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Introduction into 4-Dimensional Quantum Physics

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Abstract. Until the introduction of Special Relativity by Hendrik Antoon Lorentz, Herman Minkovski and Albert Einstein in 1905 and General Relativity by Albert Einstein in 1916, Physics has been 3-Dimensional. After this period, Physics became in generally 4-Dimensional with the time as the fourth dimension. For that reason it is remarkable that till now quantum physics has been described by 3-dimensional equations like the Schrödinger wave equation and the relativistic Dirac equation.

In this article the 4-Dimensional Relativistic Quantum Mechanical Dirac Equation expressed in the vector probability functions and the complex conjugated vector probability function will be published. To realize this, the classical boundaries of physics has to be changed. It is necessary to go back in time 300 years ago. More than 200 years ago before the Dirac Equation had been published.

A Return to the Inception of Physics. The time of Isaac Newton who published in 1687 in the "Philosophiae Naturalis Principia Mathematica" a Universal Fundamental Principle in Physics which was in Harmony with Science and Religion. The Universal Path, the Leitmotiv, the Universal Concept in Physics. Newton found the concept of "Universal Equilibrium" which he formulated in his famous third equation Action = - Reaction. This article presents a New Kind of Physics based on this Universal Fundamental Concept in Physics which results in a New Approach in Quantum Physics and General Relativity.

The physical concept of quantum mechanical probability waves has been created during the famous 1927 5th Solvay Conference. During that period there were several circumstances which came together and made it possible to create an unique idea of material waves being complex (partly real and partly imaginary) and describing the probability of the appearance of a physical object (elementary particle). The idea of complex probability waves was new in the beginning of the 20th century. Since then the New Concept has been protected carefully within the Copenhagen Interpretation. When Schrödinger published his famous material wave equation in 1926, he found spherical and elliptical solutions for the presence of the electron within the atom. The first idea of the material waves in Schrödinger's wave equation was the concept of confined Electromagnetic Waves. But according to Maxwell this was impossible. According to Maxwell's equations Electromagnetic Waves can only propagate along straight lines and it is impossible that Light (Electromagnetic Waves) could confine with the surface of a sphere or an ellipse. For that reason these material waves in Schrödinger's wave equation could only be of a different origin than Electromagnetic Waves. Niels Bohr introduced the concept of "Probability Waves" as the origin of the material waves in Schrödinger's wave equation. And defined the New Concept that the electron was still a particle but the physical presence of the electron in the Atom was equally divided by a spherical probability function.

In the New Theory it will be demonstrated that because of a mistake in the Maxwell Equations, in 1927 Confined Electromagnetic waves could not be considered to be the material waves expressed in Schrödinger's wave equation. The New Theory presents a new equation describing electromagnetic field configurations which are also solutions of the Schrodinger's wave equation and the relativistic quantum mechanical Dirac Equation and carry mass, electric charge and magnetic spin at discrete values.

Key words: General Relativity; Quantum Physics; Dirac Equation; Gravitational-Electromagnetic Interaction; Black Holes; Gravitational-Electromagnetic Confinement; Electromagnetism; Quantum Optics

Introduction

The physical concept of quantum mechanical probability waves has been created during the famous 1927 5th Solvay Conference resulting in the general accepted Copenhagen Interpretation.

The physical concept of quantum mechanical probability waves has been created during the famous 1927 5th Solvay Conference. During that period there were several circumstances which came just together and made it possible to create an unique idea of material waves being complex (partly real and partly imaginary) and describing the probability of the appearance of a physical object (elementary particle).

The idea of complex probability waves was completely new in the beginning of the 20th century and it is hard to believe that this strange non- scientific concept of probability waves has been created at a famous scientific Conference like the 1927 5th Solvay Conference. Since then the New Concept has been protected carefully within the Copenhagen Interpretation.

When Schrödinger published his famous material wave equation in 1926, he found spherical and elliptical solutions for the presence of the electron within the atom. With that outcome Bohr's model of the atom completely fell apart. Because in Bohr's model of the atom an electron as a particle can only exist at one place at one time. But according to the solutions of the wave equations, for a spherical solution the electron is everywhere at the same time dived equally along a sphere.

Literature Review

And now lines in history come together. The first idea of the material waves in Schrödinger's wave equation was the concept of confined Electromagnetic Waves. But according to Maxwell this was impossible. According to Maxwell's equations Light (Electromagnetic Waves) can only propagate along straight lines and it is impossible that Light (Electromagnetic Waves) could confine with the surface of a sphere or an ellipse.

For that reason these material waves in Schrödinger's wave equation could only be of a different origin than Electromagnetic Waves. And that conclusion opened for Niels Bohr the opportunity to save the general accepted model of the atom.

Niels Bohr introduced the unusual concept of "Probability Waves" as the origin of the material waves in Schrödinger's wave equation. And defined the New Concept that the electron was still a particle but the physical presence of the electron in the Atom was equally divided by a spherical probability function. And like Maxwell also Niels Bohr chose for the problem-solving approach.

Niels Bohr solved two problems at the same time. He found an answer for the origin of the material waves in Schrödinger's wave equation and he could keep the general accepted model of the atom.

Materials and Methods

This article presents a pure theoretical study in physics during the last 30 years. Fundamental experiments are required to test the new theory.

Back to the Roots

To change the nowadays popular concept of "Problem Solving Physics" into "Fundamental Physics" we have to go back in time for over 300 years. Back to the time when the vast areas of Science, Religion and Magic met each other and often collided towards each other in an unknown challenging world.

Back to the time of Isaac Newton who published in 1687 in the "Philosophiae Naturalis Principia Mathematica" a Universal Fundamental Principle in Physics in Harmony with Religion. The Universal Path, the Leitmotiv, the Universal Concept in Physics which was fundamental in science and not in conflict with the Catholic Church. Newton found the concept of "Universal Equilibrium" which he formulated in his famous third equation Action = -Reaction. In nowadays math the concept of "Universal Equilibrium" has been formulated as:

$$\sum_{i=0}^{i=n} \overline{\mathrm{F}_\mathrm{i}} = 0 \tag{1}$$

Because the Inertia Force is a Reaction Force, the Inertia Force appears in the equation with a minus sign.

$$\sum_{i=0}^{i=n} \overline{\mathrm{F}_\mathrm{i}} - \mathrm{m}\,\overline{\mathrm{a}} = 0 \tag{2}$$

Equation (2) is a general presentation of Newton's famous second law of motion. In a fundamental way, Newton's second law of motion describes the required electromagnetic equation for the Gravitational-Electromagnetic Interaction in general terms, including Maxwell's theory of Electrodynamics published in 1865 in the article: "A Dynamic Theory of the Electromagnetic Field" and Einstein's theory of General Relativity published in 1911 the article: "On the Influence of Gravitation on the Propagation of Light".Because Maxwell's 4 equations are not part of one whole uniform understanding of the universe like the fundamental equation of Newton's second law of motion represents, Maxwell's theory is missing a fundamental foundation. Newton's second law of motion has been based on a profound understanding of the universe which is based on the fundamental principle of Harmony and Equilibrium, expressed in equation (2). To describe the interaction between light and gravity and to understand electromagnetic waves and their interaction and to understand the concept of "photons" it is important to define the fundamental equation for the electromagnetic field based on the fundamental principle of Harmony and Equilibrium formulated by Newton in 1687 and published in his famous work: "Philosophiae Naturalis Principia Mathematica (Mathematical Principles of Natural Philosophy)".

