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Aether, Radiation, Mass-Energy Law, Gravity and Inertia

Musa D. Abdullahi

Adjunct Lecturer, Department of Physics, U.M.Y. University, Katsina, Nigeria

***Corresponding Author**
Musa D. Abdullahi, Adjunct Lecturer, Department of Physics, U.M.Y. University, Katsina, Nigeria.

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Abstract

The universal space, crisscrossed by electric fields from electric charges in bodies, is proposed to be the aether as a physical medium conceived by Maxwell, Einstein and others. The fields, in accordance with Coulomb's law, balance out everywhere. Permittivity and permeability are properties of electric fields of the aether, supporting propagation of radiation at the speed of light. A particle of charge Q is supposed to be an impregnable spherical shell of radius a, with intrinsic energy E and mass m, independent of speed. Aberration of electric field is invoked to explain the speed of light being a limit, without recourse to special relativity. Radiation, from an accelerated charged particle, is obtained outside quantum mechanics. A mass-energy equivalence law is obtained as E = ½mc^2, in contrast to the relativistic equation. The paper replaces curvature of space-time continuum, of general relativity, with distortion of electric fields of the aether, by virtue of particles occupying volumes of space, with negative potential energy, one in the shadow of the other, to make for gravitational force of attraction. An accelerated charged particle, affected by its own induction electric field, is used to explain inertia.

Keywords: Acceleration, Charge, Energy, Field, Force, Magnetic Vector Potential, Mass, Velocity

1. Introduction

It is reasonable to suppose that there is a medium, filling the universal space, which supports gravitation and in which electromagnetic waves are propagated. This luminiferous medium is called aether [1, 2, 3] as envisaged by Sir Isaac Newton [4], Albert Einstein [5], James Clerk Maxwell [6] and other great physicists. What is introduced in this paper is an electric field model of the aether, where the universal space, crisscrossed by electric fields, from electric charges in bodies, constitutes the aether [7]. Therefore, the aether exists in a vacuum or wherever there is matter in space. Electric permittivity and magnetic permeability are properties of the electric fields of the aether. A vacuum, a void, has no property.

An identification of what really constitute the aether would go a long way in resolving the difficulty with curving or warping of four-dimensional space-time continuum of general relativity [8]. It may lead to the long-awaited unification of electrostatic and gravitational forces. The force of gravity, such a pervasive and persistent force, may have a simple explanation, which has defied rational explanation by physicists, until now [10].

The electric field model of the aether is simpler in contrast to the epola (electron-positron lattice) model by Professor Menahem Simhony [11, 12], the Paul Dirac model (infinite sea of particles with negative energy) [13, 14, 15] and other particulate models.

A great scientist of the 19th Century, James Clerk Maxwell, showed that the speed c of light in free space or vacuum, occupied by electric fields, is given by:

$$c = \frac{1}{\sqrt{\mu_o \varepsilon_o}} \qquad (1)$$

where electric permittivity ε_o and magnetic permeability μ_o are properties of the aether. So, an electric field model of the aether automatically supports propagation of electromagnetic radiation at the speed of light c. What remains is to show that the aether is an elastic medium, which have equivalent pressure and density, somewhat like air in the atmosphere.

Aberration of electric field is invoked to explain radiation from a charged particle accelerated by an electric field. This is a phenomenon like aberration of light, discovered in 1728 by English astronomer James Bradley [16]. Aberration of light clearly demonstrated the relativity of speed of light, with respect to an observer. It is one of the most significant discoveries in science, but now relegated to the background in favour of constancy of speed of light, a cardinal principle of the theory of special relativity. Aberration of electric field is a missing link in classical and relativistic electrodynamics. In view of aberration of electric field, energy radiated, by a charged particle under the acceleration of an electric field, is the difference between change in potential energy and change in kinetic energy.

