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FORCE FLUX DENSITY FIELD EQUATIONS DERIVED FROM ONE-DIMENSIONAL MAXWELL'S ELECTROMAGNETIC EXACT DIFFERENTIAL EQUATIONS (MEMEDES)

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Abstract

This paper aims to derive various electromagnetic force flux density (EMFFD) equations from Maxwell's electromagnetic exact differential equations (MEMEDEs) in the Cartesian coordinate system with no warp under postulations detailed later and to derive a substructure of beam light with full-spectrum from them. For the aim, there is a need to change the existing Maxwell's equations without interactions into the MEMEDEs due to interaction ways through simply multiplying various objects and either electric flux density (D) or magnetic field flux density (B). The first postulation is that an electromagnetic source makes a continuity entity of electromagnetic flux density in a mobile cylindrical self-medium with invariable vacuum permeability and permeability. Besides, light can travel in a vacuum space with no external medium,

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and concurrently each of electric and the magnetic field flux densities with surface passing through bundling lines of action emanated from the source in the medium. The second postulate is that light's substructure constitutes of a set of two horn tori: a horn torus with clockwise looping spatial magnetic voltage continuity with angular momentum, and the other torus with anticlockwise voltage continuity with anti-angular momentum in line with an axis for light to travel. On the other, the clockwise torus has a positively charged sphere located at the center with major radius on the same axis, and the other anticlockwise torus has a negatively charged sphere on the same axis, and their coaxial sets bring into continuous line with one after the other on the axis. The third postulate is an electromagnetic indeterminacy inevitably generating so that a linear continuity has a volume multiplying a cross-section to pass through bundling lines of action and an observing length with a space interval vanishing into nothing in observing. The forth postulate is that each of spatial current and spatial voltage continuity can flow only in the self-medium. Maxwell had used the description of displacement current displacing the immobile aether media, regardless of the denial condition of immobile aether existence by the Michelson-Morley experiments. The fifth postulate is that electromagnetic waves must have a closed-loop circuit from widespread knowledge of radio wave systems so that progressive and retrogressive waves must have each way for them to propagate. If progressive and retrogressive waves travel along a loop, those waves result in a standing wave unable to travel. So that, the last postulate is longitudinal waves capable of transporting electromagnetic mass, momentum, force, energy and the self-medium at the speed of light. The transversal standing waves will be observed as traversing progressive waves for making longitudinal waves progressive, the longitudinal polarization and progressive waves due to a closed-loop circuit. Sixth is the light's substructure with two spiral polarizations and a longitudinal polarization: left-handed circularly polarized electromagnetic waves (LHPEW) are generated by an interaction between clockwise spatial magnetic flux density (CSMFD) and the diverging radial D: besides, right-handed circularly polarized waves (RHPEW) are generated by an interaction between anticlockwise spatial magnetic flux field density (ASMFFD) and the converging radial D, respectively.

1. Introduction

This paper aims to derive electromagnetic force equations, momentum and mass equations from new expanded Maxwell's electromagnetic exact differential equations (MEMEDEs) expressed as a composite unit composed of mechanical units like momentum $[\mathrm{Ns}]$, mass $[\mathrm{kg}]$, and force $[\mathrm{N}]$, and electromagnetic units like voltage $[\mathrm{V}]$, current $[\mathrm{A}]$, besides, and common unit, power $[\mathrm{W}]$, energy $[\mathrm{J}]$, in SI unit system [1].

To accomplish those aims, according to electromagnetic texts [2] and physics text [3], main terms make use of a concept of line of force [4], [5], [6] applicable to both of mechanical force and electromagnetic force.

Therefore, each of main units is in use as those expressions due to composite unit: common units, second $[\mathrm{s}]$, meter $[\mathrm{m}]$, and mechanical units, Newton $[\mathrm{N}]$, momentum $[\mathrm{Ns}]$, and energy $[\mathrm{Nm}]$, and electromagnetic units, voltage $[\mathrm{V = Nm/A/s}]$, ampere $[\mathrm{A = Nm/V/s}]$, electric charge $[\mathrm{As = Nm/V}]$, magnetic charge $[\mathrm{Vs = Nm/A}]$, power $[\mathrm{VA = Nm/s}]$, respectively, so each of those units is detailed later.

Besides, there is widespread use that each electric field term with the unit of Voltage per meter [7] and magnetic field with the unit of Ampere per meter [8], [9] in the existing Maxwell's equations. Their equations cannot derive new terms: electromagnetic momentum, mass, energy, force, power, and the mobile self-medium.

Therefore, they have no means to express the true essence of electromagnetic phenomena. In other words, this paper aims that each D and the M is defined as a flux structure passing through bundling lines of action per unit meter squared plays a role of acting force for an object, respectively. Therefore, the MEMEDEs based on the previous-stated lines of force, those flux densities use field flux density per unit surface or per unit meter squared from this point forward.

In physics, there is a need for fundamental interactions between a force and its point-like object with no size in particle physics [10]. On the other hand, *D* diverges from a positively charged sphere with size. In reverse, the other flux density converges on a negatively charged sphere with size. From that aspect alone, the concept of the MEMEDEs conflicts with the mechanical concept of a point with no size unable to emanate each of those flux densities with surface passing through bundling lines of action.

Furthermore, the momentum term, the Coulomb, and the Lorentz force cannot be derived directly from the existing Maxwell's equation. Furthermore, this paper requires replacing the existing wave-particle duality [11] by the wave-photon with mass duality [12] for a photon is not an elemental entity like an isolated particle with mass in a mechanical particle system but an electromagnetic continuity unable to chop it up as a fundamental element for an electromagnetic indeterminacy principle proposed by Ohki [13], [14]. These problems concerning the duality become clear through the MEMEDEs, as discussed in more detail below.

The MEMEDEs will lead to curious substructures that we want to fully understand the so-called light's characteristic properties:

(a) Why light does travel in keeping a straight line on an axis?

(b) Why light can travel at the speed of light in cosmic space with homogeneity and isotropy and without any media?

(c) Why energy of electromagnetic waves does not conserve at any point and at any time like mechanical energy conservation with kinetic and potential energy?

(d) Why the speed of light is invariable in any frame?

(e) Why light does not be expressed to travel along a path of a circuit in indispensable need of a closed-loop circuit like practically well-known electromagnetic waves?

(f) Why light does not have a property of transverse and longitudinal wave duality [15]?

(g) Why light has both properties of left-handed and right-handed circularly-polarized [16], longitudinal polarization?

However, the existing Maxwell's equations cannot clearly explain the above-mentioned properties of light, and cannot derive the Coulomb and Lorentz force from them.

So, to solve their above-stated issues, new proposal is one dimensional MEMEDEs only with respect to space variable z and time variable t in the Cartesian coordinate system [17].

2. The MEMEDEs

2.1.1. Terms defined and specified in the MEMEDEs

Under popularly using conditions and specifications:

・ Given Cartesian axes and unit vectors: $\mathbf{i}$: unit vector in x direction, $\mathbf{j}$: unit vector in y direction, $\mathbf{k}$: unit vector in z direction.

