ISSN: 2639-0108

Research Article

Advances in Theoretical & Computational Physics

Velocity of Transmission of Electrical Force and Aberration of Electric Field

Musa D Abdullahi

Department of Physics, Umaru Musa Yar'adua University, Katsina, Katsina State, Nigeria

*Corresponding author
Musa D Abdullahi, Department of Physics, Umaru Musa Yar'adua University, Katsina, Katsina State, Nigeria

Submitted: 09 Feb 2020; **Accepted**: 03 Mar 2020; **Published**: 23 Apr 2020

Abstract

*An electron of rest mass m_o and charge –e moving with velocity v at angle θ to an electric field of intensity **E** and magnitude E, is subject to aberration of electrid field, as a result of relativity (**c – v**) of velocity between the electric force, transmitted with velodity of light c of magnitude c and the electron moving with velocity v. The accelerating force, at time t, in accordance with Newton's second law of motion, put as **F** = - (eE/c) (**c – v**) = m (**dv**/dt), is less than the electrostatic force–e**E**, the difference being the radiation reaction force. At the velocity of light F become zero and the electron continues to move with speed c as a limit. Motion of the electron with constant mass m and its radiation power are treated under acceleration with θ=0 or deceleration with θ=π radians or at constant speed v, in a circle of radiua r, with θ=π/2 radians. It is shown that circular motion of an electron round a central force of attraction, as in the Rutherford's nuclear model of the hydrogen atom, is without radiation.*

Keywords: Aberration Angle, Acceleration, Electric Charge, Electric Field, Mass, Radiation Power, Velocity

Introduction

Aberration of electric field is a phenomenon similar to aberration of light discovered by English astronomer, James Bradley, in 1728 [1]. This is one of the most significant discoveries in science. Through this discovery, Bradley obtained the first estimate of the speed of light and confirmed that the Earth moves round the Sun. Aberration of light is a clear, but ignored, demonstration of relativity of speed of light with respect to a moving object, contrary to the theory of special relativity [2, 3]. Today, aberration of light is hardly mentioned in physics because it contradicts the principle of constancy of speed of light, a cardinal principleof the theory of special relativity. Indeed, if the speed of light were that constant, for all moving observers, it would never have been so accurately measured for umpteen times, as far as all measurements are relative to an accepted standard.

Electrical effects, like electromagnetic radiation and electrical force, are propagated in space, along an electric field, with velocity of lightc of magnitude c. In the aberration of electric field there is relativity of velocity (**c –v**) between an electrical force propagated with velocity of light **c** and an electron moving with velocity **v**. As such, the electrical force cannot catch up and impact on an electron also moving with velocity of light **c**. The velocity of light, therefore, becomes the ultimate limit to which an electric field can accelerate a charged particle, with emission of radiation and mass of the moving particle remaining constant.

As a result of aberration of electric field, for an electron of rest mass m_o and charge –e moving at time *t* with velocity **v** and acceleration *dv*/***dt*** in an electric field of intensity **E** and magnitude E, the accelerating force, proposed as **F** = – (eE/c) (**c – v**) = m_o (**dv**/*dt*), is less than the electrostatic force –e**E**, the difference is the radiation reaction force [4]. The radiation reaction force in rectilinear motion is –e**E***v*/c and radiation power eEv^2/c. In circular motion perpendicular to the electric field, the radiation power is shown to be zero. This makes motion of an electron, round a positively charged nucleus, as in the Rutherford's model of the hydrogen atom, without radiation and stable, outside Bohr's quantum mechanics [5, 6].

