A particle-free model of matter based on electromagnetic self-confinement (III)

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ABSTRACT. This article sets out to demonstrate that electromagnetic radiation with an energy density in the order of magnitude of $10^{73}[J/m^3]$ satisfies the condition of stability for gravitational self-confinement, while its corresponding electromagnetic vector wave function satisfies the classic Schrödinger wave equation and the relativistic Dirac equation. The complex electromagnetic vector wave function is denoted in this article by $\vec{\Phi}(\vec{x},t)$ and exhibits a correspondence with the scalar quantum-mechanical complex probability function $\Psi(\vec{x},t)$, that cannot be explained by chance. The electromagnetic model also admits other forms of self-confinement of electromagnetic radiation, including electromagneto-static self-confinement at considerably lower energy densities, in which circumstances the descriptive complex electromagnetic wave function also satisfies the Schrödinger wave equation.

RÉSUMÉ. Il est montré dans cet article qu'un rayonnement électromagnétique à densité énergétique d'un ordre de grandeur de $10^{73}[J/m^3]$ *satisfait la condition de stabilité pour l'autoconfinement gravitationnel et que, par conséquent, la fonction d'onde vectorielle électromagnétique correspondante satisfait la classique équation d'onde de Schrödinger et la relativistique équation d'onde de Dirac. Désignée* $\vec{\Phi}(\vec{x},t)$ *dans cet article, la fonction vectorielle d'onde électromagnétique complexe présente une concordance qui ne peut être considérée comme fortuite avec la fonction de probabilité complexe de la mécanique quantique scalaire,* $\Psi(\vec{x},t)$. *Le modèle électromagnétique autorise également d'autres formes d'autoconfinement du rayonnement électromagnétique, notamment l'autoconfinement électro-magnétostatique avec les densités énergétiques beaucoup plus faibles, en quel cas la fonction d'onde électromagnétique*

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complexe descriptive satisfait également la fonction d'onde de Schrödinger.

0. Introduction.

Due to the length, this article is split up into 3 sections. Section 1 and 2 were published in the last two editions and describe the relationships between the Maxwell equations and the Schrödinger wave equation and the relativistic Dirac equation. This section describes the confinement of electromagnetic radiation. Recent experiments within the HOZN institute have demonstrated a sibnificant foton-foton interaction between inhomogeneous electromagnetic fields at frequencies varying from 1 to 0.01 [Hz], intensities of 0,0001 - 0,01 [J/m^3] and a radiation pressure varying from 0,0001 - 0,01 [N/m^2]. University and industrial laboratories related to optical techniques (preferable lasertechniques) are invited to join the HOZN research project related to non-linear interaction in inhomogeneous monochromatic radiation, by responding to the address above.

4. Auto confined electromagnetic entities (AEONS).

The description of electro-magnetism employed in this section refers to an earlier idea of Lorentz. Namely the basic idea that the observed relativistic effects of space and time transformations are essentially based on electromagnetic transformations which are in this theory considered as the basic fundamentals of space and time. This implies that the idea of a fundamental aether in this section is not principally excluded. The theory however requires that the rest mass of the hypothetical aether is zero, and that the observed energy has to be described in terms of an aether tension due to an electromagnetic effect, while this tension is represented by a specific local mass density due to an electromagnetic energy density. This implies that in absoluted empty space (without the presence of any energy) the aether does not physically exist, but is created by the presence of electromagnetic energy.

The theory requires that the observed aether phenomena do not contradict special or general relativity. This requirement can only be fulfilled by the assumption that observers are essentially made of Aeons combinations, with the observer's own system variables Σ in which the time is determined by the rest frequency ω_0 of the concerned Aeons and space is prescribed by the corresponding rest wavelengths, indicated by $\vec{k}_0$ which transform according to (25). Only in that special circumstance, space and time, as discerned by the observer, are fundamentally supported by electromagnetic effects and the speed of light, described by an electromagnetic effect, will be observed as being independent of the velocity relative to the observer.

The model of an aether which carries the electromagnetic energy transport implies a wave equation which is comparable to an acoustic wave equation in a gas. The relativistic specific local mass of the aether is indicated by $\rho_{EM}(\vec{x},t)$ and the relativistic local elasticity of the aether is indicated as $\mathcal{E}_{EM}(\vec{x},t)$. Due to the gradient of the radiation pressure, caused by the local energy density "w", a volume element "dV" of electromagnetic energy is accelerated in the direction of the gradient of the radiation pressure. This effect is described by the relativistic acoustic aether wave equation which is rather similar to the acoustic wave equation for sound waves in gases, in which the acoustic phenomena are described by the dynamic sound pressure "p_s", which is related to the local dynamic potential energy density of the gas. The acoustic wave equation for sound waves in gases is:

$$\frac{1}{\mathcal{E}_{\mathcal{G}}}\nabla^2 p_s(\vec{x},t) = \rho_G \frac{\partial^2 p_s(\vec{x},t)}{\partial t^2} \tag{103}$$

in which $\rho_G(\vec{x},t)$ is the local specific mass of the gas and $\mathcal{E}_G(\vec{x},t)$ is the local elasticity of the gas. By multiplying both sides of equation (103) with $-1/ic\rho$, in which ρ is the unit of electric charge density, an electromagnetic equivalent for the local dynamic potential energy density of the gas is obtained by the electric potential $i\varphi/c$. Moving with velocity "v" relative to be the electromagnetic phenomena, the term $ic\rho$ turns out to be the 0-component of the source 4-vector in (5), which transforms due to relativistic effects into $(ic\rho')(1,-i\vec{v}/c)\gamma = (ic\rho,\vec{j}) = j_a$ and a Lorentz transformed potential 4-vector is observed which equals $(i\varphi'/c)(1,-i\vec{v}/c)\gamma = (i\varphi/c,\vec{A}) = \varphi_a$. Using this substitution, equation (103) transforms into the relativistic acoustic aether wave equation, in which the term acoustic indicates that energy density fluctuations propagate due to an elastic effect:

$$\frac{1}{\mathcal{E}_{\mathcal{EM}}}\nabla^2 \varphi_a(\vec{x},t) = \rho_{EM} \frac{\partial^2 \varphi_a(\vec{x},t)}{\partial t^2} \tag{104}$$