Those scalar products; $\mathbf{i} \cdot \mathbf{j} = 0$, $\mathbf{j} \cdot \mathbf{k} = 0$, $\mathbf{k} \cdot \mathbf{i} = 0$, $\mathbf{i} \cdot \mathbf{i} = 1$, $\mathbf{j} \cdot \mathbf{j} = 1$, $\mathbf{k} \cdot \mathbf{k} = 1$.

Those vector products: $\mathbf{i} \times \mathbf{j} = \mathbf{k}$, $\mathbf{j} \times \mathbf{k} = \mathbf{i}$, $\mathbf{k} \times \mathbf{i} = \mathbf{j}$.

・ Given a cylindrical coordinate system with unit vectors: $\mathbf{r}$: radiation unit vector in a radiational direction, $\mathbf{b}$: rotation unit vector in a circular looping circuit, $\mathbf{k}$: unit vector in z direction for light to travel, this z-coordinate is the same in both the cylindrical and Cartesian coordinate system.

Those scalar products: $\mathbf{r} \cdot \mathbf{b} = 0$, $\mathbf{r} \cdot \mathbf{k} = 0$, $\mathbf{k} \cdot \mathbf{b} = 0$, $\mathbf{r} \cdot \mathbf{r} = 1$, $\mathbf{b} \cdot \mathbf{b} = 1$, $\mathbf{k} \cdot \mathbf{k} = 1$.

Those vector products: $\mathbf{r} \times \mathbf{b} = \mathbf{k}$, $\mathbf{b} \times \mathbf{k} = \mathbf{r}$, $\mathbf{k} \times \mathbf{r} = \mathbf{b}$.

・ A beam continuity or a continuity is defined as a linear electromagnetic continuity [18] and has a differentiable function [19].

・ Electric charge and magnetic charge have a unit of As [As], and Vs [Vs], respectively.

・ Positively and negatively charged sphere is defined as a perfect sphere with a spherical surface radiating D bundling lots of lines of action in all directions, detailed later.

・ A set of two poles: north magnetic pole N emanating bundling lots of lines of action from an infinitesimal thin interface with size, and south magnetic pole S on the lines, so that B is defined as density per unit surface passing through the lines, and each of the lines constitutes of voltage continuity line of action and looping along at a center of the torus, detailed later.

・ Density signs: L (parameter) is Liner density per unit length meter, ϕ (parameter) is square density per unit meter squared, the exception to D and B, ρ (parameter) is the cubic density per unit meter cubed.

・ From the viewpoint of dimensional analysis, using units: Second: [s], meter: [m], mass: [kg], Length: [m], Area: A [m^2], Sphere: [m^3], N: Newton: [$\mathrm{N = kgm / s^2}$], momentum: [kgm/s = Ns], energy: [$\mathrm{Nm = kg(m/s)^2}$], power: [W = Nm/s], linear density expressed as a function with respect to variable z: $L(z)$ [z/m], linear field flux density $\phi(z)$: [$\mathrm{z/m^2}$], linear volumetric density $\rho(z)$: [$\mathrm{z/m^3}$], Ampere: [A], Voltage [V], Watt: [VA = Nm/s] in zero phase with no difference between voltage and current in phase, energy: [Nm = VAs], vacuum permittivity ε: [$\mathrm{As/Vm = N/V^2}$], vacuum permeability μ: [$\mathrm{Vs/Am = N/V^2}$], each of ε and μ is an invariable constant omitted zero subscript for simplification, one-dimensional D: [As/m^2 = N/m/V], one-dimensional B: [Vs/m^2 = N/m/A], one dimensional electromagnetic momentum density $\rho(M)$: [Ns/m^3], having one-dimensional vector for light to travel along on an axis of z with unit vector $\mathbf{k}$ in the Cartesian coordinate system, as the resulting of vector production of D and B.

Note: D and B keep as density function form, respectively.

・Main electromagnetic terms: electromagnetic constant $\varepsilon\mu$ product of invariable permittivity ε [20] and invariable permeability μ [21], each of D and B, electromagnetic energy flux density (EMEFD), electromagnetic force flux density (EMFFD) and momentum flux density (EMMFD) has a unit per meter squared in SI unit so that each of them has a property of bundling lines of relevant action.

・Furthermore, the displacement current in Maxwell's equations is defined as a specified current to flow displacing the aether medium [22], the luminiferous medium [23]. However, the immobile aether medium has been in a state of denial conditions by Michelson- Morley experiment. So, a proposal is to describe current flowing in the cosmic space postulated with homogeneity and isotropy and without external medium for each electromagnetic term. Therefore, a postulation is that a mobile cylindrical continuous self medium with invariable permittivity and permeability in free space allows bundling of spatial wave lines of action of current and voltage, emanated pushing out from an electromagnetic source, so hereafter, the spatial wave lines of action of current and voltage are used as the replacement of displacement current, respectively.

・When given a postulation that each of the self-medium and light emanates concurrently from its source, the self-medium helps light to travel at the speed of light in the cosmic space. We need to study whether or not each of permittivity and permeability in the so-called free space is equivalent to one in the cosmic space, so do not discuss those difference beyond this goal.

・Each of one-dimensional terms only with space variable z and time variable t, and is expressed with composites of electromagnetic units and mechanical units: meter unit [m], time unit [s], energy unit [J], Newton unit [N], and momentum unit [Ns], current [A], voltage [V].

・Invariable vacuum permittivity: ε [As/Vm = N/V^2]. (C-1a)

・Invariable vacuum permeability: μ [Vs/Am = N/A^2]. (C-1b)

・An electromagnetic constant is defined as product of ε and μ: $\mu\varepsilon$ [(m/s)^2]. (C-1c-1)

・The speed of light: c [m/s] is expressed as an invariant value equal to square rooted reciprocal of the constant:

$$c = dz/dt = \sqrt{1/\mu\varepsilon} \ [(\mathrm{s/m})^2]. \qquad \text{(C-1c-2)}$$

・D is expressed with radiation vector diverging from a positively charged source in all directions or retro-radiation vector converging to negatively charged source; besides, it has a function only with respect to time variable t and space variable z on a surface bundling electric lines of action below.

$$D \ [\mathrm{As/m^2}] = [\mathrm{N/m/V}]. \qquad \text{(C-2a-1)}$$

So, D with per unit of a spherical surface radiated from a source charged with $Q(e)$ [As] and with radius $R(e)$ far from the center in all directions. So that, we can get D passing through a surface bundling lines of action radiated from a sphere with charge $Q(e)$ [As], having a function with respect to space variable z and variable time t below.

$$D = Q(e)/4\pi\,(R(e))^2 \ [\mathrm{As/m^2} = \mathrm{N/m/V}]. \qquad \text{(C-2a-2)}$$

・B passing through a surface bundling rotational lines of action radiated from P magnetically charged front interface to N magnetically charged rear interface, which the interface generates by a current coil or coils around the torus, having a function with respect to space variable z and variable time t below [24].

$$B = \mu Ie/2\pi\,(R(e))^2\ [\mathrm{Vs/m^2 = N/m/A}], \tag{C-2b}$$

where Ie is defined as an electric current flowing in the coil or those coils, and a straight line current [A]. μ is invariable permeability. So, μIe has unit of magnetic charge per unit meter [Vs/m] or Newton per unit meter [N/A]. $R(m)$ is a major radius of a closed-loop along a center of the horn torus equal to minor radius.