Aberration Angle

Figure 1 depicts an electron of rest mass m_o and charge –*e* moving at a point P with velocity **v** at angle *θ* to to the force of attraction due to an electric field of intensity **E** from a stationary source charge +*Q* at O. The electron is subjected to aberration of electric field whereby the direction of propagation of the force of attraction, given by velocity vector **c**, is displaced from the the instantaneous line PO through angle of aberration α, such that:

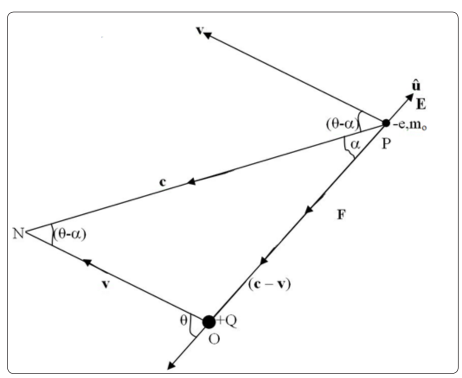

Figure 1: Depicting an electron of rest mass m_o and charge –*e* at a point P moving with velocity **v** in an electric field of intensity **E**

due to a stationary source charge $+Q$ at a point O.

$$\sin\alpha = \frac{v}{c}\sin\theta \tag{1}$$

Equation (1), with reference to Figure 1, is Bradley's formular.It is independent of the distance between a moving object (astronomer or electron at P) and a fixed object (distant star or neucleus of an atom at O).

Velocity of Transmission of an Electrical Force

With reference to Figure 1, the vector $\mathbf{z} = (\mathbf{c}–\mathbf{v})$ is the relative velocity of transmission between the electrical force propagated with velocity of light **c** and the electron moving with velocity **v**, thus:

$$\mathbf{z} = (\mathbf{c} - \mathbf{v}) = -\sqrt{c^2 + v^2 - 2cv\cos(\theta - \alpha)}\,\hat{\mathbf{u}} \tag{2}$$

Where $(\theta–\alpha)$ is the angle between the vectors **c** and **v** and $\hat{\mathbf{u}}$ is a unit vector in the direction of the field **E**. The electron can move with $\theta = 0$, $\theta = \pi$ radians, or $\theta = \pi/2$ radians.

With $\theta = 0$ there is motion in a straight line with acceleration and equations (1) and (2) give the relative speed of transmission of the electrical force as:

$$z = c - v \tag{3}$$

Where $\theta=\pi$ radians there ismotion in a straight line with deceleration and the relative speed of transmission of the force becomes:

$$z = c + v \tag{4}$$

If $\theta=\pi/2$ radians and noting that $\sin\alpha = v/c$ (equation 1), there is circular motion with constant speed v, giving the relative speed of transmission of the force as:

$$z = \sqrt{c^2 - v^2} \tag{5}$$

Equatons (3), (4) and (5) demonstrate the relativity of speed of light with respect to a charged particle moving with speed v. Equations (3) and (4) are familiar in classical mechanics but not allowed in relativistic mechanics, where the speed of light c cannot be added to or subtracted from. The issue here is with equation (5), which is a consequence of aberration of electric field.

Accelerating Force Due to an Electric Field

From Figure 1, the accelerating force **F** at time t, in a field of magnitude E, is put as:

$$\mathbf{F} = \frac{eE}{c}(\mathbf{c} - \mathbf{v}) = -\frac{eE}{c}\sqrt{c^2 + v^2 - 2cv\cos(\theta - \alpha)}\,\hat{\mathbf{u}} = m_o\frac{d\mathbf{v}}{dt} \tag{6}$$

Where $\hat{\mathbf{u}}$ is a unit vector in the positive direction of the electric field intensity **E**. For motion in a straight line under acceleration, with $\theta= 0$, equations (1) and (2) give the vector equation:

$$\mathbf{F} = -eE\left(1 - \frac{v}{c}\right)\hat{\mathbf{u}} = m_o\frac{d\mathbf{v}}{dt} \tag{7}$$

The scalar first order differential equation of motion, for an accelerated electron, is:

$$eE\left(1 - \frac{v}{c}\right) = m_o\frac{dv}{dt} \tag{8}$$

For motion in a straight line under deceleration, with $\theta=\pi$ radians, equations (1) and (2) give the vector equation:

$$\mathbf{F} = -eE\left(1 + \frac{v}{c}\right)\hat{\mathbf{u}} = m_o\frac{d\mathbf{v}}{dt} \tag{9}$$