The elasticity of electromagnetic radiation is determined by the compression of confined radiation over a small distance and measuring the radiation pressure which has to be counterbalanced during the compression. The quotient of the relative deformation and the applied mechanical pressure is indicated as the elasticity of confined radiation and equals the reciprocal of the energy density "w". The relativistic specific mass of the aether equals w/c^2. Substituting these values in (104) results in:

$$\nabla^2\varphi_a(\vec{x},t) = \frac{1}{c^2}\frac{\partial^2\varphi_a(\vec{x},t)}{\partial t^2} \tag{105}$$

The material-like treatment of light is in correspondence with Maxwell's theory because (105) is identical to the electromagnetic source equation in vacuum

$$\bar{\Box}\varphi_a(\vec{x},t) = \mu j_a(\vec{x},t) \tag{106}$$

in which $\bar{\Box}$ is d'Alembertian operator and equals:

$$\bar{\Box} = -\partial^a\partial_a = \frac{1}{c^2}\frac{\partial^2}{\partial t^2} - (\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}) \tag{107}$$

The aether model, with the restriction that the rest mass of the aether is zero in the absence of energy, does not violate relativity. When an observer moves relative to an electromagnetic wave, a Lorentz transformed specific mass and a Lorentz transformed elasticity of the aether are observed, which implies that independent of the velocity of the observer still the relative velocity "c" of the electromagnetic phenomena is measured. This accords with relativity. This model suggests that in the absence of any energy the aether also disappears which is in correspondence with Mach's principle that "If there is no matter then there is no geometry". The idea of an electromagnetic aether is also used in the description of the effect that the velocity of electromagnetic waves is lowered in matter. General relativity cannot explain this effect because the concerned mass is much too small to cause measurable space-time curvature. The only possible explanation is to couple the electromagnetic field masses of electrons to the electromagnetic aether mass in (104), while the aether elasticity changes a little due to the electromagnetic coupling of the electron to the atom. This effectively lowers the speed of light in materials. Formula (105) is derived rather to demonstrate that an aether theory does not inevitably contradict Maxwell or relativity than that it is a necessary equation to demonstrate the possibility of AEONs.

An important aspect of AEONs is inertia, or passive gravitational mass[36,37]. To explain inertia a simplified model is used in which radiation is confined e.g. between perfect reflecting mirrors. The radiation pressure on the confining system equals "$w/4$", in which "w" represents the sum of the electromagnetic wave energy density and the confining energy density, and in an inertial system the internal forces counterbalance. During an acceleration $\vec{a}$ of the system the radiation pressure is transformed. The Poynting 4-vector, describing the confined radiation, is transformed by:

$$ {}^{s}S'_{a} = {}^{+}L^{a}_{b}\,{}^{+}S_{b} + {}^{-}L^{a}_{b}\,{}^{-}S_{b} \tag{108}$$

which follows from (10A) up to and including (15A) and (51A) in the appendix. During the acceleration the radiation pressure ${}^{+}P$ on the confining system towards the acceleration is increased and the radiation pressure ${}^{-}P$ on the opposite part is decreased. In a 1-dimensional reduction (108) can be written as:

$$ {}^{s}S'_{1} = (\frac{1+\frac{v}{c}}{1-\frac{v}{c}})^{+}S_{1} + (\frac{1-\frac{v}{c}}{1+\frac{v}{c}})^{-}S_{1} \tag{109}$$

This results in a difference of the radiation pressure[28,29] ${}^{+}P$ and ${}^{-}P$ during the acceleration. The resulting force F_R on the system during the acceleration equals:

$$ F_R =^{+} F +^{-} F = \left[(\frac{1+\frac{v}{c}}{1-\frac{v}{c}}) - (\frac{1-\frac{v}{c}}{1+\frac{v}{c}})\right]\frac{w\Lambda}{4} \tag{110}$$

in which Λ is the surface of the confining system. During the acceleration in a time interval Δt the waves travel from one mirror to the opposite one which is at a distance 1 away from the other. For that reason the travelling time Δt equals $1/c$. At uniform acceleration "a" the velocity v is increased with $a \cdot \Delta t$ during the interval Δt. Substituting in (110) results in:

$$ F_R((\frac{1+\frac{al}{c^2}}{1-\frac{al}{c^2}}) - (\frac{1-\frac{al}{c^2}}{1+\frac{al}{c^2}}))\frac{w\Lambda}{4} \tag{111}$$

At accelerations $a << c^2/l$ equation (111) is approximately equal to Newton's law $F_R = Wa/c^2$ in which the passive gravitational mass equals W/c^2. This implies that the model of confined radiation obeys elementary physical laws and gives a reasonable explanation for elementary material aspects of AEONs.

An important aspect of general relativity, the elementary coupling between passive gravitational mass, presented in (111), and active gravitational mass which is the origin of a gravitational field, is the basic of the description of GEONs[24] (Gravitational Electromagnetic Entities). Equation (111) shows that a gradient in the energy density, opposite to the acceleration, causes passive gravitational mass. Subsequently confined electromagnetic radiation, situated in a gravitational field, will present a gradient of the energy density due to this gravitation, which results in a force opposite to the direction of the gravitational field.

This idea is worked out in a description of a static electromagnetic aether self-confinement in which electromagnetic waves propagate comparable to a cloud of gas in which acoustic waves propagate, described by (105) and (103) respectively, in which the term acoustic concerns the propagation of energy density fluctuations due to an elastic effect. Equations (104) and (105) describe electromagnetism as an acoustic 4-vector oriented phenomenon in a medium with a mass density proportional to the energy density of the confined phenomenon and consequently a rest mass equal to zero, this in contradiction to equation (103) which describes an acoustic scalar phenomenon in a medium with finite rest mass mainly independent of the energy density of the confined acoustic wave in e.g. a gas cloud. The relativistic effects of the electromagnetic waves propagating in the Geons are in this model observed as probability waves and described by (56) and (102).

Because gravitational forces will not exclusively lead to Geons, gravity is in this short illustration treated by a Poisson equation instead of the more valid Einstein Maxwell equations. The description of the electromagnetic aether self-confinement concerns a static phenomenon due to an extremely strong energy density, which is responsible for the confinement. The treated equations are comparable to the equations concerning static gas clouds in free space and will not describe the confining wave equation itself, but only the stability condition for electromagnetic self-confinement.