・An electrically charged object or the other object induced from the other charge is defined as density $\phi(e)$:

$$\phi(e)\text{: } [\mathrm{As/m^2 = N/m/V}]. \tag{C-3b-1}$$

・So, an electric elemental linear current density $L(e)$ is defined as

$$L(e) = c\phi(e)\text{: } [\mathrm{A/m = N/s/V}]. \tag{C-3b-2}$$

・Electric current field flux density $\phi(I)$:

$$\phi(I) = \rho(Ne)v(e)\ [\mathrm{A/m^2 = N/m/s/V}], \tag{C-4a-1}$$

where $v(e)$ is a velocity [m/s] for an elemental electric positively charged sphere to travel along on an axis. $\rho(Ne)$ means an electric volumetric density per unit volume product of a space interval and a surface passing through bundling lines of action on an axis $[\mathrm{Vs/m^3}]$.

・Spatial electric current flux continuity density $\phi(s\text{-}I)$ is defined as below.

$$\phi(s\text{-}I) = c\,\partial D/\partial z = -\varepsilon c\,\partial B/\partial t\ [\mathrm{A/m^2 = N/m/s/V}]. \tag{C-4a-2}$$

・Spatial magnetic voltage flux continuity density $\phi(s\text{-}V)$ is defined as below.

$$\phi(s\text{-}V) = c\,\partial B/\partial z = -\mu c\,\partial D/\partial t \ [\mathrm{V/m^2} = \mathrm{N/m/A/s}]. \qquad \text{(C-4a-3)}$$

・ Electromagnetic momentum density only on z axis, which is defined as a vector product of D and B:

$$\rho(M)\mathbf{k} = D\mathbf{i} \times B\mathbf{j} \ [\mathrm{Js/m^4}] = [\mathrm{Ns/m^3}]. \qquad \text{(C-5a)}$$

The scalar equation is below.

$$\rho(M) = DB[\mathrm{Js/m^4}] = [\mathrm{Ns/m^3}]. \qquad \text{(C-5b)}$$

・Electromagnetic Planck factor h is defined as below.

$$h = \int dh = \int DBdxdydz \ [\mathrm{Js}]. \qquad \text{(C-6a)}$$

DB is constant for electromagnetic momentum in equation (C-4b) conserves in detail later, so that

$$h = \int dh = DB\delta z \ [\mathrm{Js}], \qquad \text{(C-6b)}$$

where, infinitesimal volume: $dV = dxdydz$, for determination of the volume in observing, so that the volume integrating is constant: $V = \int dV$. Space interval: $\delta z = \int dz$, integrating from zero to a space interval δz.

On the other hand, space interval depends on observing methods, so this equation (C-6b) implies an indeterminacy of the electromagnetic Planck factor.

2.1.2. Geometric structure in the MEMEDEs

Geometric structures in the MEMEDEs under those above statements and definitions need two geometric and electromagnetic structures:

In general, electromagnetic geometric structures:

B is on an x - y plane longitudinally passing through for a horn torus with major radius of R [m] far from a center of an axis of z, which is orthogonal to the z axis.

On the other hand, many lines of action radiate from a positively charged sphere on an axis of z, so diverging D on the cubic surface results in bundling lines of action. In reverse, a negatively charged line of action radiates from a negatively charged sphere on the z axis reencounters the positively charged line at an arbitrary sphere making zero charged, when given conversing lines emanated from those zero charge spheres, so D converging lines results in bundling negative lines of action on a cubic surface.

In other words, given diverging D radiated from positively charged spheres set on an axis for light to travel, in reverse, converging D sunk into negatively charged spheres set on the same axis so that both electric flux density balances out at the counterbalancing x - y plane far away from the axis. Moreover, electromagnetic momentum (the M) generates due to a vector product of D on the counterbalancing x - y plane and B in the coaxial torus set on the axis.

It follows that under a uniformity of the cylindrical momentum, electromagnetic derivatives from the momentum, energy, mass, power, force, can go straight ahead, using the self-medium emanated from the source, in vacuum space with no medium.

D emanated from the x - y counterbalancing plane converges to a negatively charged sphere at the center of these horn torus on the z-axis.

Adding the existing Maxwell's equation to terms and concepts:

(A) A set of diverging radiation from a positively charged sphere and converging retro-radiation from negatively charged sphere:

(A-a) A set of divergence and convergence : divergence radiating from an electric positively charged surface in all directions and convergence converging spherically to a negatively charged sphere from all directions.

(A-b) The other set of diverging D in radiating lines of action and converging field flux density in retro-radiating lines of action, the other set of spatial electric current in radiating lines of action and spatial electric current retro-radiating lines of action.

(A-c) A closed-looping circumstance with a major radius in the horn torus helps D and spatial voltage continuity flow in the loop, bundling lots of lines of action along the center with major radius R [m] in the torus.

(B) A structure due to electric divergence and convergence makes up a cubic figure with a radius so that they are inverse proportion to 4π times the radius squared, in the other hand, the magnetic loop due to the torus structure makes up a loop with major radius so that the magnetic is inverse proportion to a circumference with the major radius times 2π.

2.2.1. Each of electromagnetic flux densities, derivations of those other densities, and its indeterminacy

According to electromagnetic text [25], electromagnetic energy density equation is described below.

$$\rho(E) = 1/2\,(D^2/\varepsilon + B^2/\mu)\ [\mathrm{J/m^3} = \mathrm{N/m^2}]. \qquad (2.2.1\text{-}1a)$$

Via multiplying both hands of the above equation by the electromagnetic constant $\varepsilon\mu$, we can define electromagnetic mass density below.

$$\rho(m) = 1/2\,(\mu D^2 + \varepsilon B^2)\ [\mathrm{VAs^3/m^5} = \mathrm{kg/m^3}]. \qquad (2.2.1\text{-}1b)$$

Multiplying both hands in equation (2.2.1-1a) by the electromagnetic constant $\varepsilon\mu$, we can get an energy equation below.

$$\rho(m) = \varepsilon\mu\rho(E)\ [\mathrm{J/m^3}]. \qquad (2.2.1\text{-}1c\text{-}1)$$

Integrating (2.2.1-1c) equation with respect to infinitesimal volume dV, we can get an electromagnetic energy equation below.

$$m = \varepsilon\mu E \text{ [kg]}. \qquad (2.2.1\text{-}1c\text{-}2)$$

Each of equations (2.2.1-1c-1) and (2.2.1-1c-2) shows that light is never massless [26].

