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EXTENDING COULOMB'S LAW FOR GRAVITATION AND RADIATION

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ABSTRACT

Coulomb's law, giving the force of repulsion or attraction between two electric charges in space, is a very important principle in physics. However, the law is not complete as it does not consider force of gravitational attraction between electric charges and does not include radiation from an accelerated charged particle. This paper extends Coulomb's law by adding a term for gravitation and incorporating a factor for radiation. In the extended law, accelerating force on a particle of mass *m* and charge *K* moving at time *t* with speed *v* in an electric field *E*, is *EK(1 - v*/c) = *m(dv/dt)* if it moves along the force, *EK(1 + v*/c) = *-m(dv/dt)* if it moves against the force and *EK{sqrt(1 – v^2//c^2)}* = *mv^2/r* for motion perpendicular to the force, in a circle of radius *r*, where *c* is the speed of light, a constant relative to the source. The particle is accelerated to a maximum speed equal to *c* with constant mass and emission of radiation. Lorentz factor γ is found to be the result of motion of a charged particle perpendicular to an electric field and nothing to do with mass. Rutherford's nuclear model of the hydrogen atom is shown to be stable outside quantum mechanics. Aether, conceived as constituted by balanced electric fields from bodies in space, is identified to be the medium for gravitation and radiation.

INTRODUCTION

Coulomb's law

The electrostatic force **F** between two stationary particles of charge *Q* at a point O and another charge *K* at a point P, separated by a distance *r* in space, as shown in Figure 1, is given by Coulomb's law, as vector:

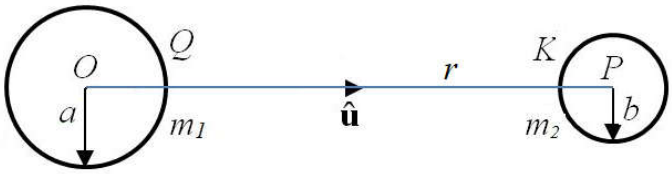

Figure 1 Force between two stationary electric charges *Q*of mass $m_1$and *K*of mass $m_2$distance *r* apart

$$\mathbf{F} = \frac{QK}{4\pi\varepsilon_o r^2}\hat{\mathbf{u}} = \mathbf{E}K \tag{1}$$

where ε_0 is the permittivity of space and **û** is a unit vector in the positive direction of the electric field of intensity **E**. The force is positive (repulsive) between like charges and negative (attractive) between unlike charges. The electric charges *Q* and *K*, in Figure 1, are supposed to be in the form of spherical shells of radii *a*and *b* and masses m_1 and m_2 respectively. Coulomb's law does not consider gravitational force of attraction or relative velocity between two charges of magnitudes *Q* and *K*.

Making Coulomb's law independent of velocity of a charged particle, moving in an electric field, led physics, early in the 20th Century, into the contraption of theory of special relativity to explain speed of light being an ultimate limit, into the contrivance of theory of general relativity to explain gravity and into the conception of quantum mechanics to explain emission of radiation from atomic particles moving at high speeds. These clever theories may not be necessary in view of the extended Coulomb's law which includes gravitation and electromagnetic radiation.

The intrinsic energy *W* or work done in creating an electric charge *Q*, as a spherical shell of radius *a*, is proportional to square of the charge, as given by the well-known classical formula:

$$W = \frac{Q^2}{8\pi\varepsilon_o a} \tag{2}$$

So, mass *m*, in the mass-energy equivalence law, being proportional to energy *W*, should also be proportional to Q^2. It isalso shown by the author [1] that *m* is proportional to Q^2. The

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gravitational force of attraction between two charges Q of massm_1 and K of mass m_2, separated by a distance r in space, as given by Newton's universal law of gravity, may be expressed as:

$$\mathbf{F}_G = -G\frac{m_1 m_2}{r^2}\hat{\mathbf{u}} = -\chi\frac{Q^2 K^2}{r^2}\hat{\mathbf{u}}$$
(3)

where $m_1 \propto Q^2$ and $m_2 \propto K^2$, G is the gravitational constant, χ is a new constant introduced here as "electro-gravity constant" and û is a unit vector in the direction of force of repulsion.