To realize this, Newton's second law of motion will be the Ground, the Leitmotiv, the Universal Concept in Physics on which the New Theory will be built. The fundamental Electromagnetic force density equation has been based integral on Newton's second law of motion and has been divided into 5 separate terms (B-1 – B-5), each one describing a part of the electromagnetic and inertia force densities.

$$\sum_{i=0}^{i=5} \mathrm{B}_\mathrm{i} = 0 \tag{3}$$

The first term B-1 represents the inertia of the mass density of light (Electromagnetic Radiation). The terms B-2 and B-3 represent the electric force densities within the Electromagnetic Radiation (Beam of Light) and the terms B-4 and B-5 represent the magnetic force densities within the Electromagnetic Radiation (Beam of Light). Fundamental in the New Theory is the outcome of (3) which always has to be zero according to Newton's fundamental principle of "Universal Equilibrium". To apply the concept of "Universal Equilibrium" within an electromagnetic field, the electric forces $\mathrm{F}_{\mathrm{Electric}}$, the magnetic forces $\mathrm{F}_{\mathrm{Magnetic}}$ and the inertia forces will be presented separately in equation (3):

$$\sum_{i=0,\,j=0}^{i=n,\,j=m} \left(\overline{\mathrm{F}_{\mathrm{Electric\text{-}i}}} + \overline{\mathrm{F}_{Magnetic-j}} - \mathrm{m}\,\overline{\mathrm{a}} \right) = 0 \tag{4}$$

The Inertia of Light (Term B-1)

Reducing Equation (2) to one single Force $\overline{F}$, equation (2) will be written in the well-known presentation:

$$\overline{F} = m\,\overline{a} \tag{5}$$

The right and the left term of Newton's law of motion in equation (5) has to be divided by the Volume "V" to find an equation for the force density $\overline{f}$ related to the mass density "ρ".

$$\begin{aligned} \overline{F} &= m\,\overline{a} \\ \left(\frac{\overline{F}}{V}\right) &= \left(\frac{m}{V}\right)\overline{a} \\ \overline{f} &= \rho\,\overline{a} \end{aligned} \tag{6}$$

The Inertia Force $\overline{F_{Inertia}}$ for Electromagnetic Radiation will be derived from Newton's second law of motion, using the relationship between the momentum vector $\overline{p}$ for radiation expressed by the Poynting vector $\overline{S}$:

$$\overline{F_{INERTIA}} = -m\,\overline{a} = -m\frac{\Delta\,\overline{v}}{\Delta\,t} = -\frac{\Delta\left(m\overline{v}\right)}{\Delta\,t} = -\frac{\Delta\,\overline{p}}{\Delta\,t} = -\left(\frac{V}{c^2}\right)\frac{\Delta\overline{S}}{\Delta t} \tag{7}$$

Dividing the right and the left term in equation (7) by the volume V results in the inertia force density $\overline{f_{Inertia}}$:

$$\begin{aligned} \overline{F_{INERTIA}} &= -m\,\overline{a} = -m\frac{\Delta\overline{v}}{\Delta t} = -\frac{\Delta\left(m\overline{v}\right)}{\Delta\,t} = -\frac{\Delta\overline{p}}{\Delta t} = -\left(\frac{V}{c^2}\right)\frac{\Delta\overline{S}}{\Delta t} \\ \frac{\overline{F_{INERTIA}}}{V} &= -\frac{m}{V}\overline{a} = -\frac{m}{V}\frac{\Delta\,\overline{v}}{\Delta\,t} = -\frac{1}{V}\frac{\Delta\,\overline{p}}{\Delta\,t} = -\left(\frac{1}{c^2}\right)\frac{\Delta\,\overline{S}}{\Delta\,t} \\ \overline{f_{INERTIA}} &= -\rho\,\overline{a} = -\left(\frac{1}{c^2}\right)\frac{\Delta\,\overline{S}}{\Delta\,t} \quad \left[N/\,m^3\right] \end{aligned} \tag{8}$$

The Poynting vector $\overline{S}$ represents the total energy transport of the electromagnetic radiation per unit surface per unit time [J / m^2 s]. Which can be written as the cross product of the Electric Field intensity $\overline{E}$ and the magnetic Field intensity $\overline{H}$.

$$\begin{aligned} \overline{f_{INERTIA}} &= -\rho a = -\left(\frac{1}{c^2}\right)\frac{\Delta\,S}{\Delta\,t} = -\left(\frac{1}{c^2}\right)\frac{\Delta\left(\overline{E}\times\overline{H}\right)}{\Delta\,t}\left[N/\,m^3\right] \\ \overline{f_{INERTIA}} &= -\left(\frac{1}{c^2}\right)\frac{\partial\left(\overline{E}\times\overline{H}\right)}{\partial\,t}\left[N/\,m^3\right] \end{aligned} \tag{9}$$

Coulomb's Law (Colomb Force) for Electromagnetic Radiation (Term B-2 and B-4)

An example of the Coulomb Force is the Electric Force $F_{Coulomb}$ acting on an electric charge Q placed in an electric field E. The equation for the Coulomb Force equals:

$$\overline{F_{Coulomb}} = \overline{E}\,Q \quad [N] \tag{10}$$

Dividing the right and the left term in equation (10) by the volume V results in the Electric force density $\overline{f_{Coulomb}}$:

$$\overline{F}_{COULOMB} = \overline{E}\, Q \quad [N]$$
$$\frac{\overline{F}_{COULOMB}}{V} = \overline{E}\, \frac{Q}{V} \quad [N/\,m^3] \qquad (11)$$
$$\overline{f}_{COULOMB} = \overline{E}\, \rho_E \quad [N/\,m^3]$$

Substituting Gauss's law in differential form in (11) results in Coulombs Law for Electromagnetic Radiation for the Electric force density $\overline{f_{Coulomb}}$:

$$\overline{f}_{COULOMB} = \overline{E}\, \rho_E$$
$$\overline{f}_{COULOMB} = \overline{E}\, \rho_E = \overline{E}\left(\nabla \,.\, \overline{D}\right) \qquad (12)$$
$$\overline{f}_{COULOMB} = \overline{E}\left(\nabla \,.\, D\right) = \varepsilon\, \overline{E}\left(\nabla \,.\, \overline{E}\right) \quad [N/\,m^3]$$

In Electromagnetic Field Configurations, there is in general no preference for the electric force densities or the magnetic force densities. In general the equations for the electric field densities are universally exchangeable with the magnetic field densities. For the magnetic field densities, equation (12) can be written as:

$$\overline{f}_{Coulomb\,-\,Electric} = \overline{E}\left(\nabla .\, \overline{D}\right) = \varepsilon\, \overline{E}\left(\nabla .\, \overline{E}\right) \ [N/\,m^3] \ \text{(Term B-2)} \qquad (13)$$
$$\overline{f}_{Coulomb\,-\,Magnetic} = \overline{H}\left(\nabla .\, \overline{B}\right) = \mu\, \overline{H}\left(\nabla .\, \overline{H}\right) \ [N/\,m^3] \ \text{(Term B-4)}$$

Lorentz's Law (Lorentz Force) for Electromagnetic Radiation (Term B-3 and B-5)

An example of the Lorentz Force is the Magnetic Force $F_{Lorentz}$ acting on an electric charge Q moving with a velocity v within a magnetic field with magnetic field intensity B (magnetic induction).

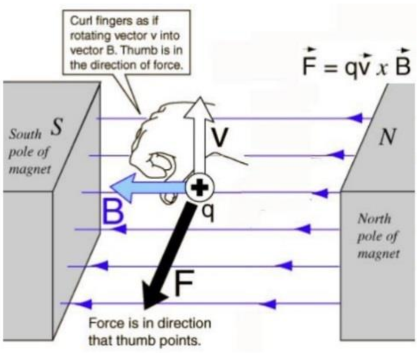

Figure 1. The Lorentz Force equals the cross product of the Magnetic Induction B and the velocity v of the charge q moving within the magnetic field times the value of the electric charge

The equation for the Lorentz Force equals:

$$\overline{F}_{LORENTZ} = Q\, \overline{v} \times \overline{B} \quad [N] \qquad (14)$$

Dividing the right and the left term in equation (14) by the volume V results in the Lorentz force density $\overline{f_{Lorentz}}$

$$\begin{aligned} \overline{F}_{LORENTZ} &= Q\,\overline{v} \times \overline{B} \quad [N] \\ \frac{\overline{F}_{LORENTZ}}{V} &= -\,\overline{B} \times \frac{Q\,\overline{v}}{V} \left[N/m^3\right] \\ \overline{f}_{LORENTZ} &= -\,\overline{B} \times \frac{Q\,\overline{v}}{V} = -\,\overline{B} \times \overline{j} = -\,\mu\,\overline{H} \times \overline{j} \left[N/m^3\right] \end{aligned} \tag{15}$$