Here, given scalar electromagnetic momentum field flux density defined as (C-5a), partial differentiation of the momentum density subjected to exact differential equation is described below.

$$d\rho(M) = d(DB) = 0 \text{ [Js/m}^4 = \text{Ns/m}^3\text{]}. \qquad (2.2.1\text{-}2)$$

On the other hand, using each of rotation equations derived from one-dimensional Maxwell's equations (2.1.2-3c) and (2.1.2-3d), besides using equation (2.2.1-1a) , we can get an equation below.

$$d\rho(M) = (\partial\rho(E)/\partial z)((dz/dt)^2\mu\varepsilon - 1)dt = 0 \qquad (2.2.1\text{-}3a)$$

and using equation (2.2.1-1b),

$$d\rho(M) = (\partial\rho(m)/\partial z)((dz/dt)^2 - 1/\mu\varepsilon)dt = 0. \qquad (2.2.1\text{-}3b)$$

Under two conditions that equation (2.2.1-3c) comes into effect and EMMFD is subject to exact differential equation, the above-equation (2.2.1-3b) leads that electromagnetic momentum density converses at any time and any place.

It follows that we can get an equation below.

$$(dz/dt)^2\mu\varepsilon = 1, \qquad (2.2.1\text{-}3c)$$

where dz/dt is electromagnetic wave velocity [m/s]. Furthermore, each electromagnetic wave form is described below.

$$D = A(D)\exp(2\pi j\theta)/\sqrt{2}\,, \qquad ((2.2.1\text{-}4a)$$

$$B = A(B)\exp(2\pi j\theta)/\sqrt{2}\,, \qquad (2.2.1\text{-}4b)$$

$$\rho(M) = A(M)\exp(4\pi j\theta)/2\,, \qquad (2.2.1\text{-}4c)$$

$$\theta = ft - kz. \tag{2.2.1-4d}$$

where f: discrete electromagnetic frequency [Nos/s = 1/s], t: time or time interval [s], k: wave number per meter length [Nos/m = 1/m], z: one radiating directional axis or space interval [m], $A(D)$: amplitude of D wave [As/m^2], $A(B)$: amplitude of B wave [Vs/m^2], $A(M)$: amplitude of electromagnetic momentum field flux density wave [Ns/m^3].

Moreover, partial differentiating electromagnetic field flux density wave equation (2.2.1-4c) subjected to the exact differential equation is below.

$$d\rho(M) = 0, \tag{2.2.1-6a}$$

$$\partial\rho(M)/\partial t = -(dz/dt)(\partial\rho(M)/\partial z). \tag{2.2.1-6b}$$

Substituting equation (2.2.1-4c) by (2.2.1-6b), we can get an equation below.

$$f = (dz/dt)k \text{ [1/s]}. \tag{2.2.1-6c}$$

In consequence, using equation (2.2.1-3c), we can get an equation below.

$$(dz/dt)^2 = 1/\mu\varepsilon = (f/k)^2 \text{ [m/s]}^2, \tag{2.2.1-7a}$$

$$dz/dt = \sqrt{1/\mu\varepsilon} = f/k \text{ [m/s]}. \tag{2.2.1-7b}$$

Given invariant permittivity ε and invariant permeability μ, $\mu\varepsilon$ product of them is constant, so that derivative of equation (2.2.1-7a) and (2.2.1-7b), is expressed, respectively.

$$d(dz/dt) = 0, \tag{2.2.1-7c-1}$$

$$d(f/k) = 0. \tag{2.2.1-7c-2}$$

In consequence, the electromagnetic wave speed is constant.

In addition, electromagnetic momentum density is expressed below.

$$d\rho(M) = dM/dV \ [\mathrm{Ns/m^3}]. \tag{2.2.1-8a}$$

Under a postulation that infinitesimal volume can separate infinitesimal area dA and space interval dz for an x - y plane on the area is perfectly orthogonal to an axis on the space interval,

$$d\rho(M) = d\phi(M)/dz \ [\mathrm{Ns/m^3}], \tag{2.2.1-8b-1}$$

where

$$d\phi(M) = dM/dA\,. \tag{2.2.1-8b-2}$$

Momentum field flux density $\phi(M)$ is defined as a derivative form in equation (2.2.1-8b-2) so that the infinitesimal volume dV is expressed as the area times the space interval.

Integrating $d\rho(M)$ and $d\phi(M)$ in the above-equation, as the result of integrating both hands in equation (2.2.1-8b-2) with respect to the volume, we can obtain equation below.

$$\rho(M)dz = \phi(M) \ [\mathrm{Ns/m^2}]. \tag{2.2.1-8c-1}$$

Using $dz = (dz/dt)dt$,

$$\rho(M)(dz/dt)dt = \phi(M) \ [\mathrm{Ns/m^2}], \tag{2.2.1-8c-2}$$

where (dz/dt) is electromagnetic velocity [m/s].

Each of those equations in (2.2.1-8c-1~2) implies, respectively, that product of momentum density and space interval is field flux density. In other words, momentum density in a thought experimental system converts into momentum field flux density in the existing observation system for each of space interval, and time interval disappears in observing.

According to one-dimensional reduction rule in Section 2.2.2 detailed later.

If the same process applies to the field flux density, we will be able to get an equation below.

$$\phi(M)dz = L(M)\ [\mathrm{Ns/m^3}], \tag{2.2.1-8d-1}$$

$$\phi(M)(dz/dt)dt = L(M)\ [\mathrm{Ns/m^3}], \tag{2.2.1-8d-2}$$

where $L(M)$ is linear momentum, dz is space interval on the z axis for light to travel.

What is more, D on the x - z plane and B on the y - z plane in the Cartesian coordinate system, we can describe a derivative of electromagnetic Planck with unit of Js below.

$$dh = DBdxdydzdz = DBdVdz\ [\mathrm{Js}], \tag{2.2.1-9a}$$

where

$$dV = dxdydz. \tag{2.2.1-9b}$$

Integrating equation (2.2.1-9a) with respect to the infinitesimal volume in equation (2.2.1-9b),

$$h = Mdz\ [\mathrm{Js}], \tag{2.2.1-9c}$$

where h is defined as an electromagnetic Planck factor [Js], which means a unit of a line of momentum action with a discrete frequency in an electromagnetic wave. M is electromagnetic momentum [Ns].

Furthermore, h is expressed as exact differential equation form,

$$\partial h/\partial t = -(dz/dt)(\partial h/\partial z)\ [\mathrm{J}]. \tag{2.2.1-10a}$$

h is expressed as wave form below.

$$h = A(h)\exp(4\pi j\theta). \tag{2.2.1-10b}$$

Substituting the above equation for equation (2.2.1-10a), using equation

(2.2.1-1c-2), we can get an electromagnetic energy equation per unit discrete frequency below.

$$E = m/\varepsilon\mu = hf = hk(dz/dt) \text{ [J]}. \qquad (2.2.1\text{-}10c\text{-}1)$$

In bundling momentum lines with discrete frequency, we can express total electromagnetic energy with N frequency numbers as below.

$$E = Nhf \text{ [J]}, \qquad (2.2.1\text{-}10c\text{-}2)$$

where N is a number of the frequency.