The purpose of this paper is to add equation (3) to Coulomb's law (equation 1) and obtain the electrostatic and gravitational forces between two particles of charges Q and K. Consider two neutral bodies, one consisting of an equal number of positive and negative charges each of magnitude Q and the other containing an equal number of positive and negative charges each of magnitude K. The electric fields from the charges and the strong electrostatic forces of repulsion and attraction between the charges, proportional to the charges, in accordance with Coulomb's law, cancel or balance out exactly everywhere in space, except at the location of the individual charges. The weak gravitational forces of attraction between the charges, proportional to square of the charges, remain and add up, in accordance with Newton's universal law of gravity.

It is shown that for a moving electric charge, the force Fin equation (1) depends on the relative velocity between the charges Q and K, contrary to classical and relativistic electrodynamics. If the charge K is free to move in space, **F** becomes the accelerating force on a charge K of mass $m_2$moving with velocity **v** in the electric field of intensity **E** due to charge Q. A charged particle moving in an electric field is subject to aberration of electric field.

A neglected link in physics is aberration of electric field, a phenomenon similar to aberration of light discovered in 1725 by English astronomer, James Bradley [2]. In aberration of light a star appears to be displaced in the forward direction of motion of an observer, from the instantaneous line joining the star and the observer, by angle of aberration,α. Aberration of light is one of the most significant discoveries in science. It is a direct indication of the relativity of speed of light, with respect to a moving observer, contrary to the principle of constancy of speed of light according to the theory of special relativity [3, 4]. So far, this contradiction has been ignored by physicists, in favour of special relativity.

The force due to an electric field is transmitted, along the field, at the speed of light c. So, a charged particle moving in an electric field should experiences aberration of electric field. Figure 2 below is a vector diagram showing an electric charge of magnitude K at a point P, of position vector rû, moving with velocity v at an angle θ to the field E of a stationary source charge Q fixed at O. As a result of aberration, the electric field appears along NP, defined by velocity of light **c**, such that the vector (**c** – **v**), in the direction of unit vector **û**, is parallel to OP, in the direction of the force **F**. The sine rule in triangle NPR of Figure 2 gives Bradley's Formula.

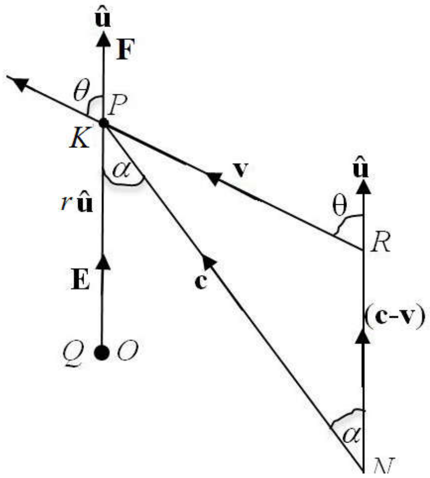

Figure 2 Depicting angle of aberration α due to a particle of charge K moving at a point P of position vector r **û**, `with velocity **v** at an angleθ to the electric field of intensity **E** due to a stationary source charge Q at a point O.

$$\sin\alpha = \frac{v}{c}\sin\theta \qquad (4)$$

Many problems of physics today, particularly those pertaining tomass, space, gravity, energy and radiation, emanate from making Coulomb's law independent of velocity of a charged particle moving in an electric field. This paper hopes to resolve some of these problems. Considering aberration of electric field, equations of motion and radiation for a charged particle, moving in an electric field, are given in accordance with Newton's laws of motion [5] and in contrast to Lamor and Abraham-Lorentz radiation formulas of classical electrodynamics [6].

Aether as the medium for gravitation and radiation

Electric fields from charges in matter or neutral bodies do exist in space, but they cancel or balance out exactly everywhere. The fields from bodies, proportional to the electric charges, in accordance with Coulomb's law, vanish at infinitely long distances from the respective sources. The surrounding space, containing isolated regions of matter, crisscrossed by electric fields from bodies, balancing out exactly everywhere and vanishing at infinitely long distances from the respective sources, constituting a medium supporting gravitation and electromagnetic radiation, is proposed to be the lumineferous aether [7], as conceived by Newton [5], Einstein [3, 4] Maxwell [8], and others. Beyond the aether, with vanishing electric fields, there is empty space, a vacuum extending to infinity. Electric permittivity ε_o and magnetic permeability μ_o should be regarded as properties of an electric field in the aether. Empty space, a vacuum, has no property.

