Classical Estimations of Mass of a Solar Radiant Beam with Full-spectrum and Electromagnetic Thermal Constant in an Ideal Gas

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Abstract

This paper, using a self-medium with field for light and the medium to travel concurrently at the speed of light in free space without the other media, proposed by Ohki's papers in viXra and ResearchGate, proposes whether or not new electromagnetic thermal constant in an ideal photon gas law is different to the existing Boltzmann constant k(B) in mechanical particle system. Besides, when given a solar radiant volume filled up electromagnetic mass passing through at the speed of light, this paper shows an estimation of a beam bungle mass passing in the volume product of a solar radiant surface and radiant length of 1 m on a surface of the Sun.

When given an ideal photon gas law that constitutes of the volume V uniformed with lots of cells equipartitioned with temperature T, N number of photons and internal pressure P in the volume, new electromagnetic thermal invariant constant b proportional to product of the temperature and the number, variable with respect to z on an radiant axis is each volume V, temperature T, pressure P, and a set product of number N and the temperature T times b, so that we can estimate the constant b and the mass.

Moreover, on the basis of 4 significant-digits arithmetic, given two volumes are: One solar radiant volume locates on solar surface of the Sun, the other volume locates on satellite over earth so that we can get only solar surface temperature T(s) with 4 digits and a radiant power flux density ϕ(We) on radiant surface the satellite, respectively.

Under those above-mentioned conditions, when applying an ideal photon gas law in dynamic volume for light to pass through the volume, the result of estimation shows a ratio of the constant b to the Boltzmann constant k(B) is surprisingly estimated 99.94%.

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i) Self-funding electric engineer researching derivations theoretically from Maxwell's complex equations on the basis of the Noether's theorem with a complex symmetry, which is constituted due to the imaginary part and the real part rotating out of phase by $j\pi/2$, under an orthogonal respective relationship between complex time axes and complex space axes in absolute complex spacetime with attributes of homogeneity, isotropy, linearity, differential continuity and electromagnetic invariant product of permittivity and permeability in a self-medium assumed to be equivalent to the so-called free space.

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Besides, we can get a bundle energy divided solar radiant energy passing the volume by the passing number, so that we can get the bundle mass under a postulation that a beam bundle mass m is equal to the bundle energy E times the electromagnetic constant εμ, that is, reciprocal of the speed of light square, m = ε μ E, proposed by Ohki.

Under the postulation, we can get estimate a solar beam bundle mass passing through a radiant surface on the surface of the Sun, given a radiant length of 1 m, is estimated, 2.956E(-45) kg.

Keyword: a self-medium, photon mass, wave-photon-field triplicity, electromagnetic thermal constant, ideal solar photon gas law, cosmic microwave background

Prior to arguments, precaution statement specified in advance, apart from well-known notation convention, to simplify and never to use superscript notation and subscript notation under no specifications to need to describe, to simplify, light is defined as a bunch of bundles integrated over full-spectrum like solar spectrum (hereinafter detailed description), so terms in this paper are defined below, respectively.

<Terms>

(a) Scalar notation for all terms under no need to specify.

(b) If need, using bold sign as unit vector: in ordinary expressions, **i** on an axis of x, **j** on an axis of y and **k** on an axis of z, respectively, most terms are one-dimensional scalar value, so that each bold sign are ruled out in case of no specifications.

They are used as each one-dimensional scalar notation as example: radiant electric flux density D just only on x axis, radiant magnetic flux density B just only on y axis and electromagnetic velocity dz/dt (= c) just only on z axis are, respectively, which their terms are describable as partial continuous differentiable function with respective to independent variables, z, and t.

(c) To avoid using superscript notation and subscript notation and to simplify their notations, both permittivity ε and permeability μ have no suffix naught for this paper discussed only in free space, if need, use ε(0) and μ(0), the other term is described as term using parentheses () or parenthesis.

(d) For the same reason, Quint(x), Quad(x) and Cub(x) mean the fifth, the fourth and the third power of x, respectively, and Sq(x) means x squared and Sqrt(x) means the square rooted of x, and Quadrt (x) means the quad rooted of x, the minus fourth power of x, besides, E(n) means tenth power of n.

(e) End notes are square brackets: [number].

(f) To use easily dimensional analysis [1], with a focus on SI basic units [2], this paper is using specified unit: electric charge [As], magnetic charge [Vs], permittivity [As/Vm], permeability [Vs/Am], radiant electric flux density [As/Sq(m)], radiant magnetic flux density [Vs/Sq(m)], frequency, that is, cycle number per unit time interval [1/s. Nos/s], wave-number, that is, wavenumber per unit space interval [1/m, Nos/m], the others accord with SI base units [3].

(g) According to Ohki's paper in viXra [4], a self-medium is defined as a medium with property of the so-called free space [5], is a medium-field capable for light to travel at the speed of light in the space and allowable for electromagnetic energy and moment, the other of octad (after detailed) to travel concurrently.

(h) Light constitutes of three properties:

(h-1) A beam string constitutes of continuity beaded with an elementary bead unable to chop off for being subjected to the indeterminacy principle [6], however, through observation, we can get the string that depends on the observation time, that is, observation space product of the time and the speed of light for the indeterminacy clears out. Besides, we can get data of those observation space with the probability distribution.

The beam string viewed as the string is defined as light's elemental continuity with a discrete frequency, however, unable to generate the beam subjected to the indeterminacy principle, so that the frequency has probability density function [7]. Besides, we will call the observed beam as a photon unable to be specified the length of the string beam for the indeterminacy disappears.

(h-2) A beam bundle of lots of those strings is defined as a collective entity, a fascicle of lots of beams, so that the string has property of full-spectrum.