In which q is the electric charge, v the velocity of the electric charge, B the magnetic induction and j the electric current density. Substituting Ampère's law in differential form in (15) results in Lorentz's Law for Electromagnetic Radiation for the Electric force density $\overline{f_{Lorentz}}$:

$$\begin{aligned} \overline{f}_{LORENTZ} &= -\,\mu\,\overline{H} \times \left(\overline{j}\right) \\ \overline{f}_{LORENTZ} &= -\,\mu\,\overline{H} \times \left(\overline{j}\right) = -\,\mu\,\overline{H} \times \left(\nabla \times \overline{H}\right) \left[N/m^3\right] \end{aligned} \tag{16}$$

In Electromagnetic Field Configurations, there is in general no preference for the electric force densities or the magnetic force densities. In general the equations for the electric field densities are universally exchangeable with the magnetic field densities. For the electric field densities, equation (16) can be written as:

$$\begin{aligned} \overline{f}_{Coulomb\text{ - }Electric} &= -\,\varepsilon\,\overline{E} \times \left(\nabla \times \overline{E}\right)\left[N/m^3\right] \quad \text{(Term B-3)} \\ \overline{f}_{Coulomb\text{ - }Magnetic} &= -\,\mu\,\overline{H} \times \left(\nabla \times \overline{H}\right)\left[N/m^3\right] \quad \text{(Term B-5)} \end{aligned} \tag{17}$$

The Fundamental Universal Equation for the Electromagnetic field (Term B-1 + Term B-2 + Term B-3 + Term B-4 + Term B-5)

Newton's second law of motion applied within any arbitrary electromagnetic field configuration results in the fundamental equation (23) for any arbitrary electromagnetic field configuration (a beam of light):

NEWTON: $F_{TOTAAL} = m\,a$ represents: $f_{TOTAAL} = \rho\,a$

$$\begin{aligned} -\rho\,a &+ f_{TOTAAL} = 0 \\ -\rho\,a &+ f_{ELEKTRISCH} + f_{MAGNETISCH} = 0 \\ -\rho\,a &+ F_{COULOMB} + F_{LORENTZ} + F_{COULOMB} + F_{LORENTZ} = 0 \\ -\frac{1}{c^2}\frac{\partial\,(\overline{E}\times\overline{H})}{\partial t} &+ \varepsilon_0\,\overline{E}\,(\nabla\cdot\overline{E}) - \varepsilon_0\,\overline{E}\times(\nabla\times\overline{E}) + \mu_0\,\overline{H}\,(\nabla\cdot\overline{H}) - \mu_0\,\overline{H}\times(\nabla\times\overline{H}) = 0 \end{aligned} \tag{23}$$

B-1 B-2 B-3 B-4 B-5

Term B-4 is the magnetic equivalent of the (electric) Coulomb's law B-2 and Term B-3 is the electric equivalent of the (magnetic) Lorentz's law B-5. The universal equation for the electromagnetic field (free electromagnetic waves and confined electromagnetic fields) has been presented in (24) and expresses the perfect equilibrium between the inertia forces (B-1), the electric forces (B-2 and B-3) and the magnetic forces (B-4 and B-5) in any arbitrary electromagnetic field configuration.

$$-\frac{1}{c^2}\frac{\partial\,(\overline{E}\times\overline{H})}{\partial t} + \varepsilon_0\,\overline{E}\,(\nabla\cdot\overline{E}) - \varepsilon_0\,\overline{E}\times(\nabla\times\overline{E}) + \mu_0\,\overline{H}\,(\nabla\cdot\overline{H}) - \mu_0\,\overline{H}\times(\nabla\times\overline{H}) = 0 \tag{24}$$

B-1 B-2 B-3 B-4 B-5

The Universal Integration of Maxwell's Theory of Electrodynamics

The universal equation (24) for any arbitrary electromagnetic field configuration can be written in the form:

$$-\frac{1}{c^2}\frac{\partial(\bar{E}\times\bar{H})}{\partial t}+\varepsilon_0\,\bar{E}(\nabla.\bar{E})-\varepsilon_0\,\bar{E}\times(\nabla\times\bar{E})+\mu_0\,\bar{H}(\nabla.\bar{H})-\mu_0\,\bar{H}\times(\nabla\times\bar{H})=0$$

$$-\varepsilon_0\mu_0\left(\bar{E}\times\frac{\partial(\bar{H})}{\partial t}+\bar{H}\times\frac{\partial(\bar{E})}{\partial t}\right)+\varepsilon_0\bar{E}(\nabla.\bar{E})-\varepsilon_0\bar{E}\times(\nabla\times\bar{E})+\mu_0\bar{H}(\nabla.\bar{H})-\mu_0\bar{H}\times(\nabla\times\bar{H})=0 \qquad (25)$$

$$-\left(\varepsilon_0\bar{E}\times\frac{\partial(\bar{B})}{\partial t}+\mu_0\bar{H}\times\frac{\partial(\bar{D})}{\partial t}\right)+\bar{E}(\nabla.\bar{D})-\varepsilon_0\bar{E}\times(\nabla\times\bar{E})+\bar{H}(\nabla.\bar{B})-\mu_0\bar{H}\times(\nabla\times\bar{H})=0$$

M-3 M-4 M-1 M-3 M-2 M-4

The Maxwell Equations are presented in (26):

$$\nabla.\bar{D}=\rho \quad \text{(M-1)} \qquad \nabla\times\bar{E}=-\frac{\partial B}{\partial t} \quad \text{(M-3)} \qquad (26)$$

$$\nabla.\bar{B}=0 \quad \text{(M-2)} \qquad \nabla\times\bar{H}=\frac{\partial D}{\partial t} \quad \text{(M-4)}$$

In vacuum in the absence of any charge density, it follows from (26) that all the solutions for the Maxwell's Equations are also solutions for the separate parts of the Universal Equation (25) for the Electromagnetic field.

Universal Equation for the Electromagnetic Field.

$$-\left(\varepsilon_0\bar{E}\times\frac{\partial(\bar{B})}{\partial t}+\mu_0\bar{H}\times\frac{\partial(\bar{D})}{\partial t}\right)+\bar{E}(\nabla.\bar{D})-\varepsilon_0\bar{E}\times(\nabla\times\bar{E})+\bar{H}(\nabla.\bar{B})-\mu_0\bar{H}\times(\nabla\times\bar{H})=0$$

M-3 M-4 M-1 M-3 M-2 M-4

(27)

4 Maxwell's Equations

$$\nabla.\bar{D}=\rho \quad \text{(M-1)} \qquad \nabla\times\bar{E}=-\frac{\partial B}{\partial t} \quad \text{(M-3)}$$

$$\nabla.\bar{B}=0 \quad \text{(M-2)} \qquad \nabla\times\bar{H}=\frac{\partial D}{\partial t} \quad \text{(M-4)}$$

Comparing the 4 Maxwell Equations (26) with the Universal Equation (24) we conclude that the 4 Maxwell equations show only the 4 parts of the Universal Dynamic Equilibrium in 4 separate terms and the 4 Maxwell equations are missing the fundamental term for inertia. For that reason it is impossible to calculate the interaction between light and gravity with the 4 Maxwell equations. To find the interaction terms between light and gravity the inertia term (B-1 in 24) is necessary.