A simplified approach to the gravitational field generated by an arbitrary mass distribution has been adopted for gravitational self-confinement. To determine the gravitational field a Poisson equation has been formulated for the gravitational potential $V_G(\vec{x})$, caused by a mass density distribution $\rho_M(\vec{x})$:

$$\nabla^2 V_G(\vec{x}) = -4\pi G\rho_M(\vec{x}) \tag{112}$$

where "G" is the gravitational constant in (11). If the mass distribution relates to a point mass "M", we have $\rho_M(\vec{x}) = M\delta(\vec{x})$. The solution for the gravitational potential is then: $V_G(r) = -GM/r$ in which "r" is the distance related to the point mass M. If the electromagnetic mass density, defined in (47) and (49), is substituted in (112) this can then be written as:

$$\nabla^2 V_G(\vec{x}) = -1/2\kappa c^2 \tilde{\Psi}_R^2 \tag{113}$$

where κ is the coupling constant in (11) and expresses the coupling of an electromagnetic energy density to a gravitational field. The solution of (113) is given by:

$$V_G(\vec{x}) = G \int_{Vol.} \frac{\tilde{\Psi}_R^2(\vec{y})}{|\vec{x} - \vec{y}|} dV \tag{114}$$

The model assumes an equilibrium between the repulsive forces, caused by the gradient of the radiation pressure and the attractive forces generated by the mass of the confined electromagnetic radiation. The occurrence of the repulsive forces in the confined electromagnetic radiation can be explained as follows. In a thought experiment the assumption is made of a double-sided perfectly reflecting mirror of thickness Δx. A plane electromagnetic wave with energy density "$w + \Delta w$" strikes the left side of the mirror and radiation energy with an energy density "w" strikes the right side. If the surface area of the mirror is "A" the resulting force on the mirror is directed to the right and is equal to $A\Delta w$. If the system is situated in a gravitational field with gravitational potential V_G, a layer thickness of electromagnetic radiation with thickness "Δx" and a surface area "A" experiences an attractive force equal to $(wA\Delta x/c^2)(\partial V_G/\partial x)$, which concept is in basic correspondence with (48A). In the thought experiment, the mirror is now replaced by electromagnetic radiation with energy density "w". In equilibrium, the rightwards-directed forces, as the result of a gradient in the electromagnetic energy density, will be compensated by the leftwards-directed forces because of a gradient in the gravitational potential. In equilibrium we have the equation:

$$\nabla w = \frac{w}{c^2} \nabla V_G \tag{115}$$

from which a simplified stability equation can be derived if the equilibrium relates to the gradient in radial direction (115). The same result follows from (47A). Under these conditions it is possible to give a rough estimate for the required energy density in the case of gravitational self-confinement. By determining the divergence of the left-hand and right-hand terms in (115) and substituting (113) in this, we obtain:

$$\nabla^2\tilde{\Psi}_R = \left(\frac{\nabla\tilde{\Psi}_R \cdot \nabla\tilde{\Psi}_R}{\tilde{\Psi}_R} - \frac{\kappa\tilde{\Psi}_R}{4}\right)\tilde{\Psi}_R \tag{116}$$

Relation (116) expresses a condition that must be satisfied by a self-confined electromagnetic wave in radial direction under the influence of a self-generated gravitational field. A particular solution which satisfies (116) is:

$$\tilde{\Psi}_R = \frac{2}{\sqrt{\kappa}}\frac{1}{r} \approx 1.5\ 10^{13}\frac{1}{r} \tag{117}$$

Equation (117) shows the energy density required for gravitational self-confinement. This energy density should be in the order of $10^{73}[J/m^3]$ at the surface of an electromagnetic self-confinement with, for example, the dimensions of a proton. In view of the small mass of elementary particles, the electromagnetic self-confinement should take place in a very thin energy shell on the surface of the confinement. Because of the local extremely high electromagnetic radiation pressure of $10^{73}[N/m^2]$ a gravitational electromagnetic self-confinement will behave like an extremely hard, non-deformable elementary particle that can only be split in collision experiments.

The presented values in table 1 (Wheeler[24]) for the averaged electric field intensity are only comparable with the results from equation (117) for low azimuthal quantum number $l \leq 10$.

	GEON I	GEON II
Mass	10^{39}[kg]	10^{39}[kg]
Radial coordinate of active zone	1.67×10^{12} [m]	1.67×10^{12}[m]
Spherical harmonic index $l^* = [l(l+1)]^{1/2}$	10	8.43×10^9
circular frequency of emergent radiation	$6 \times 10^{-4}[s^{-1}]$	$5.06 \times 10^5[s^{-1}]$
Time to collapse assuming leakage only	212 years	$\sim \infty$
Rms electric field in most active region	4.66×10^{10}[esu/cm]	4.44×10^{13} [esu/cm]

Table 1 (Wheeler)[24]

It follows from equation (117) and (3A) that for a gravitational self confinement in a spherical shell (azimuthal quantum number $l = 0$) at a radius of $1,67 \cdot 10^{12}[m]$ the required averaged field intensity $\tilde{E} = 13.5 \times 10^{14}[V/m]$ which equals in electro-static units $\tilde{E} = 4.5 \times 10^{10}[esu/cm]$ (Table 1). Gravitational self confinements have already been described by Wheeler[24,25] who introduced the GEONs (Gravitational Electromagnetic Entities) which describe gravitational confined radiation in toroidal confinements. Table 1 presents the values calculated by Wheeler, by solving the Einstein-Maxwell equations for the toroidal gravitational self confinement.

Geons at smaller dimensions are quantum objects and need a different mathematical approach. In the simplified example in (116), gravity is only used to confine electromagnetic radiation in a way as gas clouds are confined by there own gravitational field. The mass however of an elementary particle is too small for confining gravitationally electromagnetic radiation in a reasonable way. An alternative way of confinement like "electro-magneto-static" confinement is required.