(h-3) A beam bunch of lots of those bundles, light's intensity is proportional to those bundles.

(i) A self-medium with orthogonal coordinates that constitutes of x axis allowable an electric flux density, an y axis allowable magnetic flux density, and a radiance z axis for light to travel, that is, has three dimensional axes, and with a focus on a traveling direction, is allowable to one-dimensional Maxwell's equations on the z axis.

Besides, medium falls into two types:

(i-1) The self-medium pushes out from a source of light allowable full-spectrum or one discrete frequency and only as thought experiment in spite of being unallowable for the indeterminacy. So that, through using the medium, the light is able to travel at the speed of light in even though vacuum space with a medium unable to generate electromagnetic fields. It is because the self-medium with rectilinear property [8] has a field property of permittivity and permeability on each axis for light to traverse rectilinearly in free space, the other medium with multi-dimensional properties will interact with the rectilinear medium, so that will diversify the triplicity.

Besides, in the other media, their permittivity and permeability will vary, respectively, become to have a value product of the self-medium permittivity and the relative permittivity, and product of the self-medium permeability and the relative permeability.

(i-2) The other media are medium in space with relative permittivity and relative permeability over than 1.

The above-mentioned each radiant octad carrier (discussed below) having invariant permittivity and permeability together can travel concurrently at the speed of light in vacuum space. So, this paper postulates the self-medium with itself orthogonal complex coordinates independent from geometric coordinates. The invariant permittivity and permeability have a properties of isotropy, homogeneity, linearity, exact differentiable continuity with no hiatus in orthogonal coordinate system, making up a single string with a discrete and coherent frequency, a bundle of the strings integrated over full-spectrum, a bunch of the bundles for expression of intensity of light, respectively. In addition, the self-medium helps radiant octad carriers to travel at the speed of light, radiated from the source.

(j) As substitute for the wave-photon duality, in this paper, triplicity is defined as electromagnetic wave, photon with mass and field travelling at the speed of light in the self-medium, helping the waves and photons travel concurrently at the speed of light.

(k) Radiant octad carriers:

(k-1) radiant electric momentum,

(k-2) radiant magnetic momentum,

(k-3) radiant electromagnetic momentum,

(k-4) radiant electromagnetic mass,

(k-5) radiant electromagnetic energy,

(k-6) radiant electromagnetic force,

(k-7) radiant electromagnetic power,

(k-8) radiant electromagnetic indeterminacy.

All of them are able to travel concurrently at the speed of light in the self-medium, which help the light travel with discrete frequency or full-spectrum generated from a source under no annihilation into any sink.

(l) Radiant electric momentum flux density defined as $(D(x)/\varepsilon)\,\varepsilon\,\mathbf{i}\times\mu\,\mathbf{j} = D\mu\,\mathbf{k}$ [(kgm/s)/Sq(m)] : $\partial(\partial\mu D/\partial z)/\partial t$ means the second partial derivative of μD with respect to independent variable space z in free space with the self-medium and t in time, second partial D by second partial z. This definition of μD is because the self-medium harnesses electric momentum flux density per through-current on an optical ray line, unit of (kgm/s)/Sq(m)/A, in transmission optical ray line analogy to the transmission line theory.

(m) Radiant magnetic momentum flux density defined as $\varepsilon\,\mathbf{i}\times\mathbf{j}\,\mu\,(B(y)/\mu) = \varepsilon\,B\,\mathbf{k}$ [(kgm/s)/Sq(m)]: $\partial(\partial\varepsilon B/\partial z)/\partial z$ means the second partial derivative of ε B with respect to independent variable z in free space with the self-medium and t in time, second partial εB by second partial z. This definition of εB is because the self-medium harnesses as magnetic momentum flux density per across-voltage on an optical ray line, unit of (kgm/s)/Sq(m)/V, in transmission optical ray line analogy to the transmission line theory.

(n) Integral constant is able to be zero through choosing judiciously the point, so constant through the result of integrating will not be described for all terms integrating under no need to specify.

(o) All wave forms stand for root mean square (afterward, if need, uses r.m.s) for getting mechanical energy equivalent to electromagnetic energy on common criterion, respectively, so that electromagnetic wave-photon-field triplicity system will keep equivalent to mechanical particle system on the basis of energy in both systems.

(p) Δt: observable time interval with nonzero, which is on a time axis for the light to travel, which has a unit of [s],

(q) Δz: observable space interval with nonzero, space interval on a space axis for the light to travel, which has a unit of [m].

(r) Δf: observable frequency interval reciprocal of the time interval with nonzero for time interval is nonzero, time number per unit time interval on a time axis for the light to travel, which has a unit of [Nos/s]

(s) Δk: observable wave-number interval reciprocal of the space interval with nonzero, that is, wave number per unit space interval on a space axis for the light to travel, which has a unit of [Nos/m].

(t) Longitudinal [9] and traverse wave duality :

It is postulated that the self-medium helps those carriers to travel at the speed of light in vacuum space with no media, as the well-known longitudinal wave moving in the same direction of travel on an axis through the movements backwards and forwards in the continuity, so that we will be able to observe electromagnetic waves made electromagnetic distortion generating in compressing and expanding the movement through the continuity neutralized electromagnetically. However, our observation of the longitudinal wave will be extremely difficult to observe the longitudinal momentum. So, the self-medium can help both electromagnetic longitudinal and transverse waves to travel in the self-medium without external media.

(u) Indeterminacy principle on electromagnetic radiant axis

Each term on electromagnetic radiant axis is subject to indeterminacy principle on a radiant axis. It is because when given scalar electromagnetic flux ϕ(em) product of electric flux ϕ(ele) and magnetic flux ϕ(mag), each is respectively-observable and the electromagnetic flux is on a radiant axis. However, electromagnetic flux density product of observable electric flux density D on an axis of x and observable magnetic flux density B on an axis of y has a property of indeterminacy described below.