The electric field E due to a neutral body containing *N/2* positive charges and *N/2* negative charges, at a point in the aether, may be expressed as vector:

$$\mathbf{E} = (-1)^i \sum_{i=1}^{N} \mathbf{E}_i = 0 \qquad (5)$$

where $\mathbf{E}_i$ is the electric field intensity due to the *ith* charge *and i = 1, 2, 3…..N.* The electric fields cancel or balance out exactly everywhere. But the sum of square of the fields remain to account for the pressure, density or energy of the field.
Energy per unit volume, contained in the electric field, is:

$$w = \frac{1}{2}(-1)^{2i}\,\varepsilon_o\sum_{i=1}^{N}\mathbf{E}_i^2 = \frac{1}{2}\varepsilon_o\sum_{i=1}^{N}\mathbf{E}_i^2 \tag{6}$$

This energy is always positive. N, of course, may be infinitely large.

FORCE ON A CHARGED PARTICLE MOVING IN AN ELECTRIC FIELD

Rectilinear motion

On the basis of aberration of electric field, the accelerating force **F** on the charge K moving with velocity v, in the field of magnitude E (Figure 2), is proposed as vector [9]:

$$\mathbf{F} = \frac{EK}{c}(\mathbf{c}-\mathbf{v}) \tag{7}$$

where (**c** – **v**) is the relative velocity between the force propagated with velocity of light **c** of magnitude cand charge Kmoving at velocity **v**. If$v = c$ the accelerating **F** becomes zero. An electrostatic field of intensity **E** and magnitude E, on a stationary particle of charge K, may be expressed as vector:

$$\mathbf{E} = E\hat{\mathbf{u}} = \frac{E}{c}\mathbf{c} \tag{8}$$

where **c** is the velocity of light of magnitude (speed) c.Applying the cosine rule to triangle NPR of Figure 2, gives the accelerating force **F** in equation (7), for a particle of mass m_2 moving at time t with velocity $d(r\hat{\mathbf{u}})/dt$ and acceleration $d^2(r\hat{\mathbf{u}})/dt^2 = d\mathbf{v}/dt$, as vector:

$$\mathbf{F} = \pm\frac{EK}{c}\sqrt{c^2+v^2-2cv\cos(\theta-\alpha)}\,\hat{\mathbf{u}} = m_2\frac{d\mathbf{v}}{dt} \tag{9}$$

where $\hat{\mathbf{u}}$ is a unit vector in the direction of the field and $(\theta - \alpha)$ is the angle between the vectors **v** and **c.** In equation (9), for $\theta = 0$, the charge K of mass m_2 moves, in a straight line, at constant $\hat{\mathbf{u}}$, with acceleration $\hat{\mathbf{u}}\ (dv/dt)$. Equations (4) and (9) give magnitude of force **F** as:

$$F = EK\left(1-\frac{v}{c}\right) = m_2\frac{dv}{dt} \tag{10}$$

For $\theta = \pi$ radians, the particle moves in a straight line with deceleration $-\hat{u}\ (dv/dt)$. Equations (4) and (9) give the magnitude of the force F as:

$$F = EK\left(1+\frac{v}{c}\right) = -m_2\frac{dv}{dt} \tag{11}$$

Equations (10) and (11) are first order differential equations, which can be solved, for an electric field of uniform magnitude E, to give speed v in terms of time t and show that, for rectilinear motion, the speed of light c is an ultimate limit with mass m remaining constant.

Circular Motion perpendicular to an electric field

An important case is where the charge K is equal to-e, the negative charge of an electron. Here the electron may revolve, perpendicular to the radial field, in a circle of constant radius r, at speed v and centripetal acceleration $-(v^2/r)\hat{\mathbf{u}}$, under the attraction of charge Q as centre at O (Figure 2). With $\theta = \pi/2$ radians, $\cos(\theta - \alpha) = \sin\alpha = v/c$, equation (9) gives:

$$\mathbf{F} = -eE\sqrt{1-\frac{v^2}{c^2}}\,\hat{\mathbf{u}} = -\frac{eQ}{4\pi\varepsilon_o r^2}\sqrt{1-\frac{v^2}{c^2}}\,\hat{\mathbf{u}} = -m_2\frac{v^2}{r}\hat{\mathbf{u}} \tag{12}$$

Equation (12), with $m_2$equal to the mass m_e of the electron, gives the radius of revolution r, as:

$$r = \frac{eQ}{4\pi\varepsilon_o m_e v^2}\sqrt{1-\frac{v^2}{c^2}} = \frac{r_o}{\gamma} \tag{13}$$

where r_o is the classical radius and γ is the Lorentz factor. Equation (13) is interesting in that the radius of circular revolution r decreases with speed v, to zero if $v = c$.