Moreover, in the one-dimensional MEMEDEs, each D and B is described as an exact differential equation with respect to space interval z and time interval t, so that they can describe as below.

$$(1/\varepsilon)\,\partial D/\partial t = \partial B/\partial z \text{ for } dD = 0, \qquad (2.2.1\text{-}11a)$$

$$(1/\mu)\,\partial B/\partial t = \partial D/\partial z \text{ for } dB = 0. \qquad (2.2.1\text{-}11b)$$

D is subject to exact differential equation, so that $dD = 0$, so that,

$$\partial D/\partial t = -(dz/dt)\,\partial D/\partial z\,. \qquad (2.2.1\text{-}12a)$$

On the other hand, replacing right hand of the above equation $\partial D/\partial z = -\varepsilon\,\partial B/\partial t$ in Maxwell's equations, arranging them,

$$\partial D/\partial z = \varepsilon(dz/dt)\,\partial B/\partial t\,. \qquad (2.2.1\text{-}12b)$$

So that, comparing both hands in the above-equation for the same partial differential equation with respect to time variable, we can get an equation below.

$$D = \varepsilon(dz/dt)B. \qquad (2.2.1\text{-}12c)$$

Similarly, using each equation $dB = 0$ and $\partial B/\partial z = -\mu\,\partial D/\partial t$, we can get an equation below.

$$B = \mu(dz/dt)D. \qquad (2.2.1\text{-}12d)$$

Comparing equation (2.2.1-12c) and (2.2.1-12d), we can obtain the velocity equation below.

$$(dz/dt) = B/(\mu D) = D/(\varepsilon B). \qquad (2.2.1\text{-}13a)$$

Arranging the above equation,

$$D^2 = \varepsilon B^2. \qquad (2.2.1\text{-}13b)$$

Inserting this equation into the electromagnetic mass density equation (2.2.1-1b) and energy equation (2.2.1-1a), we can get an equation below, respectively.

$$\rho(M) = \mu D^2 = \varepsilon B^2, \qquad (2.2.1\text{-}14)$$

$$\rho(E) = D^2/\varepsilon = B^2/\mu. \qquad (2.2.1\text{-}15)$$

Multiplying both hands in equation (2.2.1-15) by electromagnetic constant $\varepsilon\mu$, as previously obtained equation (2.2.1-1c-1), we can get an electromagnetic energy-mass equation below.

$$\rho(m) = \varepsilon\mu\rho(E). \qquad (2.2.1\text{-}16)$$

2.2.2. One-dimensional reduction actual rule under the electromagnetic indeterminacy

Each equation (2.2.1-8c-1), (2.2.1-8d-1) and (2.2.1-9c) has a form multiplying their terms by one-dimensional space interval on an axis.

So, a postulation proposed a one-dimensional reduction rule for those electromagnetic continuities so that the continuity is subject to the linear indeterminacy of space interval disappearing in observing.

In other words, this postulation means that there is an observing object terms in the MEMEDEs, they make one-dimension lower so that each of the object terms is subject to electromagnetic indeterminacy.

This electromagnetic indeterminacy is called the indeterminacy hereafter.

Each electromagnetic continuity term is subject to indeterminacy so that volumetric density, flux and liner density lowers one-dimension, and we can obtain each of the equations, respectively.

Each electromagnetic momentum, mass, energy, power, and force continuity field flux density with the disappearance of space interval in observing is expressed as below.

$$\rho(M)\ [\mathrm{Ns/m^3}] \rightarrow \phi(M)\ [\mathrm{Ns/m^2}], \tag{2.2.2-a}$$

$$\rho(m)\ [\mathrm{kg/m^3}] \rightarrow \phi(m)\ [\mathrm{kg/m^2}], \tag{2.2.2-b}$$

$$\rho(E)\ [\mathrm{Ns/m^3}] \rightarrow \phi(E)\ [\mathrm{Ns/m^2}], \tag{2.2.2-c}$$

$$\rho(F)\ [\mathrm{Ns/m^3}] \rightarrow \phi(F)\ [\mathrm{Ns/m^2}]. \tag{2.2.2-d}$$

Moreover, we get a conversion equation from the Planck factor to electromagnetic momentum below.

$$h\ [\mathrm{Js}] \rightarrow M\ [\mathrm{Ns}]. \tag{2.2.2-e}$$

Each electric current and voltage continuity leads to the one-dimension reduction rule due to the determinacy.

Elemental electric current object per unit observation:

$$q(e)\ [\mathrm{As/m^3}] \rightarrow \phi(e)\ [\mathrm{As/m^2} = \mathrm{N/V/m}], \tag{2.2.2-f}$$

$$\phi(e)\ [\mathrm{As/m^2}] \rightarrow L(Ie)\ [\mathrm{A/m} = \mathrm{N/s/V}]. \tag{2.2.2-g}$$

Electromagnetic electric current flux continuity and voltage continuity object per unit observation:

$$J(Ie) = N\rho(e)v(e)\ [\mathrm{A/m^2}] \rightarrow L(Ie) = N\phi(e)v(e)\ [\mathrm{A/m} = \mathrm{N/Vs}]. \tag{2.2.2-h}$$

Spatial electric current continuity and voltage continuity object per unit observation:

$$-(1/\varepsilon\mu)\,\partial D/\partial z = (1/\mu)\,\partial B/\partial t = \phi(I(s\text{-}e))\ [\mathrm{A/m^2}]$$

$$\rightarrow L(I(s\text{-}e))\ [\mathrm{A/m} = \mathrm{N/Vs}], \tag{2.2.2-i}$$

$$-(1/\varepsilon\mu)\,\partial B/\partial z = (1/\varepsilon)\,\partial D/\partial t = \phi(I(s\text{-}V))$$

$$\rightarrow L(I(s\text{-}V))\ [\mathrm{V/m = N/As}]. \quad (2.2.2\text{-j})$$

2.2.3. Electromagnetic force equations and the other derivations

2.2.3.1. Objects generated electric and MFFD

Case 1. Elemental objects:

Elemental linear charged object:

$$q(e)/\varepsilon\ [\mathrm{V/m}]. \quad (2.2.3.1\text{-o-a})$$

Current continuity object:

$$L(I(e))\ [\mathrm{A/m}]. \quad (2.2.3.1\text{-o-b})$$

Spatial current continuity object:

$$L(I(s\text{-}e))\ [\mathrm{A/m}]. \quad (2.2.3.1\text{-o-c})$$

Spatial voltage continuity object:

$$L(I(s\text{-}V))\ [\mathrm{V/m}]. \quad (2.2.3.1\text{-o-d})$$

Case 2. Electric and magnetic flux densities generated from various objects

Using electric field flux densities induced as density per unit spherical surface passing through bundling lines of action generated by radiating from the elemental charge $Q(e)$ in equation (2.2.3.1-1a) below.

$$D = Q(e)\big/4\pi(R(e))^2\ [\mathrm{As/m^2 = N/m/V}]. \quad (2.2.3\text{-f-a})$$

Furthermore, B generated from voltage continuity and spatial continuity, respectively, is below.

$$B = \mu I(e)/2\pi(R(m))\ [\mathrm{Vs/m^2 = N/m/A}], \quad (2.2.3\text{-f-b})$$

$$B = \mu I(s\text{-}e)/2\pi(R(m))\ [\mathrm{Vs/m^2 = N/m/A}]. \quad (2.2.3\text{-f-c})$$

Case 3. D emanated from spatial voltage continuity

The analogy to capacitance with positive and negative charged plate, and a zero charged boundary with an interface surface canceling out their charge effects inside the capacitance, so the diverging D emanates from positively charged surface to the interface surface with zero charge, on the other hand, the converging D emanates from negatively charged surface to the interface end.