Electromagnetic flux ϕ(em):

$$\phi(em) = \phi(ele) \times \phi(mag) \quad (u\text{-}1)$$
$$= DB\, dVdz \quad (u\text{-}2)$$
$$= DB\, dV(cdt) \quad (u\text{-}3)$$

where

c is the speed of light

Electric flux ϕ(ele): $\phi(ele) = D\, dxdy$ (u-4)

Magnetic flux ϕ(mag): $\phi(mag) = B\, dydz$ (u-5)

Infinitescimal volume: $dV = dxdydz$ (u-6)

$$\Delta z = c\, \Delta t \quad (u\text{-}7)$$

Each the above-mentioned term is observable with the exception of electromagnetic flux density ϕ(em) with space interval, Δz in equation (u-2) and time interval, Δt in equation (u-3).

It follows that we can get a probabilistic electromagnetic flux density ϕ(em) so that the space interval or the time interval depends on observation, subjected to the indeterminacy of space interval or time interval disappears when we observe them.

The indeterminacy principle in EMTS may be equivalent to the well-known uncertainty principle in MPS

(v) Light in this paper is defined as an electromagnetic continuity able to travel radiant octad carriers per a discrete and coherent frequency in pushing out from the light source on the differentiable continuous self-medium field with invariant permittivity and permeability in free (vacuum) orthogonal complex space. Besides, the light has a property of integrating over all ranges from the least upper bound frequency to the least upper bound frequency. However, the light has no divisible infinitescimal element for perfect continuity unable to cut up a piece of itself for indeterminacy assumed to be the uncertainty principle.

(w) The called mass -energy equivalence [10]

According to electromagnetic text [11], electromagnetic energy density equation is $\rho(E) = 0.5((D/\varepsilon)D + (B/\mu)B)$, with that, multiplying both hands in the above-equation by $\varepsilon\mu$, $\varepsilon\mu\rho(E) = 0.5(\mu Sq(D) + \varepsilon Sq(B))$, this term of $\varepsilon\mu\rho(E)$ has unit of kg/Cub(m), so that electromagnetic mass density equation is defined as $\rho(m) = 0.5(\mu\ Sq(D) + \varepsilon Sq(B))$. In consequence, we can apply this ρ(m) as the wave equation function so that ρ(E) has well-known wave function like below.

$$\partial(\partial\, \varepsilon\mu\rho(E)/\partial z)\partial z = \varepsilon\mu\, \partial(\partial\, \varepsilon\mu\rho(E)/\partial t)\partial t \quad (w\text{-}1a)$$
$$\partial(\partial\rho(m)/\partial z)\partial z = \varepsilon\mu\, \partial(\partial\rho(m)/\partial t)\partial t \quad (w\text{-}1b)$$

so that,

$$\rho(m) = \varepsilon\mu\rho(E) \quad (w\text{-}2)$$

Each term of velocity squared in above equation is a reciprocal of invariant electromagnetic constant product of permeability μ and permittivity ε, never the speed of light squared that most physicists want to deal with light as a particle though most electricians do never regard as a particle.

It follows that we can get an equation of relationship between electromagnetic mass and energy :

m = εμ E (w-3)

integrating equation (w-2) with respect to volume variable.

1. Introduction

Most of physicians and opticists are assumed to have a misunderstanding about the displacement current in Maxwell's equation for unknowing knowledge that any current must have either a circuit or more circuits for current-flowing. Besides, the displacement current named by Maxwell [12] as a physician is assumed for the current to flow through continuous actions displacing the famous aether [13] denied by Michelson-Morley experiment, what is more, the displacement current flowing displacing something like the aether medium is current flowing on or in the self-medium with field. Furthermore, if ratio β in the Lorentz factor [14] is correctly described as equation, β = εμ Sq(v), multiplying a particle's velocity squared v and a medium factor of permittivity ε times permeability μ on a wave-function derived from one-dimensional Maxwell's equations. In consequence, a wrong assertion that light has massless will have disappeared so that the Lorentz transformation will be made a correct interpretation of the ratio.

According to Ohki's paper [15], [16], [17], there is an assertion that wave-particle duality should be rewritten electromagnetic wave-photon-field triplicity so that the existing wave-particle duality [18] in Mechanical Particular System (MPS) is entirely-different from an electromagnetic wave-photon-field triplicity system (EMTS) for the triplicity travels concurrently at the speed of light.

The above-mentioned substantial distinctions are three points:

(A) Light defined as a continuity having a property of invisible and visible region in EMTS, can travel in a **complex self-medium** at the speed of light with the medium together**, which** allowed to have both of visible real field and invisible imaginary field conserved electromagnetic energy like potential energy in MPS, subjected to **closed loop circuits** with both paths of progress and regress for the light to travel, in contract, a particle traveling has no property to return.

(B) The light on an axis of z with unit vector **k** can be described as one-dimensional direction vector product of electric flux density D **i** on an axis of x with unit vector **i** and magnetic flux density B **j** on an axis of y with unit vector **j**, so that flux of the light is expressed as one product of a scalar value of electric flux D times magnetic flux B and an infinitescimal space interval dz on a directional axis for the light to travel, subjected to **indeterminant** of either the space interval dz or the time interval, in contract, a particle determinate continuity.

Besides, those indeterminate terms, that is, either space interval or time interval, and either wave number reciprocal of the space or frequency interval reciprocal of the time interval, they disappear in interacting the other, so we can observe a bundle or bunch of string beaded photons as an observing unit, that is, a set of the photons appears in either space real observation or time real observation due to the disappearance of the indeterminant.