For an electron of charge $-e$ revolving with speed v in a circle of radius r, perpendicular to a radial electric field of magnitude E produced by a positive charge Q, the theory of special relativity gives the magnitude of centripetal force Fas:

$$F = -\frac{'m'v^2}{r} = -eE \tag{14}$$

where *'m'* is the relativistic mass. Equation (12) gives the force as:

$$F = -\frac{m_o v^2}{r} = -eE\sqrt{1-\frac{v^2}{c^2}} \tag{15}$$

where the physicalmass of the electron is a constant equal to the rest mass m_o. Equations (14) and (15) give the relativistic mass-velocity formula as:

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

where γ is Lorentz factor. Lorentz factor here is the result of motion of a charged particle perpendicular to an electric field. Equation (16) is mathematically correct but the physical interpretation is wrong.

Special relativity, with equation (16), gives the same expression r_o/γ for radius of revolution as equation (13), but for different reasons. It may be this coincidence in radius of revolution, as measured in experiments with cyclic accelerators, which lent apparent credibility to special relativity. Relativistic mass 'm' in equation (16) is not a physical quantity that has volume and weight. Relativistic mass in equation (15) is the ratio of electrostatic force $-e\ E$ to centripetal acceleration $-v^2/r$ for an electron of charge $-e$ revolving at speed v in a circle of radius r.

EXTENSION OF COULOMB'S LAW

Gravitation

An extension of Coulomb's law, for accelerating force F on a particle of charge K and mass $m_2$at a point P distance r away, moving with velocity **v** in the field of intensity **E** due to charge Q, in the direction vector $\hat{\mathbf{u}}$ (see Figure 2), is given, in conjunction with equations (3) and (7), and in accordance with Newton's second law of motion, as vector:

$$\mathbf{F} = \frac{EK}{c}\left(\mathbf{c}-\mathbf{v}\right) - \chi\frac{Q^2K^2}{r^2}\hat{\mathbf{u}} = m_2\frac{d\mathbf{v}}{dt} \tag{17}$$

where $d\mathbf{v}/dt$ is the acceleration at time t and χ is the electro-gravity constant. Equation (17), the extended Coulomb's law, includes a factor for radiation and a term for the gravitational force of attraction between two electric charges of magnitudes Q and K. The gravitational force is proportional to the product of square of the charges, which is always attractive. Equation (17), with the electrostatic field $E = Q/4\pi\varepsilon_o r^2$, in contrast to Coulomb's law of electrostatics expressed in equation (1), gives force $\mathbf{F}$ between two stationary ($\mathbf{v}$ = 0) charges of magnitudes Q and K, as:

$$\mathbf{F} = \frac{QK}{4\pi\varepsilon_o r^2}\hat{\mathbf{u}} - \chi\frac{Q^2K^2}{r^2}\hat{\mathbf{u}} \tag{18}$$

RADIATIONREACTION FORCE AND RADIATION POWER

The radiation factor, in equation (17) for a moving charged particle, is the first term containing velocity $\mathbf{v}$. Accelerating force on a charged particle moving in an electric field is less than the force on a charged particle stationary in the field. Radiation reaction force, $\mathbf{R}_f$, is the difference between the accelerating force $\mathbf{F}$on a moving charged particle (equation 17)and force(electrical and gravitational) on a stationary charged particle (equation 18), thus:

$$\mathbf{R}_f = \frac{EK}{c}\left(\mathbf{c}-\mathbf{v}\right) - \mathbf{E}K \tag{19}$$

Radiation reaction force is a kind of resistive or frictional force opposing motion of an electric charge along an electric field. Work done against the radiation reaction forcegivesradiation power and emission of radiation.