Interaction between Gravity and Light (Electromagnetic Radiation)

To define the Fundamental Equation for the Interaction between Gravity and Light, an extra term (B-6) has been introduced in equation (24). The term B-6 represents the force density of the gravitational field acting on the electromagnetic mass density.

$$F_{GRAVITY}=m\,\bar{g}\ \ [N]$$

Dividing both terms by the Volume V: (28)

$$\frac{F_{GRAVITY}}{V}=\frac{m}{V}\,\bar{g}\ \ [N/m^3]$$

Results in the force density:

$$f_{GRAVITY}=\rho\,\bar{g}\ \ [N/m^3]$$

The specific mass "ρ" of a beam of light follows from Einstein's equation:

$$W = m\,c^2$$

Divinding both terms by the Volume V results in:

$$\frac{W}{V} = \frac{m}{V}\,c^2 \tag{29}$$

which represents the energy density "w" and the specific mass "ρ" of the electromagnetic radiation:

$$w = \rho\,c^2$$

which results for an expression of the specific mass ρ:

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

The energy density "w" follows from the electric and the magnetic field intensities:

$$w = \frac{1}{2}\,\varepsilon\,E^2 + \frac{1}{2}\,\mu\,H^2$$

$$w = \frac{1}{2}\left(\varepsilon\,E^2 + \mu\,H^2\right) = \frac{1}{2}\left(\varepsilon\left(\overline{E}\,.\,\overline{E}\right) + \mu\left(\overline{H}\,.\,\overline{H}\right)\right) \tag{30}$$

Substituting equation (30) in equation (29) results in the gravitational force density $f_{GRAVITY}$ acting on an arbitrary electromagnetic field configuration (a beam of light) with mass density ρ.

$$f_{GRAVITY} = \rho\,\overline{g}$$

$$f_{GRAVITY} = \rho\,\overline{g} = \varepsilon\,\mu\,w\,\overline{g} = \frac{1}{2}\left(\varepsilon^2\mu\left(\overline{E}\,.\,\overline{E}\right) + \varepsilon\,\mu^2\left(\overline{H}\,.\,\overline{H}\right)\right)\overline{g} \tag{31}$$

Substituting equation (31) in equation (24) results in the fundamental equation describing the Electromagnetic-Gravitational interaction for any arbitrary electromagnetic field configuration (a beam of light):

$$\text{NEWTON: } \overline{F}_{TOTAAL} = m\,\overline{a}\ [N]$$

$$\text{NEWTON: Expressed in force densities: } \overline{f}_{TOTAAL} = \rho\,\overline{a}\ [N/\,m^3] \tag{32}$$

$$-\rho\,\overline{a} + \overline{f}_{TOTAAL} = \overline{0}$$

$$-\rho\,\overline{a} + \overline{f}_{ELEKTRISCH} + \overline{f}_{MAGNETISCH} + \overline{f}_{GRAVITY} = \overline{0}$$

$$\overline{f}_{INERTIA} + \overline{f}_{COULOMB} + \overline{f}_{LORENTZ} + \overline{f}_{COULOMB} + \overline{f}_{LORENTZ} + \overline{f}_{GRAVITY} = \overline{0}$$

$$-\frac{1}{c^2}\frac{\partial(\overline{E}\times\overline{H})}{\partial t} + \varepsilon_0\,\overline{E}(\nabla.\overline{E}) - \varepsilon_0\,\overline{E}\times(\nabla\times\overline{E}) + \mu_0\,\overline{H}\,(\nabla.\overline{H}) - \mu_0\,\overline{H}\times(\nabla\times\overline{H}) + \frac{1}{2}\left(\varepsilon^2\mu\left(\overline{E}\,.\,\overline{E}\right) + \varepsilon\,\mu^2\left(\overline{H}\,.\,\overline{H}\right)\right)\overline{g} = \overline{0}$$

B-1 B-2 B-3 B-4 B-5 B-6

Term B-1 represents the inertia term of the electromagnetic radiation. Term B-4 is the magnetic representation of the (electric) Coulomb's Force B-2 and Term B-3 is the electric representation of the (magnetic) Lorentz Force B-5. Term B-6 represents the Electromagnetic-Gravitational interaction of a gravitational field with field acceleration $\overline{g}$ acting on an arbitrary electromagnetic field configuration (a beam of light) with specific mass ρ. The universal equation for the electromagnetic field (free electromagnetic waves and confined electromagnetic fields) within a gravitational field with gravity field intensity $\overline{g}$ has been presented in (33) and expresses the perfect equilibrium between the inertia forces (B-1), the electric forces (B-2 and B-3), the magnetic forces (B-4 and B-5) and the gravitational force (B-6) in any arbitrary electromagnetic field configuration.

$$- \frac{1}{c^2}\frac{\partial(\bar{E}\times\bar{H})}{\partial t} + \varepsilon_0 \bar{E}(\nabla.\bar{E}) - \varepsilon_0 \bar{E}\times(\nabla\times\bar{E}) + \mu_0 \bar{H}(\nabla.\bar{H}) -$$

B-1 B-2 B-3 B-4 (33)

$$-\mu_0 \bar{H}\times(\nabla\times\bar{H}) + \frac{1}{2}\left(\varepsilon^2\mu\left(\bar{E}.\bar{E}\right) + \varepsilon\mu^2\left(\bar{H}.\bar{H}\right)\right)\bar{g} = \bar{0}$$

B-5 B-6

The Confinement of Light (Electromagnetic Radiation)

When a beam of light is approaching a strong gravitational field in the direction of the gravitational field, generated by a Black Hole, the confinement has been called a Longitudinal Black Hole. The direction of propagation of the beam of light is in the same direction (or in the opposite direction) of the gravitational field. According to the first term in (33), the beam of light will be accelerated or decelerated. However, the speed of light is a universal constant and for that reason the speed of light cannot increase or decrease. Instead the intensity of the electromagnetic radiation will increase when the beam of light approaches (propagates in the opposite direction as the direction of the gravitational field) the Black Hole. And the intensity of the electromagnetic radiation will decrease when the beam of light leaves (propagates in the same direction as the direction of the gravitational field) the Black Hole.The Gravitational-Electromagnetic Confinement for the elementary structure beyond the "superstring" / "Black Hole" is presented in equation (34).

3-Dimensional Space Domain

$$\begin{pmatrix} x_3 \\ x_2 \\ x_1 \end{pmatrix} \quad - \frac{1}{c^2}\frac{\partial(\bar{E}\times\bar{H})}{\partial t} + \varepsilon_0 \bar{E}(\nabla.\bar{E}) - \varepsilon_0 \bar{E}\times(\nabla\times\bar{E}) + \mu_0 \bar{H}(\nabla.\bar{H}) - \mu_0 \bar{H}\times(\nabla\times\bar{H}) + \frac{1}{2}\left(\varepsilon^2\mu\left(\bar{E}\cdot\bar{E}\right) + \varepsilon\mu^2\left(\bar{H}\cdot\bar{H}\right)\right)\bar{g} = \bar{0} \quad (34)$$

In which $\bar{g}$ represents the gravitational acceleration acting on the electromagnetic mass density of the confined electromagnetic radiation. A possible solution for equation (34) describing an Electromagnetic-Gravitational confinement within a radial gravitational field with acceleration $\bar{g}$ has been represented in (35).

$$\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f(r) g(\theta) h(\varphi) \operatorname{Sin}(\omega t) \\ -f(r) g(\theta) h(\varphi) \operatorname{Cos}(\omega t) \end{pmatrix} \quad \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f(r) g(\theta) h(\varphi) \operatorname{Cos}(\omega t) \\ f(r) g(\theta) h(\varphi) \operatorname{Sin}(\omega t) \end{pmatrix} \quad \bar{g} = \begin{pmatrix} \frac{G_1}{4 \pi r^2} \\ 0 \\ 0 \end{pmatrix}$$

$$w_{em} = \left(\frac{\mu_0}{2} (\bar{m} . \bar{m}) + \frac{\varepsilon_0}{2} (\bar{e} . \bar{e}) \right) = \varepsilon_0 f(r)^2 = \frac{1}{2 \mu_0} \bar{\phi} . \overline{\phi *}$$

$$\bar{\phi} = \bar{B} + \frac{i}{c} \bar{E} = \begin{pmatrix} 0 \\ \frac{1}{c} f(r) \operatorname{Cos}(p\ \theta) \operatorname{Sin}(q\ \varphi) e^{i \omega t} \\ -\frac{i}{c} f(r) \operatorname{Cos}(p\ \theta) \operatorname{Sin}(q\ \varphi) e^{i \omega t} \end{pmatrix} \tag{35}$$