Accordingly, using the indeterminate intervals, the speed of light to travel concurrently with the medium is a ratio: Δz/Δt, Δf/ Δk, where Δ z is space interval, Δt is time interval, Δf is cycle-number per unit time interval, and Δk is wave-number per unit space interval, so that the light, subjected to the indeterminacy with both Δf and Δk, generates **a wave-packet** worked as a particle in mechanical particle system. In consequence, the wave-packets in the self-medium with field is workable as light with properties of mass, momentum, and energy.

Moreover, each indeterminacy will accord to Born rule [19], so that we are able to postulate that any observation of the triplicity accords to the probability of occurrence distributions in space, like the description in Ohki's paper in viXra [20].

(C) Furthermore, reciprocal of the speed of light squared is described as an invariable constant product of permittivity ε and permeability μ, 1/εμ, in the self-medium with field, derived from electromagnetic wave equation, so that the speed of light is Sqrt(1/εμ) which means the speed of medium, that is, the self-medium allowed longitudinal [21] and transverse wave duality.

The description of c the speed of light is fallible so that we are subject to misunderstanding to regard light as the particle, however, we can use the speed of light c under conditions given a false impression.

From this time forward, we will have to research a new basic method to bridge with something in a substantial gap between MPS and EMTS on common basic foundations.

It follows that we will be able to discuss with electromagnetic mass, momentum, energy in EMTS.

And thus (there being no alternative in the above-mentioned substantial), an ideal photon gas law [22], with Boltzmann constant is reported previously, however, under those distinctions, there will be no establishment that the Boltzmann constant in MPS can apply to a new electromagnetic thermal constant correspond to the Boltzmann constant in MPS.

Therefore, this paper leads up to the new gas constant in an ideal gas law with new gas constant correspond to the Boltzmann constant in MPS.

2. An ideal gas law in EMTS

2.1 Radiometric terms

2.1.1 Radiant volume V, radiant area, A, radiant length z on a radiant axis orthogonal to the area

Given a volume product of radiant area A and radiant length z on a radiant axis orthogonal to the area in steradian or radian, we can postulate that the variable radiant area A is able to separate from variable space interval z in the volume so that the variable radiant area A is independent from variable space interval z on a radiant axis orthogonal to the area below.

$$dV = dA\, dz \quad (2.1\text{-}1)$$

where

dV: infinitescimal volume

dA: infinitescimal area

dz: infinitescimal space interval

Note. There is a postulation that a radiant area variable A can separate from space variable z in a volume product of the area A and the space z though the area A has a function of variable, z

2.1.2 Radiant energy density and power flux density

In reference to optics text with respect to radiant energy E and power W [23], their radiometric terms are defined as below, respectively.

$$\rho(E) = \partial E/\partial V \quad (2.1.2\text{-}1a)$$

$$\rho(W) = \partial \rho(E)/\partial t \quad (2.1.2\text{-}1b)$$

$$\phi(E) = \partial E/(\partial A\, \partial\omega \cos\theta) = \partial E/(\partial A \partial\omega) \quad (2.1.2\text{-}2a)$$

$$\phi(W) = \partial W/(\partial A\, \partial\omega \cos\theta) = \partial E/(\partial A \partial\omega) \quad (2.1.2\text{-}2b)$$

where

ρ(E): radiant energy density [J/Cub(m)]

ρ(W): radiant power density [W/Cub(m)]

ϕ (W): radiant power density [W/Sq(m)/sr.]

ϕ (E): radiant energy density [W/Sq(m)/sr.]

V: A volume that fills up electromagnetic energy in the self-field, product of radiant length z and a radiant area A on cubic radiant surface through which the solar radiant energy and power pass.

ω: a solid angle subtended by the area on a surface of a given radius R. Solid angles are measured in units of steradian, sr.

$\cos\theta = 1$ for discussing only a radiant axis orthogonal to the area in this paper.

2.1.3 Relationship between the area, the solid angle, and the length

Using the above-definitions, we can get each relationship below.

Reciprocal of steradian ω is described below.

$$1/\omega = Sq(z)/A \ [1/sr.] \quad (2.1.3\text{-}1)$$

Given number N that a bundled beam of light passes through the area per unit second,

$$N = \phi(W)/A \ [Nos] \quad (2.1.3\text{-}2)$$

Multiplying equation (2.2.3-1) and (2.2.3-2), we get equation below.

$$N/\omega = Sq(z)\,\phi(W) \quad (2.1.3\text{-}3a)$$

Given distance d far away from a surface with radius R of the Sun, the radiant power ϕ(E(s)) radiated the surface and the radiant power ϕ(E(e)) measured on a satellite over the Earth, using equation (2.1.3-3a), we can get equation below.

$$N/\omega = Sq(R)\,\phi(W(s)) = Sq(d)\,\phi(W(e)) \quad (2.1.3\text{-}3b)$$

where

ϕ(W(s)) is a solar radiant power flux density.

ϕ(W(e)) is a solar radiant power flux density [24] which observed on a satellite over the Earth.

2.2 Application with the Planck's radiation formula [25]

Using the same derivation process of the formula, and substituting new electromagnetic thermal constant b for the Boltzmann constant k(B) [26] in the formula, we can get solar power flux density equation below.

ϕ (W) = a Quad(bT) [J/Sq(m)] (2.2-1)

where

ϕ (W): Solar power flux density [W/Sq(m)]

a =2Quint(π)/ (15Sq(c)Cub(h)) [1/Cub(J)Sq(m)s] (2.2-1a)

b: new electromagnetic thermal constant comparable to the Boltzmann constant [J/K]

T: Temperature [K], in an electromagnetic thermal cell distributed under equipartition of energy in the volume.

a × Quad(bT): means an elementary energy in a cell equipartitioned in the radiant volume has a function of variable z, so that a size of the cell has a function of variable z, fundamentally different from the existing ideal gas law in static mechanical particle system.