In a way identical to the way that GEONs are described by the gravitational equilibrium equation (115) or its equivalence (116), EEONS (Electro-Magneto-Static Confined Electromagnetic Entities) are described by the electro-magneto-static-equilibrium equation (120). The electro-magneto-static balance equation follows from the energy-momentum tensor (8), which can be written as:

$$T^{ab} = (\epsilon E_a E_b + \frac{1}{\mu} B_a B_b - \delta_{ab} w) \tag{118}$$

in which "w" is the energy density. From (45A) and (47A) in the appendix it follows that the electro-magneto-static balance equation equals:

$$f^a = \partial_b T^{ab} = 0 \tag{119}$$

which can be written as:

$$\epsilon_0 [\vec{E}(\nabla \cdot \vec{E}) + (\vec{E} \cdot \nabla)\vec{E}] + \frac{1}{\mu}[\vec{B}(\nabla \cdot \vec{B}) + (\vec{B} \cdot \nabla)\vec{B}] = \nabla w \tag{120}$$

As an example a 3-dimensional confinement is chosen in which the vector wave function $\vec{\Phi}(r, \theta, \varphi, t)$ in (13) or (3A) is presented in spherical coordinates and equals:

$$\vec{\Phi}(r, \theta, \varphi, t) = \begin{pmatrix} \Phi_R \\ \Phi_\theta \\ \Phi_\varphi \end{pmatrix} = \sqrt{\frac{\epsilon}{2}} \begin{pmatrix} iR(r)Y_{lm}(\theta, \varphi) \\ 0 \\ R(r)Y_{lm}(\theta, \varphi) \end{pmatrix} \tag{121}$$

in which $R(r)Y_{lm}(\theta,\varphi)$ is a real function. It follows from (135) that in this type of confinement the electric field intensity is oriented along the radial coordinate. The component of $\vec{\Phi}(r,\theta,\varphi,t)$ along the azimuthal direction equals zero. The magnetic field intensity is oriented along the φ-direction. The frequency of the confinement is determined by the demand of continuity of the electric and magnetic field intensities so that $n \cdot \lambda$ equals the circumference of the confinement. In analogy with the gravitational confinement of electromagnetic radiation, described by Wheeler[24], an electro-magneto-static confinement of light requires an equilibrium between the radial outwardly pointing radiation pressure and the radial inwardly pointing electro-magneto-static forces. The radial outwardly pointing radiation pressure equals:

$$-\nabla w = -c^2 \frac{\partial(\vec{\Phi}\cdot\vec{\Phi}^*)}{\partial r} = -\epsilon R(r) Y_{lm}^2(\theta,\varphi)\frac{\partial R(r)}{\partial r} \tag{122}$$

Because in this type of confinement the magnetic field intensity is oriented perpendicular to the radial direction, only the electric field intensity is supplying the radial inwardly pointing forces to counterbalance the radial radiation pressure. It follows from equation (120) that the radially inwardly pointing electric forces equal:

$$\epsilon(E_R(\nabla\cdot\vec{E})) + (\vec{E}\cdot\nabla)E_R = 2\epsilon E_R\left(\frac{\partial E_R}{\partial r} + \frac{E_R}{r}\right) \tag{123}$$

which can be written as:

$$\epsilon(E_R(\nabla\cdot\vec{E})) + (\vec{E}\cdot\nabla)E_R = 2\epsilon R(r)Y_{lm}^2(\theta,\varphi)\frac{\partial R(r)}{\partial r} + \frac{2}{r}\epsilon R(r)^2 Y_{lm}^2(\theta,\varphi) \tag{124}$$

An electro-dynamic equilibrium exists if the radial inwardly pointing electric forces in (124) counterbalance the radial outwardly pointing radiation pressure. The electro-magneto-static balance equation becomes:

$$\epsilon R(r)Y_{lm}^2(\theta,\varphi)\frac{\partial R(r)}{\partial r} + \frac{2}{r}\epsilon R(r)^2 Y_{lm}^2(\theta,\varphi) = 0 \tag{125}$$

The electromagnetic equilibrium equation (125) can be written as:

$$\frac{\partial R(r)}{\partial r} + \frac{2}{r}R(r) = 0 \tag{126}$$

with a particular solution:

$$R(r) = \frac{K}{r^2} \tag{127}$$

where "K" an arbitrary constant. The radial dependence of the function $R(r)$ in (127) for electro-static self confinement is different from the solution (117) for gravitational self confinement. Equation (127) demonstrates that electro-magneto-static confinement is a physical possibility and that the solution (127), which is independent of ω, and $Y_{lm}(\theta, \varphi)$, is in conformity with the solution of the Poisson equation for electric fields. The solutions for the radial dependent function ($R(r)$ are determined by the chosen electro-magneto-static mode. Many aspects have not yet been discussed. But the first treatment of the theoretical possibility of electro-magneto-static self confinement perhaps will offer possibilities to develop a continuous model of matter. One aspect is that the acoustic model for electromagnetic radiation offers values for the required averaged field intensity at gravitational self confinements (GEONS) which are reasonably comparable to the solutions found by Wheeler, solving the Einstein-Maxwell equations at low azimuthal quantum number.

5. Concluding remarks.

Because of the high energy density of self-confined electromagnetic radiation, the radiation pressure is extremely high (depending on the method of self-confinement). For gravitational confinement it varies in magnitude roughly about $10^{70}[N/m^2]$ as a result of which self-confined electromagnetic radiation behaves as a virtually non-deformable particle in experiments. Electromagnetic self confinement, based on foton-foton interaction, requires considerably less energy densities than a confinement based on gravitational forces for solutions with an infinite liftime[45]. The model of the self-confinement of electromagnetic radiation presented here is possibly a first step towards a continuous model of matter and may provide a better explanation for several quantum mechanical effects than a particle model of matter.

In this electromagnetic model of matter, the behaviour of particles is not described by quantum mechanical probability waves. Particles and the corresponding probability waves are not considered to be complementary aspects of the same object and are unified in such a way that the electromagnetic wave phenomenon itself carries mass[28], charge[3] and interaction[2]. Quantum mechanical probability waves are in most treatments considered to be massless and virtually, and by exception [28,3] only considered to be the carrier of charge, mass[28] or interaction forces. This makes a theory necessary to explain remarkable continuity aspects of particles like tunneling or a continuous charge distribution based on elementary particles, while a characteristic aspect of particles is the discontinuity.