$$\bar{\phi} = \frac{1}{c} \begin{pmatrix} 0 \\ 1 \\ -i \end{pmatrix} f(r) \operatorname{Cos}(p\ \theta) \operatorname{Sin}(q\ \varphi) e^{i \omega t} = \frac{1}{c} \begin{pmatrix} 0 \\ 1 \\ -i \end{pmatrix} \psi$$

$$\overline{\phi *} = \bar{B} - \frac{i}{c} \bar{E} = \begin{pmatrix} 0 \\ \frac{1}{c} f(r) \operatorname{Cos}(p\ \theta) \operatorname{Sin}(q\ \varphi) e^{-i \omega t} \\ \frac{i}{c} f(r) \operatorname{Cos}(p\ \theta) \operatorname{Sin}(q\ \varphi) e^{-i \omega t} \end{pmatrix}$$

$$\overline{\phi *} = \frac{1}{c} \begin{pmatrix} 0 \\ 1 \\ i \end{pmatrix} f(r) \operatorname{Cos}(p\ \theta) \operatorname{Sin}(q\ \varphi) e^{-i \omega t} = \frac{1}{c} \begin{pmatrix} 0 \\ 1 \\ i \end{pmatrix} \psi *$$

Quantum Numbers: (p = 0,1,2,3....) and (q = 0,1,2,3.....)

In which the radial function f(r) equals:

$$f[r] = K\, e^{-\frac{-\frac{G1\, \varepsilon_0\, \mu_0}{r} + 8\pi \log[r]}{8\pi}} \tag{36}$$

The solution has been calculated according to Newton's Shell Theorem.

Confinement of Light (Electromagnetic Radiation) in the Region Smaller than "SuperStrings" with an Electromagnetic Mass of emm = 1.6726 x 10^{-27} [kg] and the Radius = 3 x 10^{-58} [m]

For an electromagnetic mass of the confinement: emm = 1.6726 x10^{-27} [kg] (mass of proton), the radius of the confinement equals approximately 3 x 10^{-58} [m]. This is far beyond the order of Planck's Length, The Plot graph of the Electric Field Intensity f(r) of the confinement has been presented as a function of the radius in Figure (2) and Figure (3):

$$Plot\left[e^{-\frac{-\frac{G1\, \varepsilon_0\, \mu_0}{r} + 8\pi \log[r]}{8\pi}}, \{r, 10^{-59}, 10^{-55}\} \right]$$

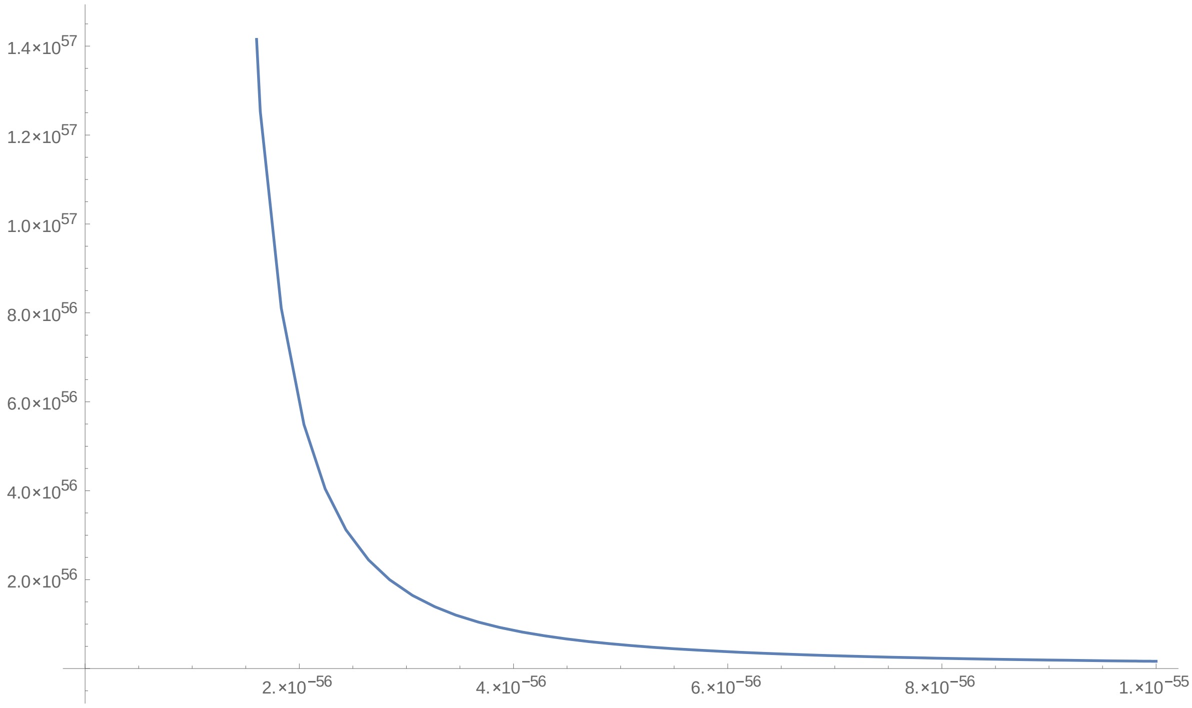

Figure 2. PlotGraph of the Electric Field Intensity f(r) [V/ m] for the region $10^{-59} < r < 10^{-55}$ [m] in which the gravitational field acceleration has been chosen accordingly an electromagnetic mass of 1.6 726 x 10^{-27} [kg] located at the center of the confinement, according to Newton's Shell Theorem

$$Plot\left[e^{-\frac{-\frac{G1\, \varepsilon_0\, \mu_0}{r} + 8\, \pi\, \log[r]}{8\, \pi}}, \{r, 10^{-59}, 10^{-57}\} \right]$$