The scalar first order differential equation of motion, for a decelerated electron, is:

$$eE\left(1 + \frac{v}{c}\right) = -m_o\frac{dv}{dt} \tag{10}$$

Equations (8) and (10) are easily solved, as first order differential equations with constant coefficients, where E is a uniform field, to give the speed v as a function of time t. The solution of equation (8) for an electron accelerated from zero initial speed is:

$$v = c\left\{1 - \exp\left(-\frac{at}{c}\right)\right\} \tag{11}$$

Where $a = eE/m_o$ is a constant. The solution of equation (10) for an electron decelerated from the speed of light c is:

$$v = 2c\exp\left(-\frac{at}{c}\right) - c \tag{12}$$

Equations (11) and (12) show the speed of light, c or $-c$, as the limit attainable by the electron.

Figure 2 are graphs of v/c against at/c for an electron accelerated from zero initial speed or decelerated from speed of light c, by a uniform electric field of magnitude E; lines *A1* and *A2* according to classical electrodynamics, dashed curve *B1* and line *B2* according to relativistic Electrodynamics and the dotted curves *C1* and *C2* according to equations (11) and (12) respectively. Curves *B1* and *C1* are almost in agreement for accelerated electrons but there is a marked departure between curves *B2* and *C2* for decelerated electrons.

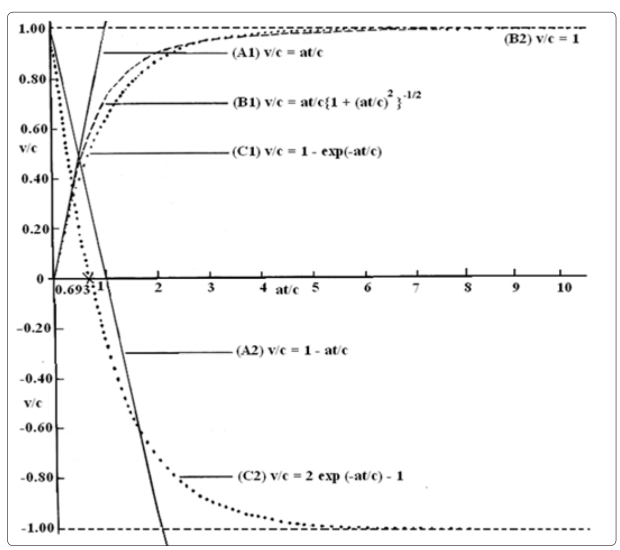

Figure 2: *v/c (speed in units of c) against at/c (time in units of c/a)* for an electron of charge $–e$ and rest mass m_o accelerated from zero

initial speed or decelerated from speed of light c, by a uniform electric field of magnitude E, where $a = eE/m$; lines $A1$ and $A2$ according to classical electrodynamics, the dashed curve $B1$ and line $B2$ according to relativistic electrodynamics and the dotted curves $C1$ and $C2$ according to equations (11) and (12).

Where $\theta=\pi/2$ radians there is motion in a circle of radius r with constant speed v and centripetal acceleration $-v^2/r$. Noting that $sin\alpha = v/c$, equations (1) and (2) gives the vector:

$$\mathbf{F} = -eE\sqrt{1-\frac{v^2}{c^2}}\hat{\mathbf{u}} = -m_0\frac{v^2}{c}\hat{\mathbf{u}} \qquad (13)$$

The scalar equation is:

$$eE\sqrt{1-\frac{v^2}{c^2}} = m_0\frac{v^2}{c} \qquad (14)$$

Equation (14)may be written as:

$$eE = m_0\left(1-\frac{v^2}{c^2}\right)^{\frac{-1}{2}}\frac{v^2}{r} = m\frac{v^2}{r} \qquad (15)$$

This is the case in relativistic electrodynamics, where E is supposed to be independent of speed of an electron of charge –e in an electrid field of magnitude E. Equation (15) gives:

$$m = m_0\left(1-\frac{v^2}{c^2}\right)^{\frac{-1}{2}} = \gamma m_o \qquad (16)$$

Where m is the relativistic mass and γ the Lorentz factor.