The electromagnetic model possibly offers an explanation why electromagnetic radiation should be emitted if an electron drops back to a lower energy level, when the light emitted in this model is regarded as the building material. It offers the possibility of explaining by the effect of spatially generated charge [30], why an electron in a stable orbit around a proton can completely screen this proton electrically, which would be impossible for a point charge like an electron as a particle, if this charge is not moving at infinite velocity. This model may provide an explanation of the fact that an electron in a stable orbit does not emit electromagnetic radiation [28,40]. In it, the Poynting vector of the confined electromagnetic wave is directed along the energy shell and it is only during the change in energy level that the surface integral of the Poynting vector across the energy shell is positive when the energy drops and negative during a transition to a higher-energy orbit [20]. This could explain why all atoms are excited only by the absorption of electromagnetic radiation and can only drop to a lower energy state when emitting radiation [17,40].

The effect of slowing down the speed of light by matter, like wave propagation in lenses, cannot be explained in terms of general relativity [15], because the concerned mass is much too small. Considering electromagnetism as an aether-tension effect, (104) and (105) offer a possibility to change the electromagnetic mass density of the aether or the elasticity by coupling with interacting electrons while this approach will not conflict with Maxwell or relativity [17,38]. The acoustical model of light results in the confinement equation (116). The spherical solution (117) for azimuthal quantum number $1 = 0$ demonstrates a value for the required averaged electric field intensity of $4.5 \times 10^{10}[esu/cm]$ which corresponds reasonably with the value of $4.66 \times 10^{10}[esu/cm]$, table 1, calculated by Wheeler[24] by solving the Einstein-Maxwell equations for a GEON with spherical harmonic index $1 \approx 10$.

The acoustic approach of light (105) possibly will offer a useful method to describe electro-magneto-static modulation to deflect laser beams by electro-magneto-static lenses. Experiments with electrostatically charged micro-electrodes with separations comparable to the wavelength of the beam, have been done successfully and show a possibility to electro-magneto-static (self-) confinement.

The electromagnetic model of matter is hypothetical. An attempt has been made to prove within the boundaries of classical theories that quantum-mechanical probability possibly originates in the relativistic effects of AEONs and that electromagnetic self-confinement is a physical possibility without contradicting Maxwell, Quantum mechanics or Relativity. The fact that the Maxwell Equations (100) and (101) demonstrate a remarkable correspondence with the Dirac equation (102) indicates an electromagnetic origin of matter.

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Appendix :Classical electromagnetism related to relativity and quantum mechanics.

This appendix presents a brief view of classical electromagnetism in relation to special relativity and quantum mechanics. A well known equation in quantum mechanics is the law of conservation of probability, presented as:

$$\frac{\partial w_p}{\partial t} + \nabla \cdot \vec{J} = 0 \tag{1A}$$

in which w_p is the probability density and equals $\Psi^*\Psi$ and $\vec{J}$ is the probability density flux. The continuity equation for electromagnetic radiation, given in equation (42) in the article and in (63A) in the appendix, is presented as a basic equivalent for the law of conservation for probability in which the electromagnetic energy density "w" is an equivalent for the probability density w_p and the Poynting vector $\vec{S}$ describing the energy density flux of electromagnetic radiation, turns out to be the equivalent for the probability density flux, presented by $\vec{J}$.

$$\frac{\partial w}{\partial t} + \nabla \cdot \vec{S} = 0 \tag{2A}$$

By introducing the equivalence of both equations, the law of conservation of probability transforms into the law of conservation of energy.

The continuity equation (42) (in the article) is relativistically transformed into (56), which equation has a clear correspondence with the Schrödinger equation for probability waves. The relation between probability and electromagnetic energy density is created by the introduction of the electromagnetic vector wave functions $\vec{\Phi}(\vec{x},t)$ and $\vec{\Phi}^*(\vec{x},t)$ in (13). It is important to notice that both vector wave functions are complex and have no physical meaning. They are in no way related to a real electric or magnetic field and physically both hypothetical vector wave functions do not exist. Substitution of (1) and (2) in (13), in the absence of a gravitational field, results in:

$$\vec{\Phi}(\vec{x},t) = \sqrt{\frac{\epsilon}{2}}(\vec{B} + \frac{i\vec{E}}{c}) \tag{3A}$$

The scalar product of the vector wave functions $\vec{\Phi}(\vec{x},t)$ and $\vec{\Phi}^*(\vec{x},t)$ times the square of the velocity of light is a real physical quantity and equals the electromagnetic energy density "w":

$$w(\vec{x},t) = c^2\vec{\Phi}(\vec{x},t)\cdot\vec{\Phi}^*(\vec{x},t) = \frac{1}{2}(\frac{B^2}{\mu} + \epsilon E^2) \tag{4A}$$

This equation is related to the definition of the quantum mechanical probability density w_p for which quantity prevails:

$$w_p = \Psi\Psi^* \tag{5A}$$

The equations (4A) and (5A) demonstrate an initial correspondence between quantum mechanical probability waves and electromagnetic waves. The electromagnetic energy density flux is presented by the Poynting vector $\vec{S}$ and equals:

$$\vec{S}(\vec{x},t) = ic^3(\vec{\Phi}^* \times \vec{\Phi}) = \frac{1}{\mu}(\vec{E} \times \vec{B}) \tag{6A}$$

Substituting (4A) and (6A) into (2A) results in an equation for the hypothetical non-existing vector waves functions $\vec{\Phi}(\vec{x},t)$ and $\vec{\Phi}^*(\vec{x},t)$, which describes a physical real process of the conservation of electromagnetic energy.

$$\frac{\partial(\vec{\Phi}\cdot\vec{\Phi}^*)}{\partial t} + ic\nabla\cdot(\vec{\Phi} \times \vec{\Phi}) = 0 \tag{7A}$$

In section (2) the Schrödinger wave function is relativistically derived from equation (7A) in a way comparable to section (3) where the relativistic Dirac equation is derived from the same equation (7A). This demonstrates a further correspondence between the hypothetical electromagnetic complex wave functions $\vec{\Phi}(\vec{x},t)$ and $\vec{\Phi}^*(\vec{x},t)$ and the quantum mechanical complex probability wave functions $\Psi(\vec{x},t)$ and $\Psi^*(\vec{x},t)$, while both equations (1A) and (2A) describe real physical processes.