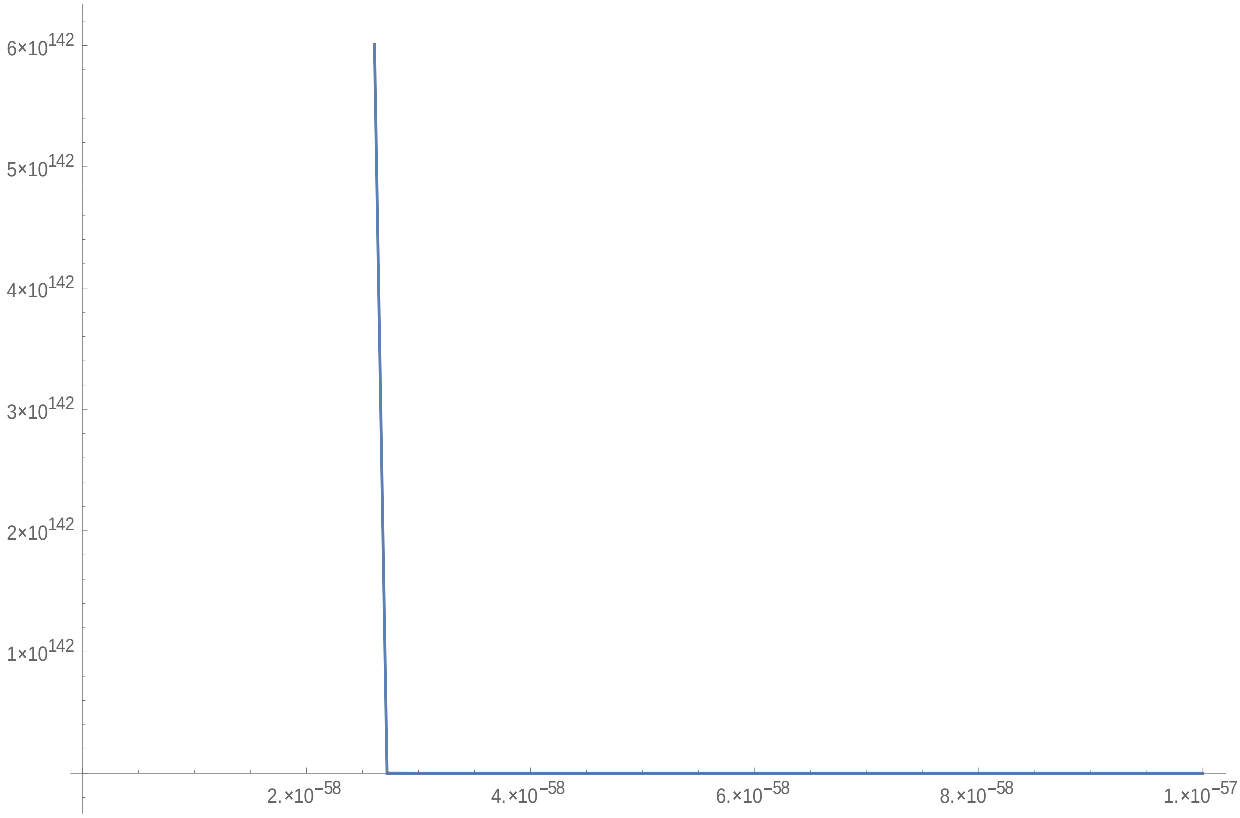

Figure 3. PlotGraph of the Electric Field Intensity f(r) [V/m] for the region $10^{-59} < r < 10^{-57}$ [m] in which the gravitational field acceleration has been chosen accordingly an electromagnetic mass of 1.6726 x 10^{-27} [kg] located at the center of the confinement, according to Newton's Shell Theorem

The fundamental question is: How it is possible to create confinements from "visible light" (with a wave length between 3.9 x 10^{-7} [m] until 7 x 10^{-7} [m]) within dimensions smaller than Planck's Length? This is only possible when the wave length of the confined radiation is smaller than de dimensions of the confinement. This requires extreme high frequencies. The transformation in frequency from visible light into the extreme high frequency of the confinement is possible because of the Lorentz/ Doppler transformation during the collapse of the radiation when the confinement has been formed (implosion of visible light).

Confinement of Light (Electromagnetic Radiation) in the Region of "Superstrings" with Dimensions in the Order of Planck's Length with an Electromagnetic Mass of 10^{-4} [kg] and a Radius = 2 x 10^{-35} [m])

Figure 4 and Figure 5 represent the electromagnetic field density (along the vertical axis) as a function of the distance (along the horizontal axis) of the center of the Confinement of Light with dimensions in the order of Planck's length. The chosen values equal:

$$
\begin{aligned}
& f[r] = K\, e^{-\frac{-\frac{G1\ \text{emm}\ \varepsilon_0\ \mu_0}{r} + 8\,\pi\,\log[r]}{8\,\pi}} \\
& G1 = 6.6740810^{-11} \\
& \text{emm} = 10^{-4}\ [\text{kg}] \\
& \varepsilon_0 = 8.8510^{-12} \\
& \mu_0 = 1.2566370614359172\,10^{-6}
\end{aligned}
\qquad (37)
$$

In which "emm" represents the electromagnetic mass of the confinement located at the center according to Newton's Shell Theorem. For an electromagnetic mass emm = 10^{-4} [kg] of the Confinement of Light, the radius of the confinement equals approximately 2 x 10^{-35} [m] and the first harmonic frequency equals 1.5 10^{27} [Hz]. The Plot graph of the Electric Field Intensity f(r) of the confinement has been presented as a function of the radius in Figure (4) and Figure (5):

$$Plot\left[e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\,\pi\,\log[r]}{8\,\pi}}, \{r, 10^{-36}, 10^{-25}\} \right]$$

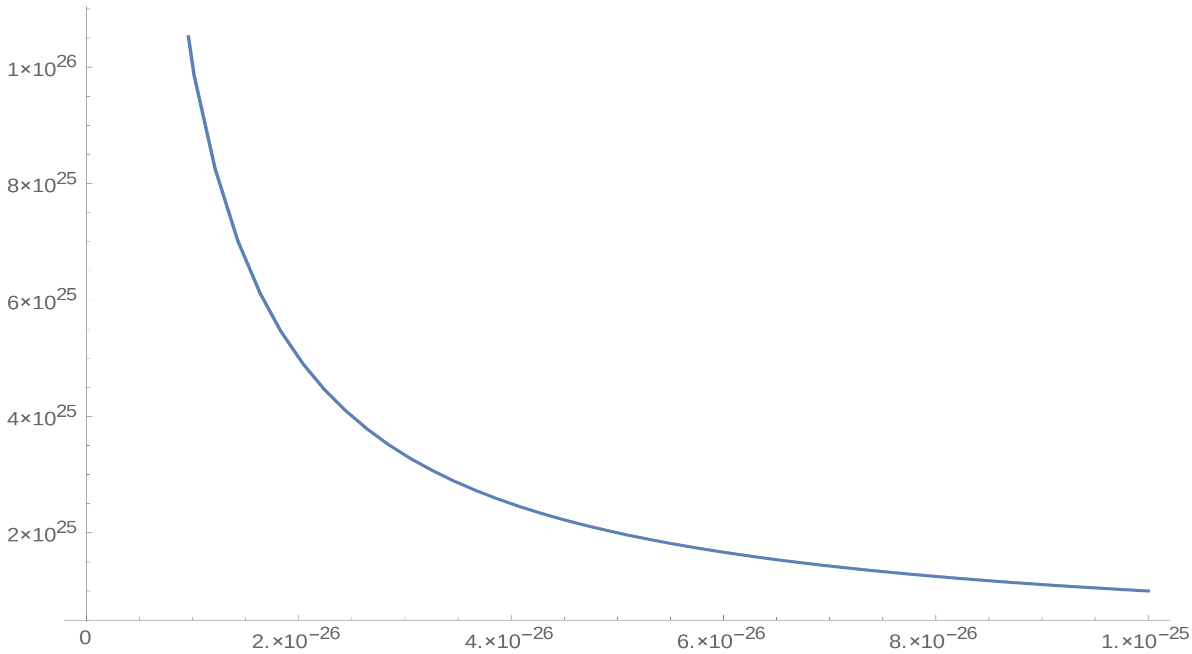

Figure 4. PlotGraph of the Electric Field Intensity f(r) [V/ m] for the region 10^{-36} < r < 10^{-25} [m] in which the gravitational field acceleration has been chosen accordingly an electromagnetic mass of 10^{-4} [kg] located at the center of the confinement, according to Newton's Shell Theorem

$$Plot\left[e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\,\pi\,\log[r]}{8\,\pi}},\{r,10^{-36},10^{-35}\} \right]$$