2. Characteristics of the Aether

The aether is proposed as an 'atmosphere' of electric fields, a crisscross of balanced electric fields from bodies in space. Electric fields from bodies, containing N/2 positive charges and N/2

negative charges, do exist in space, but, being equally positive and negative, balance out exactly everywhere. At any point in space, the aether is characterised as follows:

$$\sum_{i=1}^{N}(-1)^i Q_i = 0 \text{ and } \sum_{i=1}^{N} Q_i^2 > 0 \qquad (2)$$

$$\sum_{i=1}^{N}(-1)^i \mathbf{E}_i = 0 \text{ and } \sum_{i=1}^{N} E_i^2 > 0 \qquad (3)$$

where Q_i is the magnitude of the i^{th} charge, E_i the electric field intensity and E_i the magnitude of electric field from the i^{th} charge, in a neutral body, where $i = 1, 2, 3 \ldots N \ldots \infty$.

While the electric charges and fields from a neutral body, cancel out exactly everywhere, the square of each electric charge (Q_i^2) and square of each electric field (E_i^2) are always positive and they add up to account for the equivalent pressure, energy density and mass density of the aether. Any imbalance in the electric fields of the aether would cause polarization of the electrical charges in a body and possible flow of charges as electric currents. Indeed, the aether is comparable to air in the atmosphere, which produces wind and serves as a medium for sound propagation at a speed determined by the pressure and density.

3. Equivalent Energy Density Mass Density and Pressure of Aether

Energy density w or energy per unit volume due to electric fields E_i of the aether, is:

$$w = \frac{\varepsilon_o}{2}\sum_{i=1}^{\infty} E_i^2 \qquad (4)$$

Total pressure P due electric fields E_i of the aether, at a point in the aether, is the sum:

$$P = \varepsilon_o \sum_{i=1}^{\infty} E_i^2 = 2w \qquad (5)$$

The aether, an elastic medium of density ρ, supports propagation of light with speed c, as:

$$c = \sqrt{\frac{P}{\rho}} = \sqrt{\frac{2w}{\rho}}$$

$$\rho c^2 = 2w \qquad (6)$$

$$w = \frac{1}{2}\rho c^2$$

$$\int_V w(dV) = E_n = \frac{c^2}{2}\int_V \rho(dV) = \frac{1}{2}Mc^2$$

where V is volume of mass M. For a particle of mass m:

$$E_n = \frac{1}{2}mc^2 \qquad (7)$$

Equation (7) is a mass-energy equivalence law, different from the relativistic equation $E = mc^2$. All the different mass-energy equivalence laws give, $E_n \propto m$.

4. Coulomb's law and Electric Field

Virtually all electrical phenomena can be explained in terms of electric fields from electric charges, stationary or in motion, relative to an observer. Coulomb's law, perhaps the most important principle in physics, was enunciated in1785 by French physicist and engineer, Charles-Augustin de Coulomb. It gives the force **F** of repulsion or attraction between two stationary electric charges Q and K separated by a distance r in space, as:

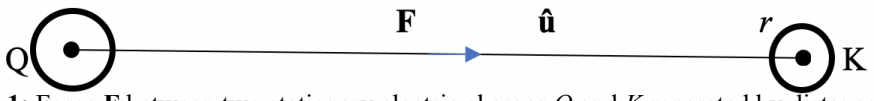

Figure 1: Force **F** between two stationary electric charges Q and K separated by distance r.

$$\mathbf{F} = \frac{QK}{4\pi\varepsilon_o r^2}\hat{\mathbf{u}} = \frac{QK}{4\pi\varepsilon_o r^2}\frac{\mathbf{c}}{c} \qquad (8)$$

Electrostatic field $\mathbf{E}_o$ of a stationary particle of charge Q, at a distance r from the charge, is:

$$\mathbf{E}_o = \frac{Q}{4\pi\varepsilon_o r^2}\hat{\mathbf{u}} = \frac{Q}{4\pi\varepsilon_o r^2}\frac{\mathbf{c}}{c} \qquad (9)$$

where c is the velocity of light, a vector quantity of magnitude c, and $\hat{\mathbf{u}} = \mathbf{c}/c$ is a unit vector in the direction of application of the electrostatic force. The electrostatic field of a point charge or a spherical charge, is radial, extending to infinity. This electrostatic field is present as long as the electric charge exists. Any effect or disturbance in the field is transmitted at the speed of light c. Even for a neutral body, consisting of an equal number of positive and negative electric charges, the fields exist but they balance out exactly everywhere in space.