To clarify the relativistic derivation of the Schrödinger wave equation from the continuity equation (2A), a brief introduction is given in special relativity which describes the transformations of space, time and electromagnetism in any inertial system. Because a uniform velocity relative to an object in a coordinate system Σ can be described as a one dimensional movement by a rotation of the coordinate system, an explanation is given for a one dimensional Lorentz transformation along the 1-axis which is indicated in the following as x-axis.

A monochromatic electromagnetic wave with frequency ω and amplitude E_0 is considered, confined in an arbitrary system. The considered one dimension (indicated as the x-axis) is parallel to the observer's direction of movement. In this description of 1-dimension a confined electromagnetic wave can be described as:

$$\vec{E}(\vec{x},t) = \vec{E}_0 \sin(\omega t)\sin(kx) \tag{8A}$$

In which "k" equals $2\pi/\lambda$ in which λ is the wavelength of the confined monochromatic wave. When an observer is moving relative to the confined wave (along the x-axis), a transformed frequency, wavelength, x-coordinate and t-coordinate are observed. It is impossible to transform equation (1) by a Lorentz transformation, because every confined wave has to be considered as the superposition of waves propagating away from the observer and waves in opposite direction. For that reason (8A) is written as:

$$\vec{E}(\vec{x},t) = \frac{\vec{E}_0}{2}[\cos(\omega t - kx) - \cos(\omega t + kx)] \tag{9A}$$

The Lorentz transformation depends on the relative velocity. For waves propagating towards the observer (the velocity of the observer relative to the confining system is "$+v$") an increased frequency $^+\omega$ is measured while waves moving in opposite direction are observed with a decreased frequency $^-\omega$. The shifted frequency $^+\omega$ of the waves moving towards the observer is described by the zero component of the wave 4-vector (24), which transforms as follows:

$$^{+}\omega' =^{+} k^{0'} =^{+} L^{0}_{a} k^{a} = \gamma\omega(1 + \frac{v}{c}) \tag{10A}$$

in which $^{+}L^{0}_{a}$ is the Lorentz transformation tensor, presented in (57A). The frequency of the waves moving away from the observer is observed as $^{-}\omega'$ and equal to:

$$^{-}\omega' =^{-} k^{0'} =^{-} L^{0}_{b} k^{b} = \gamma\omega(1 - \frac{v}{c}) \tag{11A}$$

in which $^{-}L^{0}_{b}$ is given in (58A). In a comparable way the x-component "k_x" of the wave 4-vector k_a transforms as follows:

$$^{+}k'_x =^{+} k'_1 =^{+} L^{1}_{b} k^{b} = \frac{\gamma\omega}{c}(1 + \frac{v}{c}) \tag{12A}$$

for the waves moving toward the observer, and as follows

$$^{-}k'_x =^{-} k'_1 =^{-} L^{1}_{b} k^{b} = \frac{\gamma\omega}{c}(1 - \frac{v}{c}) \tag{13A}$$

for the waves moving in the same direction as the observer. The coordinate x, which is the 1-component of the Minkowski 4-vector x^a will transform thus:

$$x' = L^{1}_{a} x^{a} = \gamma(x - vt) \tag{14A}$$

(The coordinate system Σ' is connected to the moving observer and the system Σ is connected to the confining system) The coordinate ict, which is the 0-component of the 4-vector x^a will transform thus:

$$ict' = L^{0}_{a} x^{a} = ic\gamma(t - \frac{vx}{c^2}) \tag{15A}$$

The first part of (9A) presents the waves travelling in the positive x-direction and are moving in the same direction as the observer. They will be observed with a lowered frequency. The second term in (9A) presents the waves travelling towards the observer and are measured with an increased frequency. The observer perceives the transformed wave:

$$\vec{E}(\vec{x}, t) = \frac{\gamma\vec{E}_0}{2}[\cos(^{-}\omega' t' -^{-} k' x') - \cos(^{+}\omega' t' +^{+} k' x')] \tag{16A}$$

Substituting (10A) up to and including (13A) in (16A) results in:

$$\begin{aligned}\vec{E}(\vec{x},t) = & \frac{\gamma \vec{E}_0}{2}[\cos\{\gamma\omega(1-\frac{v}{c})t' - \gamma k(1-\frac{v}{c})x'\}] \\ & - \frac{\gamma \vec{E}_0}{2}[\cos\{\gamma\omega(1+\frac{v}{c})t' + \gamma k(1+\frac{v}{c})x'\}]\end{aligned} \tag{17A}$$

subsequently, (17A) is written in a way comparable to (8A). Using the simple goniometric equation:

$$\cos(p) - \cos(q) = 2\sin(\frac{p+q}{2})\sin(\frac{q-p}{2}) \tag{18A}$$

(17A) can be written as:

$$\vec{E}'(\vec{x}',t') = \gamma \vec{E}_0 \sin(\gamma\omega t' + \frac{\gamma k v x'}{c})\sin(\gamma k x' + \frac{\gamma\omega v t'}{c}) \tag{19A}$$

Introducing the phases α and β, (19A) is presented by:

$$\vec{E}'(\vec{x}',t') = \gamma \vec{E}_0 \sin(\beta)\sin(\alpha) \tag{20A}$$

Equation (20A) is comparable with the first part of (27) (in the article), while α and β are presented in a comparable way in (28) and (29) for a 1-dimensional wave. The second part of (27) follows from the complete Lorentz transformation for electromagnetic fields which implies that a part (proportional to v/c) of an electric field is transformed into a magnetic field and a part of a magnetic field (proportional to v/c) is transformed into an electric field due to the transformation of the 4-potential.