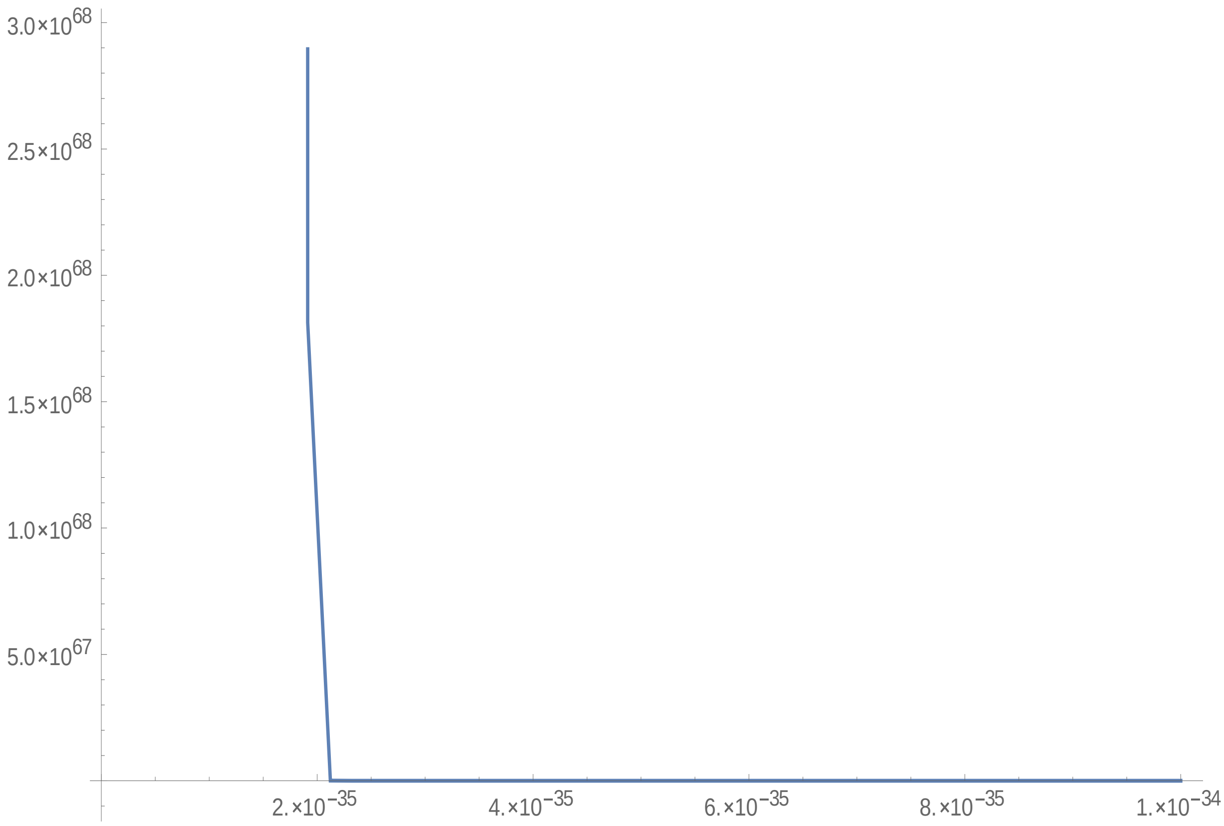

Figure 5. PlotGraph of the Electric Field Intensity f(r) [V/ m] for the region $10^{-36} < r < 10^{-35}$ [m] in which the gravitational field acceleration has been chosen accordingly an electromagnetic mass of 10^{-4} [kg] located at the center of the confinement, according to Newton's Shell Theorem

It follows from Figure 5 that the radius of the stable gravitational electromagnetic confinement equals approximately 2 x 10^{-35} [m], which is the size of the Planck length. According the theory of superstrings, the fundamental constituents of reality are strings of the Planck length (about 1.62 10^{-35} [m]) that vibrate at resonant frequencies.

Confinement of Light (Electromagnetic Radiation) in the Region of a Longitudinal Black Hole with an Electromagnetic Mass of 10^{40} [kg], a Radius = 1.5 x 10^{9} [m] at a Frequency of 0.2 {Hz]

To realize a Gravitational-Electromagnetic confinement for a conventional Black Hole with an Electro Magnetic Mass: emm = 10^{40} [kg], the solution (30) and (31) for the Gravitational Electromagnetic Equilibrium Equation (34) results in a Gravitational Electromagnetic Confinement radius r = 1.5 10^{9} [m] (Figure 6 and Figure 7).

$$f[r] = K\, e^{-\frac{-\frac{G1\ emm\ \varepsilon_0\ \mu_0}{r} + 8\pi \log[r]}{8\pi}}$$
$$G1 = 6.6740810^{-11}$$
$$emm = 10^{40}\ [kg] \tag{38}$$
$$\varepsilon_0 = 8.8510^{-12}$$
$$\mu_0 = 1.2566370614359172 10^{-6}$$

In which "emm" equals the electromagnetic mass of the Single Harmonic Black Hole located at the center according to Newton's Shell Theorem. For an electromagnetic mass of the Single Harmonic Black Hole (SHBH), the value for the electromagnetic mass (emm) equals: emm = 10^{40} [kg], the radius of the confinement equals approximately 1.5 x 10^9 [m] and the first harmonic frequency equals 0.2 [Hz]. The Plot graph of the Electric Field Intensity f(r) of the SHBH has been presented as a function of the radius in Figure (6) and Figure (7):

$$Plot\left[e^{-\frac{-\frac{G1\ \varepsilon_0\ \mu_0}{r} + 8\pi \log[r]}{8\pi}}, \{r, 10^5, 10^{12}\}\right]$$

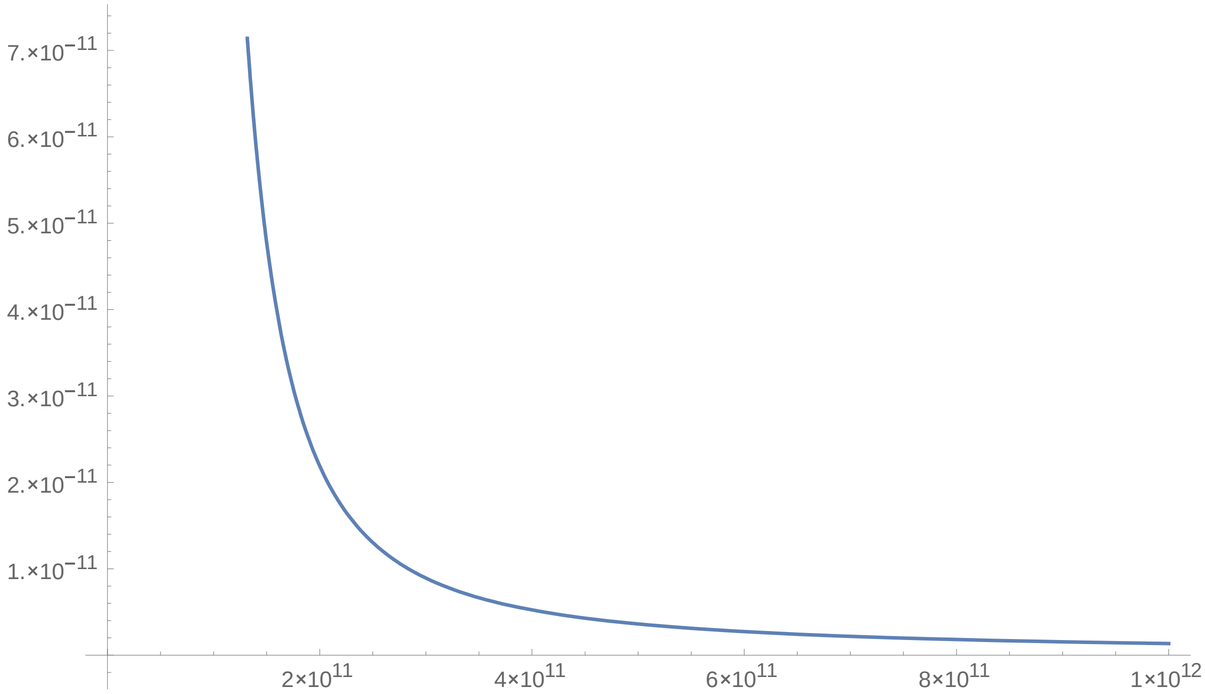

Figure 6. PlotGraph of the Electric Field Intensity f(r) V/ m] (vertical axis) for the region $10^5 < r < 10^{12}$ [m] (horizontal axis) in which the gravitational field acceleration has been chosen accordingly an electromagnetic mass of 10^{40} [kg] located at the center of the confinement, according to Newton's Shell Theorem

$$Plot\left[e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\,\pi\,\log[r]}{8\,\pi}}, \left\{r, 10^9, 4\times 10^9\right\} \right]$$