If a charged particle moves with velocity v, relative to an observer, Coulomb's law, equation (8) becomes the vector equation:

$$\mathbf{F} = \frac{QK}{4\pi\varepsilon_o cr^2}(\mathbf{c}+\mathbf{v}) = \frac{E_o K}{c}(\mathbf{c}+\mathbf{v}) \tag{10}$$

$$\mathbf{E}_v = \frac{Q}{4\pi c\varepsilon_o r^2}(\mathbf{c}+\mathbf{v}) = \frac{E_o}{c}(\mathbf{c}+\mathbf{v}) \tag{11}$$

where $\mathbf{E}_v$ is the intensity of a dynamic electric field, different from the electrostatic field $\mathbf{E}_o$. The increase of the electric field, from $\mathbf{E}_o$ (equation 9) to $\mathbf{E}_v$ (equation 11), relative to an observer, accounts for the kinetic energy, $\frac{1}{2}mv^2$, of the particle of constant mass m.

Where another electric charge, of mass *m*, moves at time *t*, with velocity **v** relative to the charge *Q*, Coulomb's law, in accordance with Newton's second law of motion becomes:

$$\mathbf{F} = \frac{QK}{4\pi\varepsilon_o cr^2}(\mathbf{c}-\mathbf{v}) = \frac{E_o K}{c}(\mathbf{c}-\mathbf{v}) = m\frac{d\mathbf{v}}{dt} \tag{12}$$

The velocity of light **v** = **c**, being an ultimate limit, is implicit in equation (12). Equations (10) and (12) are modifications of Coulomb's law for radiation.

5. Intrinsic Energy of an Electric Charge

If a charged particle, such as an electron, is to assume any configuration, it is most likely to be a spherical shell of radius *a*. Such a figure has electrostatic energy or intrinsic energy E_n, equal to the work done in creating the charge from *0*, as given by volume integral:

$$E_n = \frac{\varepsilon_o}{2}\int_V E_o^2(dV) = \frac{\varepsilon_o}{2}\int_a^\infty \left(\frac{Q}{4\pi\varepsilon_o r^2}\right)^2 \left(4\pi r^2\right)(dr) = \frac{Q^2}{8\pi\varepsilon_o a} \tag{13}$$

Equation (13) is a well-known classical formula. The intrinsic energy E_n is contained in the electrostatic field $\mathbf{E}_o$ but may be expressed in terms of the charge *Q* creating the field.

Equations (1), (7) and (13) give the mass of a particle of charge *Q*, an impregnable spherical shell or hollow sphere of radius a, as:

$$m = \frac{\mu Q^2}{4\pi a} \tag{14}$$

6. Aberration of Electric Field

In equations (11) the dynamic electric field $\mathbf{E}_v$ is in the direction of vector (**c** + **v**). The inclination between **c** and (**c** + **v**) is angle of aberration α. Figure 2 shows aberration of electric field for a particle of charge *Q* at O moving with velocity **θ** relative to observer. The electric field is increased in the forward direction and decreased in the backward direction. An electrostatic field $\mathbf{E}_o$, at angle θ to velocity **v**, becomes a dynamic electric field $\mathbf{E}_v$, shifted forward by aberration angle *a*. The moving charge, with potential *φ* at a distance *r*, creates a magnetic field **H** and induction electric field $\mathbf{E}_a$ in the opposite direction of acceleration.