From another standpoint on bundling lines of action of electric flux density, their lines constitute a circuit connecting both the diverging point and the converging point set on an axis so that those diverging and converging lines can emanate the clockwise and anticlockwise B, respectively.

In consequence, standing on the above-stated points, inserting the density from equation (2.2.3-fb) into equation (2.2.1-12c), using $(dz/dt) = c$, we can get D equations below.

$$D = I(e)/2\pi(R(m)c)\ [\mathrm{As/m^2} = \mathrm{N/m/A}], \qquad (2.2.3\text{-f-d})$$

$$D = I(s\text{-}e)/2\pi(R(m)c)\ [\mathrm{As/m^2} = \mathrm{N/m/A}]. \qquad (2.2.3\text{-f-e})$$

Case4. The B emanated from spatial magnetic continuity is below.

$$B = \mu L(I(s\text{-}V))/2\pi(R(m))\ [\mathrm{Vs/m^2} = \mathrm{N/A}]. \qquad (2.2.3\text{-f-g})$$

Here, preparative both of objects and fields finished, so that we can get electromagnetic force equations through those interactions between electric object and each of magnetic density fields and between voltage continuity object and generates linear electromagnetic forces below.

(1) Elemental force due to equation (2.2.3.1-o-a)

Electric linear elemental field flux density force

$$= (q(e)/\varepsilon)\cdot D\ [\mathrm{N/m^2}]. \qquad (2.2.3\text{-F-a})$$

(2) Electric linear continuous flux force density per unit meter

squared on an axis with unit vector $\mathbf{k}$ in the Cartesian coordinate system.

Linear current flux force density

$$\mathbf{k} = I(e)\mathbf{i} \times B\mathbf{j} = L(I(e))B\mathbf{k}\ [\mathrm{N/m^2}]. \qquad (2.2.3\text{-F-b})$$

Electric spatial linear flux force density

$$\mathbf{k} = I(s\text{-}e)\mathbf{i} \times B\mathbf{j} = L(I(s\text{-}e))B\mathbf{k}\ [\mathrm{N/m^2}]. \qquad (2.2.3\text{-F-c})$$

Magnetic spatial linear flux force density

$$\mathbf{k} = L(I(s\text{-}V))\mathbf{j} \times D\mathbf{i} = -L(I(s\text{-}V))D\mathbf{k}\ [\mathrm{N/m^2}]. \qquad (2.2.3\text{-F-d})$$

Now, among the most important are equations, linear flux force density in equation (2.2.3-F-a) is the well-known empirical Coulomb law is expressed below.

$$F(\text{Coulomb}) = (q(e)/\varepsilon) \cdot Q(e)/4\pi(R(e))^2\ [\mathrm{N/m^2}], \qquad (2.2.3\text{-}1)$$

where vector sign is omitted for one-dimensional flux force density.

Besides, an interaction between electric current continuity object in equation (2.2.2-j) and MFFD in equation (2.2.3-2b), linear flux force density is expressed below.

$$F(\text{current}) = Ie(L(\mu Ie))/(2\pi R(m))\ [\mathrm{N/m^2}], \qquad (2.2.3\text{-}2)$$

where $L(Ie)$ is a linear current object [A/m], $L(\mu Ie)$ is linear magnetic density [Vs/m].

Above equations are different from the well-known empirical Lorentz law with a unit of volume for the law is an interaction between MFFDs and a charged point with no size that most physicists like a point with no size.

Furthermore, an interaction between spatial current continuity object in equation (2.2.3.1-o-d) and MFFD in equation (2.2.3.1-f-c), the new interacting force between spatial voltages is expressed below.

$$F(\text{spatial force})$$

$$= -\mu L(I(s\text{-}V))L(\text{anti-}I(s\text{-}V))/2\pi R(m)\ [\text{N/m}^2], \tag{2.2.3-3}$$

where $L(I(s\text{-}V))$ is spatial voltage flux continuity along a clockwise looping circuit path. $L(\text{anti-}I(s\text{-}V))$ is spatial voltage flux continuity along an anticlockwise looping circuit path.

This above equation with negative sign as propulsive force plays an important role in a substructure of light is detailed later.

2.2.4. Conservation law in each wave of electromagnetic momentum, energy, mass and force density

Under conditions that each term describes with root mean squared, we can get each equation below.

The D wave form:

$$D = A(D)\exp(2\pi j(ft - kz))/\sqrt{2}\ [\text{As/m}^2]. \tag{2.2.4-1a}$$

The B wave form:

$$B = A(B)\exp(2\pi j(ft - kz))/\sqrt{2}\ [\text{Vs/m}^2]. \tag{2.2.4-1b}$$

Manifest momentum density wave form:

$$M(\rho(M)) = A(M)\exp(4\pi j((ft - kz) + j\pi))/2\ [\text{Ns/m}^3], \tag{2.2.4-1c}$$

where *manifest* means directly observable waveform, each of $A(D)$, $A(B)$ and $A(M)$ is amplitude in wave forms, respectively.

On the other hand, D wave form out of phase $\pi/2$ is

$$D = A(D)\exp(2\pi j((ft - kz) + j\pi/2))/\sqrt{2}\ [\text{As/m}^2]. \tag{2.2.4-2a}$$

Besides, B wave form out of phase $\pi/2$ is below.

$$B = A(B)\exp(2\pi j((ft - kz) + j\pi/2))/\sqrt{2}\ [\mathrm{As/m^2}]. \qquad (2.2.4\text{-}2b)$$

Potential momentum density wave form is below.

$$P(\rho(M)) = A(M)\exp(4\pi j((ft - kz) + j\pi))/2\ [\mathrm{Ns/m^3}]. \qquad (2.2.4\text{-}2c)$$

where $P(\ )$ function, the potential term means entity unable to be directly observable.