The wave in (19A) propagates with an apparent phase velocity[19,p.145], related to the phase β, indicated as v_β:

$$v_\beta = \frac{x'}{t'} = -\frac{\gamma\omega}{\gamma k v/c} \tag{21A}$$

Using the basic relation $k = \omega/c$, (21A) changes into:

$$v_\beta = -\frac{c^2}{v} \tag{22A}$$

In the original article the relative velocity between the observer and the confining system is indicated as the group velocity v_G and (22A) is comparable to (30). The “negative” sign indicates that the observed wave propagates with an apparent phase velocity, inversely proportional to the momentum of the confined wave, towards the observer. From the phase β in (19A) it follows that the observed wavelength λ equals:

$$\lambda = \frac{2\pi}{k'} = \frac{2\pi c}{\gamma k v} = \frac{c^2}{f\gamma v} = \frac{m_0 c^2}{f m v} = \frac{W_0}{fp} \tag{23A}$$

substituting (21) in (23A) results in:

$$\lambda = \frac{h_E}{p} \tag{24A}$$

Equation (24A) shows that the observed wavelength λ is inversely proportional to the momentum ”p” of the confined electromagnetic radiation, which is a characteristic phenomenon for probability waves. Substituting (14A) and (15A) into (19A) yields:

$$\beta = (\gamma\omega t' + \frac{\gamma k v x'}{c}) = (\gamma^2\omega(t - \frac{vx}{c^2}) + \frac{\gamma^2\omega v}{c^2}(x - vt)) = \omega t \tag{25A}$$

This means that the phase β is Lorentz invariant. In a comparable way the phase α equals:

$$\alpha = (\gamma k x' + \frac{\gamma\omega v t'}{c}) = (\gamma^2 k(x - vt) + \gamma^2 k v(t - \frac{vx}{c^2})) = kx \tag{26A}$$

Equation (26A) proves that also the phase α is Lorentz invariant, which is a necessary requirement for a Lorentz transformation.

To derive the Schrödinger equation (56) from (7A) relativistically, a Lorentz transformation is required of the Maxwell energy-momentum tensor (8). Substituting (1) and (2) into (4) (in the article), the Maxwell tensor is presented by:

$$F_{ab} = \begin{pmatrix} 0 & -\frac{i}{c}E_x & -\frac{i}{c}E_y & -\frac{i}{c}E_z \\ \frac{i}{c}E_x & 0 & -B_z & B_y \\ \frac{i}{c}E_y & B_z & 0 & -B_x \\ \frac{i}{c}E_z & -B_y & B_x & 0 \end{pmatrix} \tag{27A}$$

In non-relativistic units the inhomogeneous Maxwell equation (6) becomes:

$$\partial_b F_{ab} = -\mu_0 j_a \tag{28A}$$

Substituting (5) in the covariant Maxwell equation (28A) and using (27A), this results in the inhomogeneous Maxwell equation for "a" varying from 1 and "b" varying from 0 up to and including 3:

$$\nabla \times \vec{B} - \frac{1}{c^2}\frac{\partial \vec{E}}{\partial t} = \mu_0 \vec{j} \tag{29A}$$

and for "a" $= 0$ and "b" varying from 1 up to and including 3 for the inhomogeneous Maxwell equation:

$$\nabla \cdot \vec{E} = \frac{\rho}{\epsilon_0} \tag{30A}$$

The homogeneous Maxwell equations are presented by (7). Using (27A) and for $a = 1$, $c = 2$ and $b = 3$, this results in:

$$\nabla \cdot \vec{B} = 0 \tag{31A}$$

and for the values $a = 0$ and b and c varying from 1 up to and including 3, (7) results in:

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \tag{32A}$$

In the absence of gravity the energy-momentum tensor (8) reduces for non-relativistic units to:

$$T_{ab} = \frac{1}{\mu_0}(F_{ac}F_{cb} + \frac{1}{4}\delta_{ab}F_{cd}F^{cd}) \tag{33A}$$

Substitution of (27A) in (33A) gives the result that T_{00} equals the electromagnetic energy density "w":

$$T_{00} = \frac{1}{2}(\epsilon_0 E^2 + \frac{B^2}{\mu_0}) = w \tag{34A}$$

and for the terms (T_{01}, T_{02}, T_{03}):

$$(T_{01}, T_{02}, T_{03}) = \frac{-i}{c}(S_x, S_y, S_z) = \frac{-i}{c}\vec{S} \tag{35A}$$

in which $\vec{S}$ is the Poynting vector $\vec{S} = \vec{E} \times \vec{B}/\mu_0$. In the absence of external confining forces, the row icT_{ab} (for $a = 0$) in the tensor (33A), transforms like a (pseudo-) 4-vector and is introduced as the Poynting 4-vector in (36), which modulus is Lorentz invariant under inertial movements relative to the observer.

Substituting the Lorentz invariant quantities: the interval $ds = \sqrt{-x^a x^a}$, the restmass m_0, the speed of light c, the scalar product $A^a x^a$, and the electric charge q in the action integral S, results in:

$$S = \int_{t_1}^{t_2} [-m_0 c ds + q(\vec{A} \cdot d\vec{r} - \varphi dt)] \tag{36A}$$

Separating the time-interval dt in (36A) results in:

$$S = \int_{t_1}^{t_2} [-m_0 c\sqrt{1 - \frac{v^2}{c^2}} + q(\vec{A} \cdot \vec{v} - \varphi)]dt = \int_{t_1}^{t_2} L dt \tag{37A}$$

where "L" is the Lagrangian. The action integral "S" is zero over a small time-interval $t_1 - t_2$ when "L" satisfies the Euler-Lagrange equation:

$$\frac{d}{d}(\frac{\partial L}{\partial \vec{v}}) - \frac{\partial L}{\partial \vec{r}} = 0 \tag{38A}$$

Equation (38A) is split up into two parts:

$$\frac{\partial L}{\partial \vec{v}} = \frac{m_0 \vec{v}}{\sqrt{\frac{1-v^2}{c^2}}} + q\vec{A} = p + q\vec{A} \tag{39A}$$

and:

$$\frac{\partial L}{\partial \vec{r}} = \nabla L = q(\nabla(\vec{A} \cdot \vec{v}) - \nabla \varphi) \tag{40A}$$

Substituting (39A) and (40A) into (38A) leads to the Lorentz invariant equation:

$$\frac{d\vec{p}}{dt} = -q\frac{\partial \vec{A}}{\partial t} - q\nabla\varphi + q(\vec{v} \times (\nabla \times \vec{A})) \tag{41A}$$