It follows that, using equation (2.2-1), we can get new electromagnetic thermal constant below.

b = Quadrt ((ϕ (W) /a))/T (2.2-2)

Besides, using equation (2.1.3-3), under an example given radiant powers and temperatures in the radiant volume, we can get the electromagnetic thermal constant.

b = Quadrt ((ϕ (W(e)) /a) × Sqrt(d/R)/T(s)) (2.2-3)

we can get observation data, radiant power on the satellite located far away from the surface with radius of the Sun, temperature T(s) on the surface of the Sun.

In consequence, we reach one target for the electromagnetic thermal constant.

2.3 An ideal gas law

2.3.1 An ideal solar gas law in EMTS

When given a beam bundle integrated a string with discrete frequency over full-spectrum and a beam bunch integrated those bundles passing through solar radiant area A, and a radiant volume V product of the area and radiant length z, analogy to well-known equations in an ideal gas law [27], an ideal gas law in EMTS is defined as below.

E= PV = N bT [J] (2.3.1-1a)

E/V= P [N/Sq(m)] (2.3.1-1b)

Using equation above, we can get an ideal solar radiant photon gas equation at a position z far away from a center of the Sun below.

E(z) = P(z)V(z) = N(z) bT(z) (2.3.1-1c)

where

z makes replacement of s term for the Sun, e term for a satellite over the Earth in solar radiant volume, respectively.

E(z) is a solar radiant energy [J], radiating uniformly and uninterrupted-continuously from a cross-sectional surface of solar radiant area A(z) in the volume filled with lots of beam bundles in the self-medium with field.

V(z=s) is a solar radiant volume on a surface of the Sun, unit of [Cub(m)], filled up electromagnetic beam bunches flowing at the speed of light in the self-medium, product of A(s) and a radiant length z(s), unit of meter on an axis for the volume.

P(z=s) is a solar pressure in the volume V(s), unit of [N/Sq(m)], dividing the energy by the volume in an ideal gas law or the energy by the surface.

N(z) is number of bundles [Nos], in EMTS, integrating over full-spectrum in the self-medium.

N(I: z) is total number of beam bunches [Nos], integrating over all of bundles in EMTS, expressed light intensity.

b is invariable electromagnetic thermal constant, defined as the energy per unit number [J/K/Nos], in EMTS, comparable to Boltzmann constant in an ideal gas law in mechanical particle system (MPS).

T(z) is absolute temperature [K], in equipartitioned cell distributed uniformly for producing equable pressure in the volume V(z).

A set of a × Quad(bT), that is, ϕ(W) is a solar radiant cell power located at z position on a radiant axis, and has a function with respect to variable, z.

2.3.2 Solar photon mass density in free space

Using equation (2.3.1-1), we can get a beam bundle energy below.

E(s) /N(s)= bT(s) (2.3.2-1)

According to Ohki's papers in ResearchGate and viXra,

ρ(E) = ρ(m) Sq(c) (2.3.2-2a)

Integrating both hands in equation (2.3.2-2a) with a solar volume filled up lots of beam bundles, we can get equation with respect to solar radiant energy E below.

E = m Sq(c) (2.3.2-2b)

where

m is a beam bundle mass

On the other hand, using equation (2.3.2-1) and (2.3.2-2b), on a surface of the Sun, a relationship between a solar beam bundle energy and mass energy product of beam bundle mass and the speed of light squared, we can get a beam bundle mass below.

$$m\,\mathrm{Sq}(c) = E(s)/N(s) = bT(s) \quad (2.3.2\text{-}3a)$$

$$m = bT(s)/\mathrm{Sq}(c) \quad (2.3.2\text{-}3b)$$

where

m: a beam bundle mass

In a solar radiant volume product of a solar radiant area on the surface of the Sun and a radiant length of 1 m, reciprocal of length traveling at the speed of light in unit second, we can get a beam bundle mass in the volume below.

$$m = bT(s)/\mathrm{Cub}(c) \quad (2.3.2\text{-}3c)$$

2.3.3 Number of bundles in solar volume on the surface of the Sun

Using equation (2.3.1-1a) with respect to an ideal solar photon gas law, dividing radiant energy E in the equation by the radiant area A, we can get radiant energy flux density ϕ(E) below.

$$\phi(E) = E/A\ [\mathrm{J/Sq(m)}] \quad (2.3.3\text{-}1)$$

A radiant energy flux density ϕ(E) with property of exact differential equation is expressed below.

$$d\,\phi(E) = (\partial\phi(E)/\partial t)dt + (\partial\phi(E)/\partial z)dz = 0 \quad (2.3.3\text{-}2a)$$

$$d\,\phi(E) = \phi(W)\,dt + \phi(F)\,dz = 0 \quad (2.3.3\text{-}2b)$$

where

Radiant power flux density:

$$\phi(W) = \partial\phi(E)/\partial t\ [\mathrm{W/sq(m)}] \quad (2.3.3\text{-}2c)$$

Radiant force flux density:

$$\phi(F) = \partial\phi(E)/\partial z\ [\mathrm{N/Sq(m)}] \quad (2.3.3\text{-}2d)$$

Using equation (2.3.3-2b) and c = dz/dt, the speed of light,

$$\partial\phi(E)/\partial z = (-1/c)\,\phi(W) \quad (2.3.3\text{-}2e)$$

On the other hand, using equation (2.3.1-1b: E/V= P) and (2.3.3-2d), we can get equation below.