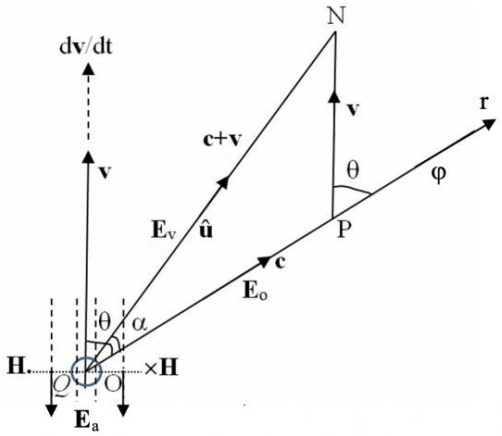

Figure 2: Dynamic field $\mathbf{E}_v$ with effective velocity (**c**+**v**), shifted by aberration angle *a*, from electrostatic field $\mathbf{E}_o$, due to the charge *Q* moving with velocity **v** and acceleration *dv*/*dt*.

In Figure 2, sine law in triangle OPN gives:

$$\sin\alpha = \frac{v}{c}\sin(\theta - \alpha) \tag{15}$$

Figure 3 depicts aberration of electric field for a charged particle moving with velocity **v** at angle θ to the electric field due to a stationary charge Q at O.

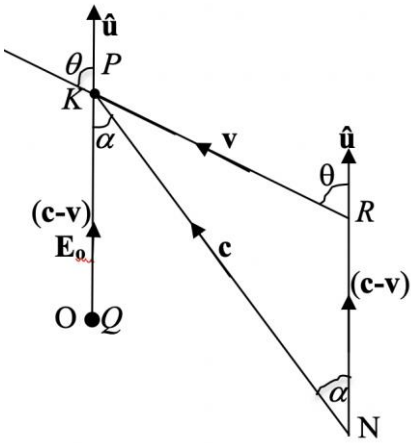

Figure 3: Field $\mathbf{E}_o$, due to charge Q at O, with transmission at velocity **c**, shifted from OP to NP through aberration angle a, due to charge K at P moving with velocity **v** at angle θ to OP, such that (**c** - **v**) is along OP.

In Figure 3, sine law in triangle RPN gives:

$$\sin\alpha = \frac{v}{c}\sin\theta \tag{16}$$

This is Bradley's universal formula, an equation applicable at atomic and astronomical levels.

7. Kinetic Energy of Moving Charged Particle

Energy of dynamic field $\mathbf{E}_v$ (equation 11), is given by volume integral:

$$W = \frac{\varepsilon_o}{2}\int_V E_v^2(dV) = \frac{\varepsilon_o}{2}\int_a^\infty \left\{\frac{E_o}{c}(\mathbf{c}+\mathbf{v})\right\}^2 (dV)$$

$$W = \frac{\varepsilon_o}{2}\int_a^\infty \left\{\left(\frac{E_o}{c}\right)^2 \left(c^2 + v^2 + 2vc\cos\theta\right)\right\}(dV) = E_n + \frac{1}{2}mv^2 \tag{17}$$

$$\frac{\varepsilon_o}{2}\int_a^\infty \left\{\left(\frac{E_o}{c}\right)^2 2vc\cos\theta\right\}(dV) = 0 \tag{18}$$

where θ is the angle between the vectors **v** and **c** in Figure 2 and ½ mv^2 is the kinetic energy. The intrinsic energy is given by equation 13.

$$\frac{\varepsilon_o}{2}\int_a^\infty \left\{\left(\frac{E_o}{c}\right)^2 v^2\right\}(dV) = \frac{E_n}{c^2}v^2 = \frac{1}{2}mv^2$$

$$E_n = \frac{1}{2}mc^2 \tag{19}$$

8. Radiation from a Moving Charged Particle

Equation (12) shows that accelerating force on a moving charged particle, is less than the force on a stationary one. The difference is radiation reaction force $\mathbf{R}_f$, thus:

$$\mathbf{R}_f = \frac{E_o K}{c}(\mathbf{c}-\mathbf{v}) - \mathbf{E}_o \qquad (20)$$