Radiation power R_p, the scalar product $-\mathbf{v}.\mathbf{R}_f$, is obtained, in terms of the angles θ and α, with reference to Figure 1, as:

$$R_p = -\mathbf{v}.\mathbf{R}_f = -\mathbf{v}.\left\{\frac{EK}{c}\left(\mathbf{c}-\mathbf{v}\right) - e\mathbf{E}\right\} = EKv\left\{\cos\theta - \cos\left(\theta-\alpha\right) + \frac{v}{c}\right\} \tag{20}$$

For $\theta = 0$ or $\theta = \pi$ radians, equation (20) gives radiation power as $R_p = EKv^2/c$. Where $\theta = \pi/2$ radians, as in circular motion of a charged particle around a central force of attraction, the radiation powerbecomes zero. So, an electron revolving in a circle around a positively charged nucleus, perpendicular to the radial electric field, is without any radiation. Emission of radiation takes place if the electron is dislodged from the stable circular orbit and it moves with a component of its velocity in the direction of an electric field.

RESULT AND DISCUSSION

Making Coulomb's law independent of velocity of a charged particle in an electric field necessitated the contraption of the theory of special relativity to explain why an electron cannot be accelerated beyond the speed of light by an electric field. It brought about the conceptionof quantummechanics to explain the source of radiation from accelerated charged particle. It resulted in the contrivance of special relativity to explain gravitation.

The expression:

$$\mathbf{F} = \frac{QK}{4\pi\varepsilon_o r^2 c}\left(\mathbf{c}-\mathbf{v}\right) - \chi\frac{Q^2K^2}{r^2}\hat{\mathbf{u}} = m_2\frac{d\mathbf{v}}{dt}$$ is the extended Coulomb's law for a particle of charge K, mass m_2, moving at time t with velocity $\mathbf{v}$ in an electric field due to a source charge Q, $\mathbf{c}$ being the velocity of light of magnitude c and χ the "electro-gravity constant". With the extension of Coulomb's law to include gravitation and incorporate radiation, giving the speed of light as the ultimate limit for a charged particle accelerated by an electric field and explaining the source of radiation from accelerated charged particles, there should be no need for the theories of relativity and quantum mechanics.

Lorentz factor γ, in relativistic electrodynamics, has nothing to do with mass. The factor is the ratio of electrostatic force $K\mathbf{E}$, on a particle of charge K, to the accelerating force $\mathbf{F}$ (of magnitude F) in the direction of the field $\mathbf{E}$ (of magnitude E), for the particlemoving perpendicular to the field, as in circular revolution of an electron around a positively charged nucleus, thus:

$$\gamma = \frac{K\mathbf{E}}{\mathbf{F}} = \frac{KE}{F} = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$$

Circular motion of an electron around a nucleus, perpendicular to a radial field, is inherently stable. Radiation takes place whenever the electron is dislodged from the circular orbit. There should be no need for Bohr's quantum theory to stabilise the Rutherford's nuclear atom.

CONCLUSIONS

1. As the charge of a moving particle is independent of its velocity and mass can be expressed in terms of electric charge, there is no reason to suppose that mass should increase with speed as in the relativistic mass-velocity formula of the theory of special relativity.
2. The relativistic mass-velocity formula is mathematically correct, but the physical interpretation is wrong. The formula is correct for circular motion, not because mass of a moving particle increases with its speed to become infinitely large at the speed of light but because accelerating force decreases with speed, reducing zero at the speed of light c.
3. Relativistic mass 'm' is not a physical quantity that has volume and weight. Relativistic mass is the ratio of electrostatic force $-eE$ to centripetal acceleration $-v^2/r$ for an electron of charge $-e$ revolving at speed v in a circle of radius r.
4. A neutral body moves under the force of gravity without friction and without radiation but with change in kinetic energy equalling change in potential energy.
5. A moving charged particle radiates if it has a component of velocity along an electric field. Energy radiated is the difference of changes in kinetic and potential energies.
6. Identification of the aether as a crisscross of electric fields emanating from neutral bodies in space, cancelling or balancing out exactly everywhere and vanishing at infinitely long distances from the respective sources,

should put into question the notion of four-dimensional space-time continuum of the theory of general relativity.

7. Aberration of light discovered in 1725 by English astronomer James Bradley should be revived and restored to its rightful and significant place in physics in spite of the theory of special relativity.

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