Equation (15) is applicable in circular motion only. Equation (16) is the relativistic mass-velocity formula. This formula is a physical misinterpretation of a mathematical equation. In circular motion, decrease in accelerating force with speed (equation 13), has the same effect as increase in mass with speed (equation 16). Applying equation (16) to rectilinear motion is anexpensive mistake in physics.

Radiation Power

The difference between the accelerating force **F**, as given by equation (6), and the electrostatic force or impressed force –e**E**, is the radiation reaction force, a vector $\mathbf{R}_f$ given by:

$$\mathbf{R}_f = \frac{eE}{c}(\mathbf{c}-\mathbf{v}) + e\mathbf{E} \qquad (17)$$

The radiation power R_p is the scalar product –**v.Rf**, thus:

$$R_p = -\mathbf{v}.\mathbf{R}_f = -\frac{eE}{c}(\mathbf{c}-\mathbf{v}).\mathbf{v} - e\mathbf{E}.\mathbf{v} \qquad (18)$$

With reference to Figure 1, radiation power R_p is expressed in terms of the angles θ and α, as:

$$R_p = \frac{eEv^2}{c} - eEv\cos(\theta-\alpha) + eEv\cos\theta \qquad (19)$$

Equation (19) shows that readiation power is $eEv^2/c$for acceleration with $\theta= 0$ or deceleration with $\theta=\pi$ radians. For $\theta=\pi/2$, there is circular motion, with contant speed and no radiation.

Results and Discussions

1. Equations (3), (4) and (5) show that the speed of transmission of an electrical force, same as the speed of light, relative to an observer, can be subtracted from or added to, contrary to the relativistic principle of constancy of speed of light for all observers, statioary or moving. So, a cardinal principle of the theory of special relativity becomes questionsble.
2. In equation (15), the relativistic mass-velocity formula is rationalised as a physical misnterpretation of a mathematical equation applicable in circular motion only. The relativistic mass is just a mathematical expression not representing a physical reality. Doing away with infinite masses at the speed of light, should bring great relief to physicists all over the world.
3. Lorentz factor γ in equation (16) has nothing to do with mass. It is the result of motion of a charged particle perpendicular to an electric field.
4. An important result of this paper is contained in equation (19). Here, if $\theta=\pi/2$ radians, there is circular motion, round a central force of attraction, with zero radiation power. This makes Ruthrford'snuclear model of the hydrogen atom inherently stable. Radiation takes place where the electron is dislodged from a circular orbit. It then revolves in an elliptic orbit with emission of radiation at the frequency of revolution, before reverting to the stable circular orbit.

Conclusion and Recommendation

1. By invoking aberration of electric field, the paper has succeeded in showing that an electron is accelerated, by an electric field, to the speed of light, as a limit, at constant mass and with emission of radiation.So, there should be no need for the theory of special relativity devised, early in the 20th Century, to explain the speed of light as an ultimate limit or quantum mechanics to explain emission of radiation from accelerated charged particles.
2. Aberration of light and aberration of electric field, hitherto neglected links in physics, should be brought back to their rightful and significant places in science.

References

1. J Bradley (1728) https://en.wikipedia.org/wiki/James_Bradley. Phil Trans Royal Soc 35: 406.
2. A Einstein (1905) "On the Electrodynamics of Moving Bodies". Ann Phys 17: 891-921.
3. H Sommerfeld A, Lorentz HA, Einstein Albert, Minkowski H, Weyl P (1923) The Principles of Relativity, Matheun, London.
4. M Abdullahi (2014) Motion of an Electron in Classical and Relativisticelectrodynamics and an Alternative Electrodynamics.
5. E Rutherford (1911) "The Scattering of α and β Particles by Matter and the Structure of the Atom". Phil Mag 21: 669.
6. N Bohr (1913) On the Constitution of Atoms and Molecules. Phil Mag Series 6: 1-24.