Radiation power, scalar product $-\mathbf{v}.\mathbf{R}_f$, obtained in terms of the angles θ and α of Figure 3, is:

$$-\mathbf{v}.\mathbf{R}_f = -\mathbf{v}.\left\{\frac{E_o K}{c}(\mathbf{c}-\mathbf{v}) - K\mathbf{E}_o\right\} = vE_o K\left(\cos\theta + \frac{v}{c} - \cos(\theta-\alpha)\right) \qquad (21)$$

In Figure 3, the particle at P may move with the angle $\theta = 0$, π *or* $\pi/2$ radians. For $\theta = 0$ or π radians, radiation power (equation 21), is $E_o K v^2/c$. For $\theta = \pi/2$ radians, as in circular motion round O, a central force of attraction, radiation power is zero.

9. Magnetic Vector Potential and Induction Electric Field

Where there is relative velocity v between a charged particle and an observer, as in equations (10) and (12), a magnetic field **H** is brought about, as vector product, thus:

$$\mathbf{B} = \mu_o \mathbf{H} = \mu_o \varepsilon_o \mathbf{v} \times \mathbf{E}_s = \mu_o \varepsilon_o \mathbf{v} \times \mathbf{E}_o = -\mu_o \varepsilon_o \mathbf{v} \times \nabla\varphi = \mu_o \varepsilon_o \nabla \times \varphi\mathbf{v} = \nabla \times \mathbf{A} \qquad (22)$$

where **B** is magnetic flux intensity, symbol ∇ denotes the gradient of a scalar point-function, $\nabla\times$ denotes the curl of a vector point-function and $\nabla\times\mathbf{v} = 0$. Magnetic vector potential A, is:

$$\mathbf{A} = \mu_o \varepsilon_o \varphi \mathbf{v} \qquad (23)$$

where φ is the electrostatic potential at α point distance r from the charge.

An accelerated charge creates induction electric field $\mathbf{E}_a$, given by Faraday's law, as:

$$\nabla \times \mathbf{E}_a = -\frac{\partial \mathbf{B}}{\partial t} = -\frac{\partial}{\partial t}\nabla \times \mathbf{A}$$
$$\mathbf{E}_a = -\frac{\partial \mathbf{A}}{\partial t} \qquad (24)$$

The reactive electric field $\mathbf{E}_a$ is the same as the induction electric field given by Faraday's law (equation 24), so that:

$$\mathbf{E}_a = -\frac{\partial \mathbf{A}}{\partial t} = -\mu_o \varepsilon_o \varphi \frac{\partial \mathbf{v}}{\partial t} \qquad (25)$$

where magnetic vector potential A is in equation (23). The induction electric field acts on the same charge Q, to produce inertial force, equal and opposite to the accelerating force, so that:

$$Q\mathbf{E}_a = -\mu_o \varepsilon_o Q\varphi \frac{\partial \mathbf{v}}{\partial t} = -m\frac{\partial \mathbf{v}}{\partial t} \qquad (26)$$

$$m = \mu_o \varepsilon_o Q\varphi \qquad (27)$$

The product $Q\varphi$ is zero everywhere in space except at the boundary where the final charge is Q and the final potential is U to give $QU = 2E_n$, where E_n is the intrinsic energy, so that:

$$m = \mu_o \varepsilon_o Q\varphi = \mu_o \varepsilon_o QU = 2\mu_o \varepsilon_o E_n$$

$$E_n = \frac{m}{2\mu_o \varepsilon_o} = \frac{1}{2}mc^2 \qquad (28)$$

Equation (28), with $1/\mu_o\varepsilon_o = c^2$, is the most authentic derivation of a mass-energy equivalence law as $E_n = ½\, mc^2$.