Substituting (1) and (2) in (41A) gives the Lorentz invariant equation for the mechanical force $\vec{F}$ acting on a charged mass in an electromagnetic field:

$$\vec{F} = \frac{dp}{dt} = q(\vec{E} + \vec{v} \times \vec{B}) \tag{42A}$$

The current 4-vector J^a is defined as:

$$J^a = qv^a = q(ic, v_x, v_y, v_z) \tag{43A}$$

The current density 4-vector is defined in (5) and is presented in a similar way as (43A):

$$j^a = (ic\rho, \vec{j}) = \rho v^a = \rho(ic, v_x, v_y, v_z) \tag{44A}$$

The force density 3-vector $\vec{f}$ is now defined, according to (42A), as:

$$\vec{f} = \rho(\vec{E} + \vec{v} \times \vec{B}) \tag{45A}$$

Then the force density 4-vector can be presented as:

$$f^a = -F^{ab} j^b \tag{46A}$$

which follows from substitution of (27A) and (44A) in (46A) and gives a similar result as equation (45A). Substituting (28A) in (46A) yields:

$$f^a = \frac{1}{\mu_0} F^{ab} \partial_c F_{bc} = \partial_b T^{ab} \tag{47A}$$

From (47A) it follows that in 3 dimensions the mechanical force $\vec{F}$ acting on an arbitrary electromagnetic confinement equals:

$$\vec{F} = \int \vec{f} dV = \int_{volume} \nabla \cdot \vec{\vec{T}} dV = \int_{surface} n \cdot \vec{\vec{T}} dS \tag{48A}$$

For that reason the energy-momentum tensor is often presented by:

$$T^{ab} = \begin{pmatrix} w & \frac{-i}{c}\vec{S} \\ \frac{-i}{c}\vec{S} & \vec{\vec{t}} \end{pmatrix} \tag{49A}$$

in which the tension sub-tensor $\vec{\vec{t}}$ describes the force density acting on the electromagnetic confinement. The momentum 4-vector in (33) is presented by:

$$p^a = \frac{i}{c} \int_{volume} T^{a0} dV \tag{50A}$$

which equation equals (39) in the article. In this example a simplified energy-momentum tensor is chosen that describes the confinement of a monochromatic electromagnetic wave, presented in 8A, which propagates along the x-axis between perfect reflecting mirrors, which counterbalance the radiation pressure due to the confinement. This balance is e.g. realized by putting an opposite electric charge on both perfect reflecting mirrors. When the energy density $w_S = 1/2E_x^2$ of this static electric field equals the energy density w_D of the confined electromagnetic radiation, averaged over the period time, the system is in balance and under that restriction the Lorentz transformation of the energy-momentum tensor is allowed. The energy-momentum tensor equals:

$$T^{ab} = \begin{pmatrix} w_S + w_D & \frac{-i}{c} S_x & 0 & 0 \\ \frac{-i}{c} S_x & w_S - w_D & 0 & \epsilon_0 E_x E_z \\ 0 & 0 & T_{22} & 0 \\ 0 & \epsilon_0 E_x E_z & 0 & T_{33} \end{pmatrix} \tag{51A}$$

where w_S is the static energy density due to the electric charge on both confining mirrors and equals:

$$w_S = \frac{1}{2}\epsilon_0 E_x^2 \tag{52A}$$

and w_D is the dynamic energy density of the confined electromagnetic radiation, propagating along the x-axis:

$$w_D = \frac{1}{2}\epsilon_0 E_z^2 + \frac{1}{2\mu_0} B_y^2 \tag{53A}$$

The term T_{22} equals:

$$T_{22} = \frac{1}{\mu_0} B_y^2 - w_S - w_D \tag{54A}$$

and the term T_{33} is equal to:

$$T_{33} = \epsilon_0 E_z^2 - w_S - w_D \tag{55A}$$

From (51A) it follows that the trace T^{aa} of the energy-momentum tensor is zero. The Lorentz transformation of (52A) is described by:

$$T^{cd'} = L_a^c T^{ab} L_b^d \tag{56A}$$

in which the tensor L_a^c equals:

$$L_a^c = \begin{pmatrix} \gamma & \frac{i\gamma v}{c} & 0 & 0 \\ \frac{-i\gamma v}{c} & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \tag{57A}$$

and the tensor L_b^d equals:

$$L_b^d = \begin{pmatrix} \gamma & -\frac{i\gamma v}{c} & 0 & 0 \\ \frac{i\gamma v}{c} & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \tag{58A}$$

Substituting (51A), (57A) and (58A) in (56A) results in the term T'_{00} of the transformed energy-momentum tensor:

$$T'_{00} = w'_D + w'_S = \gamma^2((1 + \frac{v^2}{c^2})w_D + \frac{w_S}{\gamma^2} - \frac{2vS_x}{c^2}) \tag{59A}$$

and for the transformed term T'_{10}:

$$T'_{10} = -\frac{i}{c}S'_x = -\frac{i\gamma^2}{c}((1 + \frac{v^2}{c^2})S_x - 2vw_D) \tag{60A}$$

The quantity S_x describes the dynamic part of the Poynting vector and is indicated in the article as S_{DX}. Than (60A) can be written as:

$$S'_{DX} + S'_{SX} = \gamma^2((1 + \frac{v^2}{c^2})S_{Dx} + \frac{S_{SX}}{\gamma^2} - 2vw_D) \tag{61A}$$

The transformations (59A) and (61A) are presented in the article in equation (41). The 0-component of equation (47A) equals:

$$f^0 = -F^{0b}j^b = \partial_b T^{0b} \tag{62A}$$

Using (46A) to determine f^0 and substituting (33A) in (62A) results in the Poynting Theorem, better known as the continuity equation:

$$\vec{E} \cdot \vec{J} = -\frac{\partial w}{\partial t} - \nabla \cdot \vec{S} \tag{63A}$$

In the absence of gravity and in a perfect vacuum the left hand side of (62A) equals zero. In the article it was demonstrated (equation 56) that the Schrödinger equation is a special notation for:

$$\partial_b T^{0b} = 0 \tag{64A}$$

at non-relativistic velocities, so that the energy and the momentum are observed as separated quantities in which circumstance the Schrödinger equation controls the energy domain.

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