$$P = \phi(F) = \partial\phi(E)/\partial z \quad (2.3.3\text{-}3a)$$

Besides, using equation (2.1.2-1a: ρ(E) = ∂E/∂V), (2.1.2-1b: ρ(W) = ∂ρ(E)/∂t), and (2.3.3-2e). using separation of variable, radiant area A, radiant length z in a radiant volume, we can obtain a radiant solar energy below.

$$E = \int \rho(E)dV = \int ((\partial E/\partial A)/\partial z)dA\,dz$$

$$= \int dA \int (\partial\phi(E)/\partial z)\,dz = (-A/c)\int \phi(W)\,dz \quad (2.3.3\text{-}3b)$$

$$= (-A/c)\times \mathrm{Cub}(a)) \int \mathrm{Cub}\,(a\,bT)\,d(a\,bT) \quad (2.3.3\text{-}3c)$$

where

$$A = \int dA \quad (2.3.3\text{-}3d)$$

Furthermore, using equation (2.2-1:ϕ (W) = a Quad(bT)), integrating Quad (a bT) in equation (2.3.3-3c) with respect to variable z, we can obtain an equation below.

$$E = (A/4c\mathrm{Cub}(a))\,\mathrm{Quad}(a\,bT) \quad (2.3.3\text{-}3e)$$

$$= (Aa/4c)\,\mathrm{Quad}(bT) \quad (2.3.3\text{-}3f)$$

Moreover, using equation (2.3.1-1a: E=N bT), we can get equation below.

$$N = (Aa/4c)\,\mathrm{Cub}(bT) \quad (2.3.3\text{-}3g)$$

Dividing E in equation (2.3.3-3e) by equation (2.3.3-3f), a beam bundle energy is, by necessity, expressed as below.

$$E/N = bT \quad (2.3.3\text{-}3h)$$

Given a postulate that a beam bundle energy is equal to energy product of beam bundle mass and the speed of light squared, we can get equation below.

$$m = bT/\mathrm{Sq}(c) \quad (2.3.3\text{-}4a)$$

Given a solar radiant volume product of radiant area and radiant length of 1 m, dividing (2.3.3-4a) by the speed of light, we can get equation equal to equation (2.3.2-3c) below.

$$m = bT/\mathrm{Cub}(c) \quad (2.3.3\text{-}5)$$

It follows that under condition given the solar radiant volume with temperature T(s) on the surface of the Sun, as second target, we can get beam bundle mass in the volume below.

$$m(s) = bT(s)/\mathrm{Cub}(c) \quad (2.3.3\text{-}6)$$

2.3.4 A bundle mass in every solar radiant cubic meter of space for cosmic microwave background

Given the temperature, 2.726 [K], using equation (2.3.3-6) able to calculate as one solar radiant axis, we can get one-way bundle mass per unit solar radiant volume with cubic meters due to cosmic microwave background [28] below.

$$m = 1.396\,E(-48)\ [\mathrm{kg/Cub(m)}] \quad (2.3.2\text{-}3d)$$

3. Conclusions

First target is to get electromagnetic thermal constant b, correspond to the Boltzmann constant k(B), so that value of b is below.

$$b = 1.380\,E(-23) \quad (3\text{-}1a)$$

$$k(B) = 1.380649\,E(-23) \quad (3\text{-}1b)$$

$$b/k(B) = 0.9994\ [\mathrm{times}] \quad (3\text{-}1\text{-}c)$$

So that, ratio of b to k(B)

m(bundle) =2.956 E(-45) [kg] (3-2)

Under limitation of 4 digits calculations, it follows that electromagnetic thermal constant b may be equal to the Boltzmann constant k(B).

Second target is to get Photon's mass, electromagnetic mass and energy has continuous entity subjected to the indeterminacy principle, so that only thought actual experiments to make the indeterminacy disappear or thought experiments to force the continuity slice, we will get photon's mass.

Given a radiant volume product a radiant area on surface of the Sun and a radiant length of 1 meter on radiant axis, dividing the area by the number for the radiant beam bundle, we can get a beam bundle mass below.

m(s: bundle) = 2.956 E(-48) kg (3-3)

This conclusion get estimating process detailed, referring the below reference and appendix.

In spite of well-established thought of massless photon, we have gotten the previously-reported submissions [29] .

m ≤ 1.51 E(−48) kg (3-3b)

m ≤ 1.58 E(-48) kg(3-3c)

Moreover, is reported [30]

m≤ 2 E(−46) kg(3-3d)

m≤ E(−46) kg(3-3e)

m≤ 2 E(−50) kg(3-3f)

m≤ 4 E(−51) kg(3-3g)

The result of estimation is nearly-equal, this proposal may not mistake.

Reference : Table 1 Estimation of electromagnetic solar radiant thermal constant due to 4 significant-digits arithmetic