10. Gravitational forces between two electric charges

The small force **f** between two electric charges, Q of mass m_1 and K of mass m_2, distance r apart, is a combination of electrostatic force of repulsion or attraction given by Coulomb's law and gravitational force of attraction given by Newton's universal law, thus:

$$\mathbf{f} = \pm\frac{QK}{4\pi\varepsilon_o r^2}\hat{\mathbf{u}} - G\frac{m_1 m_2}{r^2}\hat{\mathbf{u}} \qquad (29)$$

where $\hat{\mathbf{u}}$ is a unit vector in the direction of force of repulsion and G the gravitational constant. For two neutral bodies, each composed of equal numbers of positive and negative electric charges, the strong electrostatic forces, in accordance with Coulomb's law, balance out exactly, everywhere. The week gravitational forces, being always negative, add up to constitute the gravitational force of attraction, in accordance with Newton's universal law.

A particle of charge Q in the form of an indestructible spherical shell, or hollow sphere, of radius a, has intrinsic energy E_n and mass m proportional to Q^2 (equation 14). Equation (29) for $Q^2 \propto m_1$ and $K^2 \propto m_2$ gives:

$$\mathbf{f} = \pm\frac{QK}{4\pi\varepsilon_o r^2}\hat{\mathbf{u}} - \chi\frac{Q^2K^2}{r^2}\hat{\mathbf{u}} \qquad (30)$$

where χ = is a magneto-gravity constant. While electrostatic force may be positive or negative, gravitational force is always negative. Equation (30) for electric charges may be interpreted as an electric field E, on encountering an impregnable electric charge, occupying an impenetrable volume V in the aether, an elastic medium, gets blocked or reflected, thereby forming a particle with negative potential energy P, as:

$$P = -\frac{\varepsilon_O E^2}{2}V \qquad (31)$$

Equation (31) for a body composed of an infinitely large number of particles, is akin to Paul Dirac's seminal insight of "infinite sea of particles with negative (potential) energy". Negative potential energy connotes attraction between bodies.

The force of attraction $\mathbf{F}_G$ between one body of mass M_1 consisting of $N_1/2$ positive charges and $N_1/2$ negative charges, each of magnitude Q and another body of mass M_2 containing $N_2/2$ positive and $N_2/2$ negative charges, each of magnitude K, is deduced from equations (30), as:

$$\mathbf{F}_G = -G\frac{M_1M_2}{Z^2}\hat{\mathbf{u}} = -\frac{\chi}{Z^2}\sum_{n=1}^{N_1}Q_n^2\sum_{n=1}^{N_2}K_n^2\hat{\mathbf{u}} = -\frac{\chi}{Z^2}N_1N_2Q^2K^2\hat{\mathbf{u}} \qquad (32)$$

where Z is the distance between the centers of gravity of the masses. The numbers N_1 and N_2, of course, may be infinitely large. The strong electrostatic forces, being equally positive and negative, cancel out, to give equation (32).

11. Cause of Gravity

Equation (28) gives a mass-energy equivalence law as:

$$E_n = \frac{1}{2}mc^2 = \frac{m}{2\mu_o\varepsilon_o} = \frac{Q^2}{8\pi\varepsilon_o a} \qquad (33)$$

where c is the speed of light in a vacuum, as obtained by James Clerk Maxwell, in equation (1). Equation (33) gives mass m of an electron of charge $Q = -e$, as an impregnable and indestructible hollow sphere of radius a, with surface charge intensity, a constant vector **σ** coulomb per unit area, as:

$$m = \frac{\mu_o Q^2}{4\pi a} = \frac{\mu_o\left(4\pi a^2\right)^2\sigma^2}{4\pi a} = 3V\mu_o\sigma^2 \qquad (34)$$

where V is the volume of sphere of radius a. With **s** as a universal constant, Newton's universal law of gravity for force of attraction between mass m_1 of volume V_1 and mass m_2 of volume V_2, distance r apart, in space, may be expressed as:

$$\mathbf{F} = -G\frac{m_1m_2}{r^2}\hat{\mathbf{u}} = -G\frac{(3\mu_o\sigma^2)^2V_1V_2}{r^2}\hat{\mathbf{u}} = -\zeta\frac{V_1V_2}{r^2}\hat{\mathbf{u}} \qquad (35)$$

where ζ is a constant. The interpretation of equation (35) is that gravitational force of attraction is a pushing force between two bodies, by virtue of a volume of the aether being occupied by a body, one in the shadow of another. Bodies in the aether, an elastic medium, naturally attract one another, with a force inversely proportional to the square of distance between them This is reminiscent of curving of space-time continuum of general relativity, to account for gravitation, but here we have a physical medium, not empty space.

12. Cause of Inertia

A body of mass *M* containing *N/2* positive charges and *N/2* negative charges, each of charge *Q* and mass *m*, moving at constant velocity **v**, carries along its straight lines of radial electric fields without distortion. In the event of an acceleration *dv/dt* at time *t*, a sudden change of velocity, the effect, transmitted at the speed of light, is not instantaneously and simultaneously communicated to all the distant radial fields, particularly the transverse ones. Consequently, the field lines become bent, away from the moving charge, thereby producing a reactive component $\mathbf{E}_a$ in the opposite direction of acceleration, to give the inertial force. This reactive electric field acts only on the charge producing it, the other positive and negative actions cancel out, such that:

$$NQ\mathbf{E}_a = -Nm\frac{d\mathbf{v}}{dt} = -M\frac{d\mathbf{v}}{dt} \qquad (36)$$

where *N* is the number of positive and negative charges in the body. Equation (36) explains inertial force as an electrical property within a body.

13. Results and Discussion

- The aether as an electric field medium filling a vacuum, automatically supports propagation of electromagnetic radiation at the speed of light *c*.
- Equation (7), (19) and (28) give a mass-energy equivalence law as $E = ½\ mc^2$, in contrast to the relativistic equation $E = mc^2$.
- Aberration of electric field, illustrated in Figures (2) and (3), is a missing link in classical and relativistic electrodynamics.
- Equation (28) is the most authentic proof of a mass-energy equation as $E_n = ½\ mc^2$.
- Equation (30) is a unification of electrostatic and gravitational forces.
- Curvature of space-time continuum of general relativity is replaced by blocking or reflection of electric field lines of an electric field, on encountering another electric charge in space, thereby forming a "hole" particle with negative potential energy, to account for gravitational force of attraction.
- The aether has equivalent energy density and mass density in accordance with mass-energy equivalence equation $E_n = ½\ mc^2$.
- A body composed of electric charges, moving at constant velocity, carries along its straight lines of radial electric fields.
- Identifying Faraday's induction electric field due to a changing magnetic field, with reactive electric field due to an accelerated charged particle, is a new insight.
- Equation (31) is a new expression giving the negative potential energy of a particle occupying a volume *V* in the aether and giving rise to gravitational force of attraction.
- Bending of electric field lines of an accelerated charged particle, away from the particle, due to finite speed of light, producing a reactive field, is the cause of inertia.
- For an electron of charge $e = 1.602\times10^{-19}\ C$, radius $a = 2.817\times10^{-15}\ m$, should be the smallest length, and mass, $m = 9.110\times10^{-31}\ Kg$, the lightest particle known in nature.

14. Conclusion

The paper, succeeding in explaining the aether as an electric field medium; getting the speed of light as an ultimate limit, without recourse to special relativity; obtaining radiation from accelerated charged particles, outside quantum mechanics; describing inertia as an electrical property within a body and explaining gravity as a pushing force by virtue of a particle occupying an impenetrable volume of space, with negative potential energy, in the aether, has introduced a new electrodynamics applicable to all particles and bodies up to the speed of light with mass of a moving particle remaining constant at the rest mass.

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