Total (M) is defined as an addition of the manifest momentum density wave and the potential momentum density wave is described as below.

$$\text{Total }(M) = M(M) + P(M)$$

$$= A(M)\exp(4\pi j(ft - kz))(1 + \exp(+j\pi)) = 0\ [\mathrm{Ns/m^3}]. \qquad (2.2.4\text{-}3c1)$$

Furthermore, in equation (2.2.1-4c), given $\rho(M)$ is defined as a one-dimensional wave function of $g(t, z)$ with respect to space variable z and time variable t below

$$\partial(\partial g(t, z)/\partial t)/\partial t = (dz/dt)^2\, \partial(\partial f(t, z)/\partial z)/\partial z. \qquad (2.2.4\text{-}3c2)$$

Next, inserting $\rho(M)$ into the wave function in the above equation below, we can get a momentum density wave function below.

$$\partial(\partial \rho(M)/\partial t)/\partial t = (f/k)^2\, \partial(\partial \rho(M)/\partial z)/\partial z. \qquad (2.2.4\text{-}3c3)$$

According to equation ((2.2.1-7b), the speed of light is equal to $f/k = dz/dt$, so that electromagnetic momentum density can travel at the speed of light.

In consequence, when we replace each waveform of momentum, mass, energy, power, and force density into the equation (2.2.4-3c2) wave function $g(t, z)$, from the result, we will know an implication that each wave with a discrete frequency in equation (2.2.4-3c3) can concurrently travel at the speed of light.

2.3. Light's properties in the MEMEDEs

According to the cause of the above statements, light can travel at the speed of light by measures of the self-medium in the cosmic space, so light is defined as a continuity having a property of full-spectrum beyond visible spectrum.

Here, a substructure of the light is proposed below.

(a) D diverges from a positively charged sphere on an axis of z at a midpoint of the horn torus for a clockwise looping, which gets at an end point for transforming from the diverging to converging density. The diverging D emanated from the sphere gets at a negatively charged sphere on the z axis at the other midpoint of an anticlockwise looping in the horn torus with space interval to each other. Through the postulate, we will be able to observe that two spiral waves. So that when given left-handed and right-handed circularly polarized electromagnetic wave, they generate both a vector product of clockwise spatial B and radial diverging D, the other interrelation between anticlockwise spatial B and converging D on the radial direction, respectively.

2.3.1. Light's geometric substructure

It is reported that a beam of light can also be rotating around its own axis [27].

So, a postulation is proposed that light beam continuity means a beam continuity beaded with a connection between tori according a looping magnetic path and at whose center allocates on an axis for light to travel.

Wrap-up of one dimensional expression of the duality of the light is re-described as follows.

$$\rho(M) = DB \ [\text{Ns/m}^3], \qquad \text{(C-5a)}$$

$$\rho(E) = (1/2)(D^2/\varepsilon + B^2/\mu)\ [\mathrm{J/m^3}], \tag{2.2.1-1a}$$

$$\rho(m) = (1/2)(\mu D^2 + \varepsilon B^2)\ [\mathrm{kg/m^3}], \tag{2.2.1-1b}$$

$$\rho(m) = \varepsilon\mu\rho(E), \tag{2.2.1-1c-1}$$

$$m = \varepsilon\mu E\ [\mathrm{kg}], \tag{2.2.1-1c-2}$$

$$dz/dt = 1/\sqrt{\mu\varepsilon}\ [\mathrm{m/s}]. \tag{2.2.1-7a}$$

Applying the one-dimensional reduction rule to the density in equation (C-5a), so the EMMFD is described as a wave function form below.

$$\phi(M) = A(M)\exp(4\pi j\theta)/2\ [\mathrm{Ns/m^2}]. \tag{2.3.1-1a}$$

This equation is expressed as a longitudinal wave function with respect to space variable z and time variable t. Furthermore, the light with the duality in full-spectrum under a postulation that the light uses the self-medium obtained from a source of the light in free space with no external medium, so the postulation derives lots of unique properties:

(a) to travel at the speed of light due to equation (2.2.2-3c).

(b) to travel in a straight line due to only on the z axis to travel due to one-dimensional Maxwell's equations.

(c) Electromagnetic momentum conserved at any point and at any time for being able to describe as the exact differential equation concerning equations (2.2.1-3b) and (2.2.1-3c), so that each of electromagnetic momentum, mass, energy, power, and force converses through the same process, respectively.

(d) The light must have a property of both progressive waves to travel along a progressive way and retrogressive waves to travel along a retrogressive way to make a closed-loop circuit [28] like the well-known practical radio radiation antenna system with both antennae isolated from earth and the earth.

(e) Electrically neutral entity regarded light as linearity neutralized closely positioning due to each of charged spheres equal to electric charge located on an axis to travel, reported an electrically charged photon [29].

(f) Left-handed and right-handed circularly-polarized duality [30] and longitudinally polarized light [31], [32].

For those properties, geometric light substructures propose:

(2.3-A) The B is on an x - y plane orthogonal to the z axis, longitudinally passing through for the horn torus with a major radius of R [m] far from a center of the z axis, on which lines up at a space-interval of d [m] behind one another in turn. Besides, each of the densities is specified as the magnetic x - y plane looping clockwise direction or anticlockwise, so that B can loop on either plane.

(2.3-B) Furthermore, each of the other magnetic x - y planes lines up on the z axis at a space-interval of d [m] behind one another.

On the other hand, each of radial electric field flux densities with space variable z and time variable, diverges from a positively charged sphere on the z axis and converses to negatively charged sphere with the equal charged amount on the same z axis with their interval of d [m]. So that, D on its x - y mid plane placed at a half distance between the horn tori balances out a positively charged effect with its negative effect.

In consequence, their densities on the mid x - y plane result in zero with counter balancing due to an equivalence of positive and negative effects.

(2.3-C) As a whole of effects mentioned above, light is defined as a beam per unit surface passing through bundling a line of action with a discrete frequency on z axis at a center of the self-medium in the Cartesian coordinate, so that the light can travel in vacuum space with no external medium and the electromagnetic constant.

Therefore, new one-dimensional Maxwell's equations with space variable z and time variable t are expressed as follows.

(2.3-C-1) A center axis in the self-medium is an axis of z with a unit vector $\mathbf{k}$, which helps light travel at the speed of light on the z axis.

$\mathbf{k}$ is a progressive directional unit vector on an axis of z.

$\mathbf{b}$ is a unit vector rotating along a clockwise closed-loop on an x - y plane orthogonal to the z axis at a center of horn torus with major radius of R meter.

$\mathbf{r}$ is a radial vector unit diverging from a positively charged sphere on the z axis, and $-\mathbf{r}$ is a radial vector unit converging vector sunk to a negatively charged sphere on the z axis.

d is a distance between those planes.

(2.3-C-2) A postulation of neutral due to each positively and negatively charged sphere placed on the z axis is that light seems to be neutral as a far view for a consequence of neutralizing positive and negative charge equal to the positive charge amount, in line with a rule of equally-spaced intervals made alternation array on the z axis.