A result whether a relationship corresponds to or not, between the existing Boltzmann constant and new electromagnetic thermal constant.					
No.	Terms	Sign	Value	Unit	Citations & equations
C0	New electromagnetic solar radiant thermal constant	b	**1.380 E(-23)**	J/K	**Equation(2.2-3)**
C01	Ratio of the constant to Boltzmann constant	b/k(B)	**0.9994**	times	
Basic reference data					
B1	The existing Boltzmann constant	k(B)	**1.381 E(-23)**	J/K	[31]
B2	The speed of light	c	**2.998E(8)**	m/s	[32]
B3	Planck constant	h	**6.626 E(-34)**	Js	[33]
B4	Stefan-Boltzmann constant	σ	**5.670 E(-8)**	W/Sq(m)/Quad(K)	[34]
B5	Radius of the sun	R	**6.963 E(8)**	m	[35]
B6	Radius of the earth	R(e)	**6.371 E(6)**	m	[36]
B7	L(Earth-Sun) between each center: Au	L	**1.496 E(11)**	m	[37]
B8	Altitude of a Satellite with a solar panel	Sat	**2.040 E(7)**	m	[38]
B9	Sun's temperature on surface of the sun	T(s)	**5.772 E(3)**	K	[39]
B10	Radiant power per unit area on the satellite	ϕ(We)	**1.361 E(3)**	W/Sq(m)	[20], [24]
Calculations					
C1	a = σ/Quad(b)	a	**1.561 E(84)**	1/Cub(J)/s/Sq(m)	**(2.2-1a)**
C2	Radiant area on the satellite	A(e)	1.000	Sq(m)	Specified Value
C3	A cubic meter volume on the satellite	V(e)	1.000	Cub(m)	Specified Value
C4	Distance from the center of the sun to the satellite	d	**1.495 E(11)**	m	d = L-R(e)-Sat
C5	Ration of the distance d to the sun's radius R	d/R	**2.146 E(2)**		
C6	Radiant power per unit area on the surface sun	ϕ(Ws)	**1.938 E(5)**	W/Sq(m)	
C7	Radiant area on a surface of the sun	A(s)	**2.167 E(-5)**	Sq(m)	A(s) = Sq(d/R) A(e)
C8	A volume product of 1meter radiant length and the area on the sun	V(s)	**2.167 E(-5)**	Cub(m)	
C9	Radiant energy per unit radiant volume on the surface sun	Es	**1.358E(3)**	J/Cub(m)	
C10	Number passed through radiant area on the Sun's surface	N(s)	**1.706 E(22)**	Nos	
C11	Radiant beam bundle mass per unit meter in a volume for light to pass through on the surface of the Sun	m(s: bundle) = m(s)/c	**2.956 E(-45)**	kg	m(s) Sq(c) = A(s)/N(s) m(s) /c= (bT(s))/Cub(c)

Note 1. Stefan-Boltzmann constant σ = (2/15) × Quint(π) × Quad(k(B)/(Cub(h) × Sq(c))= 5.670374419 E(-8) [W/Sq(m)/Quad(K)].

Note 2. X E(n) means X times ten raised to the power of n.

Note 3. Sq(X),Cub(X), Quad (x), Quint(X) means the squared, the third power and the fourth power of x, respectively.

Note 4. Nos means number of nothing units

Appendix

A.1 Premises for an ideal gas law in EMTS

Under premise conditions that both of space and time have a property of homogeneity, isotropy, differential continuity exact differentiable continuity with no hiatus and warp in self-medium with orthogonal coordinate system, regarded as the so-called frees pace without loss, generation, and annihilation in all directions whatsoever, so that both of permittivity and permeability are invariant in the self-medium workable one-dimensional Maxwell's exact differential equations, respectively.

(1) Each electromagnetic variant term is described as exact differential function in orthogonal coordinates different from the curvature of spacetime.

(2) Their terms expressed as one-dimensional Maxwell's equations, subjected to the exact differential function.

(3) Easily to understand each terms from unit analysis due to using analysis with fundamental units, A, V, m, J, s, Nos (number), under conditions that each well-known term is omitted citation, main terms with unit are:

(a) Well-known electric flux density D [As/Sq(m)].

(b) Well-known magnetic flux density B [Vs/Sq(m)]

(c) In free space, omitted zero in the conventional form, well-known permittivity ε [As/Vm]

(d) In free space, omitted zero in the conventional form, well-known permeability μ [Vs/Am]

(e) Well-known electromagnetic energy density:

ρ(E) = 0.5(D(D/ ε) + B(B/μ)) [J/Cub(m)] (e-1)

(f) Well-known electromagnetic wave equation:

∂(∂ρ(E) /∂z)/∂z = ε μ ∂(∂ρ(E) /∂t)/∂t (f-1)

The speed of light equivalent to Sqrt(1/ε μ) in orthogonal coordinates:

$$c = Sqrt(1/\varepsilon\mu)[m/s] \quad (g\text{-}1)$$

$$Sq(c)\,\varepsilon\mu = 1 \quad (g\text{-}2)$$

(h) Well-known electric flux density wave function

$$D = A(D)\,Exp(2\pi j\theta)/Sqrt(2) \quad (h\text{-}1)$$

where A(D) is amplitude

(i) Well-known magnetic flux density wave function

$$B = A(B)\,Exp(2\pi j\theta)/Sqrt(2) \quad (i\text{-}1)$$

where A(B) is amplitude

(j) Well-known electromagnetic energy density wave function:

$$\rho(E) = A(E)Exp(4\pi j\theta)/2 \quad (j)$$

where A(E) is amplitude

(k) θ: wave angle [rad.]

(l) f : wave frequency [Nos/s]

(m) k: wave number [Nos/m]

(4) According to Ohki's pre-print paper, derivations from one-dimensional Maxwell's exact differential equations with invariant permittivity and permeability are:

$$dc = 0, d\varepsilon = 0, d\mu = 0 \quad (o)$$

$$D = c\,\varepsilon\,B \quad (p)$$

$$B = c\,\mu\,D \quad (q)$$

$$\varepsilon : \text{defined as } D/cB \quad (r)$$

$$\mu : \text{defined as } B/cD \quad (s)$$

$$\varepsilon\,Sq(B) = \mu\,Sq(D) \quad (t)$$

Electromagnetic mass density[kg/Cub(m)]:

$$\rho(m) = \varepsilon\mu\,\rho(E) = 0.5(\varepsilon\,Sq(D) + \mu\,Sq(B)) \quad (u\text{-}1)$$

$$\rho(m) = \varepsilon\,Sq(D) = \mu\,Sq(B) = DB/c \quad (u\text{-}2)$$

(v) Electromagnetic wave equation:

$$\partial(\partial\rho(m)/\partial z)/\partial z = \varepsilon\mu\,\partial(\partial\rho(E)/\partial z)/\partial z$$
$$= Sq(\varepsilon\mu)\,\partial(\partial\rho(E)/\partial t)/\partial t = \varepsilon\mu\,\partial(\partial\rho(m)/\partial t)/\partial t \quad (v\text{-}1)$$

