.

6. Results and Discussion

- A particle of charge q, mass m may move in the direction of electric field E or perpendicular to it.
- As electrical force is transmitted at the speed of light c, this speed becomes the terminal speed to which a charged particle may be accelerated by an electric field at constant mass as the rest mass.
- The missing link in physics today is aberration of light (Figure 1), discovered in 1728 by English astronomer James Bradley. It demonstrated relativity of speed of light, with respect to moving observer.
- Equations (5), (6) and (7) show the relativity of lightspeed, relative to moving observer contrary to the theory of special relativity.
- No reason or benefit for the relativistic principle of constancy of light speed c, for all observers, stationary or moving.
- Light automatically adjusting its speed, in a vacuum, to become the same $c = 299\,792\,458$ m/s for all observers, stationary or moving, and yet remaining at c, is incomprehensible.
- Principle of constancy of light speed stands on the reputation of the initiator, renowned physicist Professor Albert Einstein.
- In vacuum, light speed, relative to source, is a universal constant, well measured as $c = 299\,792\,458$ m / s.
- Speed of light c may be exceeded, relative to a moving observer, as in equation (6) and (7).
- Hubble-Lemaitre Law, equation (13), leading to recession speed exponentially increasing with time (equation 14), is questionable.
- Hubble's relation between redshift R and distance L of Galaxy (equation 12) is produced in equation (15).

7. Conclusions

- ✓ Aberration of light is a missing link, necessitating special relativity to explain speed of light as a limit, quantum mechanics to explain radiation from charged particles and general relativity to explain gravity.
- ✓ Speed of light *c* is attained as a terminal speed to which a charged particle may be accelerated by an electric field, not a result of mass increasing with speed becoming infinitely large at speed *c*.
- ✓ Speed of light depends on motions of the source and the observer (equations 5, 6, 7, 8, 9), contrary to the principle of constancy of speed of light, according to the theory of special relativity.
- ✓ Redshift, in physical cosmology, is not a result of Expanding Universe but due to reduction in the speed of light by refractions (equation 15) in vast intergalactic distance traversed by starlight to reach the Earth.

8. Recommendations

- o James Bradley's discovery of aberration of light should be resurrected and accorded its very significant place in physics.
- o Relativistic principle of constancy of speed of light should be rejected as it is destructive to physics.
- o Hubble-Lemaitre Law (equation 13) for recession speed of Galaxies, and Expanding Universe at speed exponentially increasing with time, should be rejected as it is a misinterpretation of an observation.

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