(2.3-C-3) Each looping B [Ns/m/A] and D [Ns/m/V] has a function of space variable z and time variable t, so the light has the electromagnetic momentum generated from vector product of B and D, so the electromagnetic momentum field flux density is given below.

$$D\mathbf{r} \times B\mathbf{b} = DB\mathbf{k} \ [\mathrm{Ns/m^3}]. \qquad (2.3.1\text{-}1b)$$

Under a postulation that free space has a property of electrically and magnetically neutral medium with vacuum permittivity and permeability, we can get a one dimensional Maxwell's equations concerning spatial current flux continuity below.

$$-\partial D/\partial t = J(s\text{-}A) = \varepsilon\partial B/\partial z \ [\text{A/m}^2 = \text{N/V/m/s} = \text{Ns/V/(m/s}^2)], \quad (2.3.1\text{-}2)$$

where $J(s\text{-}A)$ is spatial current flux continuity.

On the other hand, we can get a one-dimensional Maxwell's equations below spatial voltage flux continuity below.

$$-\partial B/\partial t = J(s\text{-}V) = \mu\partial D/\partial z \ [\text{V/m}^2 = \text{N/A/m/s} = \text{Ns/A/(m/s}^2)], \quad (2.3.1\text{-}3)$$

where $J(s\text{-}V)$ is spatial voltage flux continuity.

2.3.2. Longitudinal progressive and transverse standing waves duality

We know that shuttled waves become standing waves unable to carry the energy and the momentum. However, on the other hand, according to the previous statement, electromagnetic waves must have a return path or distributing paths of retrogressive waves for making a closed-loop circuit. Therefore, an idea for light to carry electromagnetic energy and momentum will contact reality for longitudinal electromagnetic waves to carry them through those tori longitudinally vibrating like sonic waves in the air, rather than the transverse waves.

3. Conclusions

Various electromagnetic forces are derived from MEMEDEs, so the purpose is achieved through the MEMEDEs. However many postulations assumed in the MEMEDEs must be validated by relevant actual observations. Those postulations will solve or shed light on many issues left unsolved for a long time.

Besides, the existing Lorentz force constitutes of a point with electrically charge density per unit volume despite the point particle being dimensionless [33], an electric field with unit [V/m], and a magnetic field with magnetic flux density $[\text{Vs/m}^2]$, which has a unit of per unit volume [34]. In this paper, new proposed electromagnetic force constitutes of the charge density per unit surface, an electric flux density with unit $[\mathrm{Vs/m^2}]$ and a magnetic field with magnetic flux density $[\mathrm{Vs/m^2}]$, which has a unit of per unit surface, per unit meter squared. The existing Lorentz force per unit volume is different from this force flux density field which means a field imposed by a force density per unit surface passing through bundling lines of force action for object. Consequently, all fields unify the same form so that each field acts on an object through a field imposed by a force density per unit surface passing through bundling lines of action. Thus, the electric field acts on the magnetic object, and the magnetic field acts on the electric object. Moreover, the electromagnetic field acts on the electromagnetic object.

3.1. Derivation of the electromagnetic mass conflicting with the existing mechanical particle system

The existing mechanical system of a particle with no size has stood a position regarded light as massless particle for a long time [35].

However, according to a derivation that the speed of light squared is described as reciprocal electromagnetic constant $\mu\varepsilon$, so that, using equation (C-1c) and (2.2.1-7b) of the speed of light, Lorentz factor β [36] in the Lorentz transformation is expressed as below.

$$\beta = \mu\varepsilon(v)^2 = (v(k/f))^2, \tag{3-1}$$

where v is a velocity [m/s] of a mechanically isolated particle in vacuum space allowed to travel like a bullet.

$\mu\varepsilon$ is electromagnetic constant in vacuum space noted earlier, reciprocal of the speed of light square rooted.

Besides, $\sqrt{f/k}$ is the speed of the electromagnetic mass, momentum, energy and force.

So, equation (3-1) implies that electromagnetic continuity entity with size is unable to regard as a particle with no size in a mechanical system for the electromagnetic constant is the property in vacuum space and electromagnetic continuity beam has a property of electromagnetic mass density and mass proven in equation (2.2.1-1c-1) and (2.2.1-1c-2).

Consequently, the point particle system [37] is mutually exclusive to the above-stated efforts. The reason is assumed that those results conflict with modern physics [38] based on a particle regarded light as no mass.

This paper does not aim to discuss conflicts between the point particle systems. Therefore, most electricians do not need to argue with them beyond the electromagnetic field, so that most physicists who believe light particle should solve contradictions.

More is the pity, to this date, the continuous linear property of light has never taken root in general. However, a source with a closed-loop circuit radiates the electromagnetic waves discovered by Heinrich Rudolf Hertz after a theory of electromagnetism developed by James Clerk Maxwell by 1873 [39], so it is unbelievable that most people believe a particle entity of light.

3.2. Wrap-up fruitages

A. The substructure of light:

(Aa) The repulsive force between clockwise spatial voltage continuity in a torus and anti-clockwise voltage continuity in the other torus gives a force pushing out from the source. On the other hand, attractive Coulomb force between positive and negative charge sphere on the same axis.

So, residual repulsive force subtracted the attractive force from the repulsive force generates propulsive force for light to advance on the axis.

(Ab) By subsequent repulsive force on the z axis for light to travel, a front torus on the z axis is pushed out from the subsequent rear torus by mutual repulsive spatial force equation (2.2.3-3).

(Ac) When given the circular magnetic flux density *B***b** in a torus's center located on an axis for light to travel, and a radiator constituted by electric radially diverging and converging flux density *D***r** by electrically charged sphere, electromagnetic momentum *M***k** product of the vector *B***b** and the vector *D***r** forms into a momentum ring for light to travel, so the ring makes the projectile going straight ahead in the self-medium for a coaxial uniformity of the momentum in the torus. So, the momentum keeps in the self-medium, the derivatives of the momentum, that is, the electromagnetic mass, momentum, energy, power, and force can travel on only one axis.

(Ad) Left/right-handed circularly-polarization duality.

Interaction between torus longitudinal wave and clockwise spatial magnetic voltage continuity in the torus will generate right-handed circularly-polarization. The other interaction between the other longitudinal wave and anti-clockwise spatial magnetic voltage continuity will generate left-handed circularly-polarization.

The detailed specifications will make open later.

B. Various force flux density fields:

(Ba) Each of various force flux density fields acts on the object.

(Bb) Coulomb static force between static elemental electric object and electric flux density.

(Bc) The static force between the current line and magnetic flux density.

(Bd) The static force between spatial current and magnetic flux density, and static force between electric current lines.

(Be) The static force between spatial voltage continuity and electric flux density.

(Bf) The static force between spatial voltage continuities.

C. Electromagnetic indeterminacy:

We know that we cannot pick up a part of a wave in a cycle so that the indeterminacy will control the wave. Besides, we know that a photon deterministically interacts with an atom [40]. So, these interactions will have no other choice that there is not a photon like mechanical particle, and an observable property of the photon depends on these interactions subject to the indeterminacy.

D. Conservation law that electromagnetic mass, momentum, energy, power, and force conserve at any time and any place.

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