(w) Electromagnetic mass density wave function:

$$\rho(m) = A(m)\,Exp(4\pi j\theta)/2 \quad (w\text{-}1)$$

where A(m) is amplitude

$$A(m) = \varepsilon\mu\,A(E) \quad (x\text{-}1)$$

(5) β (the ratio of v to c) in Lorentz factor [40] is not Sq(v/c), by good rights, β is ε μ Sq(v) so that a value product of ε and μ is invariant on orthogonal coordinates in all directions

(6-1) The value product of ε and μ is able to postulate invariant in all frames, so that c is postulated as invariant in all frames.

(6-2) Deviation of invariance of the speed of light: Under the above-mentioned premise, unity is one product of the speed of light c squared and both of permittivity ε and permeability μ, when differentiating c, ε and μ, that is, we can get terms, dc = 0, d ε = 0 and dμ = 0. However, if spacetime is curvature, the curvature will be assumed to lead up to d ε ≠ 0 and dμ ≠ 0, so that thus speed of light in the curvature will have a high probability to be deviated away from the existing speed of light.

(6-3) In a relative velocity unattainable to the speed of light in the Lorentz transformation, the ratio β of the relative velocity to the speed of light in a vacuum, β leads up to light's massless where a particle's velocity of v is the relative velocity between inertial reference frames, c is the speed of light in a vacuum.

(6-4) The facts and observations of the Lorentz transformation for a particle have validated in a region unattainable to the speed of light, however, the velocity of the particle is impossible to reach the speed of light, so that the Lorentz transformation should be applied a particle with velocity less than the speed of light, that is, c = Sqrt(1/ ε μ).

(7) Unfortunately, a thought of light's massless has taken a root from a cause that β reach an infinite value when the velocity reach the speed of light under the Lorentz transformation with Lorentz factor β.

(8) In consequence, any mechanical particle travels at the speed less than the speed of light for limitation due to the Lorentz transformation, in contrast, the linear bundled strings travel at the speed of light in free space under condition freed from the transformation.

In consequence, the Lorentz transformation will reach impasse in applying to light's massless.

A.2 Comparison table for an ideal gas law in mechanical thermodynamic system and electromagnetic thermal system in the self-medium with field to help light to travel in free space with nothing

Table A.2 Comparison table for an ideal gas law in mechanical thermodynamic system and electromagnetic wave-photon-field triplicity system

Terms	An ideal gas law in MPS	An ideal photon gas law in EMTS
Mass	An isolated particle with mass	continuity, like a string with mass in self-medium with field
Volume	Three-dimensional volume	One-dimensional medium volume
Confining	The volume is confined to lots of mass with velocity	The medium is confined to lots of strings defined as continuity
Velocity	Three-dimensional vector velocity in the volume	One-dimensional scalar velocity only in the self-medium with three dimensions
The speed	The velocity less than the speed of light	the speed of light
Independence	The particle independent of each other for the isolation	The string independent of each other with discrete frequency
Constitution and the observation	An independent particle with no sub-particle, is continuity unable to observe a particle for the uncertainty principle.	As a thought experiment, the string constitutes of elemental bead unable to cut up like a photon, subjected to indeterminacy assumed to be the uncertainty principle, we can observe the continuity constituted of bundles of those strings to disappear the indeterminant terms in observing. However, those indeterminate terms, that is, either space interval or time interval, either wave number reciprocal of the space or frequency interval reciprocal of the time interval, they disappear in interacting the other, so we can observe a string as an observing unit, that is, a set of photons which appear in either space real observation or time real observation. Their reciprocals generate wave-packets in electromagnetic wave-photon-field triplicity , so that we can observe the wave-packet regarded as a particle in mechanical particle system .
Subjection	No subjection	The continuity is subject to the uncertainty principle when we observe the continuity as the electromagnetic momentum and the energy for the uncertainty term disappears.
No loss	No loss for perfect elasticity between the particle and wall of the volume, particles	No loss for complete reflection as the wave in the self-medium with field for nearly parallel to the medium and no collision for translation parallel to the medium as the string with the mass equivalent to the discrete frequency through the Planck constant.
Energy and momentum conservation	The kinetic energy and the momentum conserve for no loss due to the particle 's perfect elastic collision.	Electromagnetic wave energy is defined as one product of the Planck constant and the discrete frequency independent of each other, the string energy is one product of the mass and the speed of light squared. The string momentum is defined as one product of the mass and the speed of light. They are no loss for no interference between the self-medium with field and the continuity in the triplicity for their translation.
Equipartitioned cell	The volume constitutes of independent partition cells with equipartition of kinetic energy and momentum.	The volume constitutes of independent equipartitioned cell each other in the self-medium with field, distributed into an equipartition of a single string with either wave energy product of the Planck constant and the frequency, or string energy product of the mass and the speed of light squared. Besides, the volume fills up lots of bundles that pack into lots of strings.
Equipartitioned energy and the distribution	Kinetic energy in a partition is proportional to the Boltzmann constant k(B) unit, accords with Boltzmann distribution	Electromagnetic energy in a partition is proportional to value product of the bundle number and electromagnetic thermal constant b times temperature T in the radiant volume. The energy accords with the Planck radiation formula [41]

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