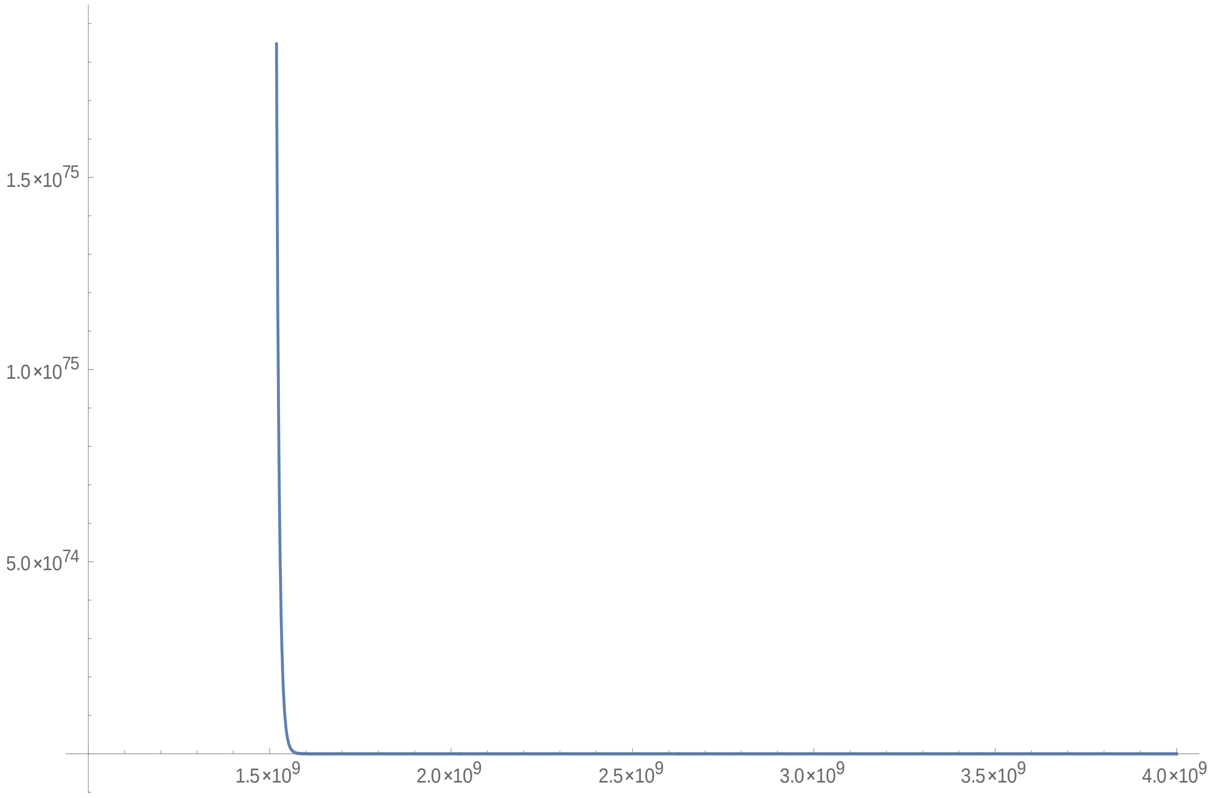

Figure 7. PlotGraph of the Electric Field Intensity f(r) [V/m] (vertical axis) for the region $10^9 < r < 4\ 10^9$ [m] (horizontal axis) in which the gravitational field acceleration has been chosen accordingly an electromagnetic mass of 10^{40} [kg] located at the center of the confinement, according to Newton's Shell Theorem. And a corresponding Single Harmonic frequency of 0.2 [Hz]

It follows from Figure 7 that the radius of the stable gravitational electromagnetic confinement of the SHBH equals approximately $1.5\ 10^9$ [m].

The Transversal Black Hole

We consider a beam of light passing a strong gravitational field, generated by a Black Hole. According to the first term in (1) the beam of light will follow a circular orbit around the Black Hole. The required Equilibrium will exist at the radius where the centrifugal electromagnetic inertia forces will be equal and opposite directed to the centripetal oriented gravitational forces on the electromagnetic mass. Figure 12 represents the orbit (colored red) of a LASER beam around a uniform intense gravitational field (Black Hole).

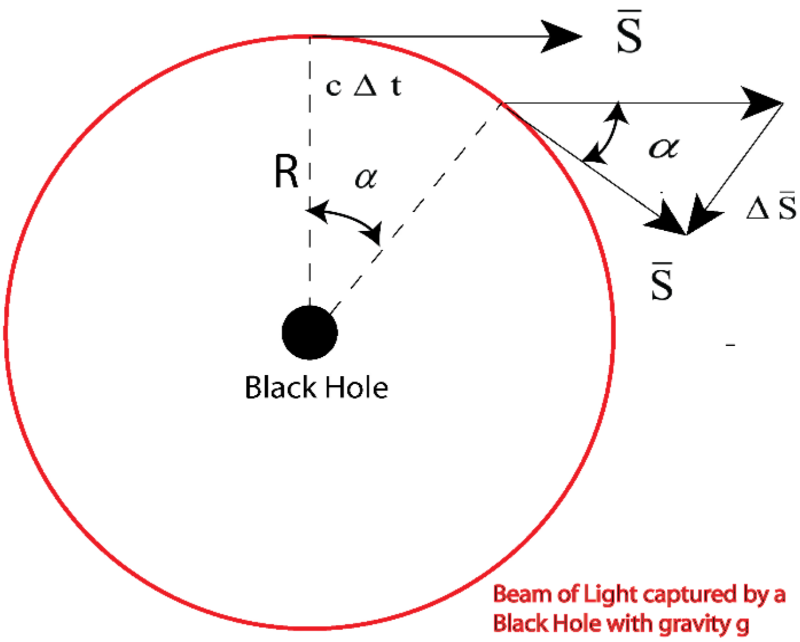

Figure 8. A LASER beam around a Black Hole captured in a circular orbit around the Black Hole in a Transversal Modus by the Gravitational interaction of the Black Hole with the mass (inertia) of the Laser Beam

In general, Newton's second law of motion has been presented as:

$$F = m\,a \tag{39}$$

In which "a" represents the acceleration which equals the difference of the velocity Δ v divided by the time interval Δ t.

$$a = \frac{\Delta v}{\Delta t} \tag{40}$$

The momentum p of a mechanical mass equals:

$$p = m\,v \tag{41}$$

Then Newton's second law of motion can be presented as:

(mechanical mass)

$$F_{INERTIA} = m\,a = m\frac{\Delta v}{\Delta t} = \frac{\Delta (m\,v)}{\Delta t} = \frac{\Delta (p)}{\Delta t} \tag{42}$$

Like a mechanical mass expresses the property of inertia, also a beam of light expressed the property of inertia. When the sun shines on the earth, the radiation of the sun presses on the earth with thousands of Newton. Like a mechanical mass, also a beam of light has momentum. The momentum of a beam of light has been expressed by the Poynting vector S and equals the mechanical momentum vector p multiplied by the square of the speed of light c divided by the Volume.

(mechanical mass) (beam of light)

$$F_{INERTIA} = m\,a = m\frac{\Delta v}{\Delta t} = \frac{\Delta (m\,v)}{\Delta t} = \frac{\Delta (p)}{\Delta t} = \frac{V}{c^2}\frac{\Delta (S)}{\Delta t} \tag{43}$$

The inertia force density "f" equals the inertia force "F" divided by the Volume "V".

(mechanical mass) (beam of light)

$$f_{INERTIA} = \left(\frac{m}{V}\right) a = \rho \frac{\Delta v}{\Delta t} = \frac{1}{c^2}\frac{\Delta (S)}{\Delta t} \quad (44)$$

The well-known equation of Einstein equals:

$$W = m c^2$$

$$w = \frac{W}{V} = \frac{m}{V} c^2 = \rho c^2 \quad (45)$$

In which "w" represents the electromagnetic energy density and equals:

$$w = \frac{1}{2} \varepsilon E^2 + \frac{1}{2} \mu H^2 \quad (46)$$

For electromagnetic radiation the electromagnetic impedance Z_0 equals:

$$Z_0 = \frac{E}{H} = \sqrt{\frac{\mu}{\varepsilon}}$$

$$H = E\sqrt{\frac{\varepsilon}{\mu}} \quad (47)$$

$$w = \frac{1}{2} \varepsilon E^2 + \frac{1}{2} \mu H^2 = \frac{1}{2} \varepsilon E^2 + \frac{1}{2} \varepsilon E^2 = \varepsilon E^2$$

Substituting equation (47) in (45) and (46) results in:

$$w = \rho c^2 = \varepsilon E^2$$

$$\rho = \frac{\varepsilon}{c^2} E^2 \quad (48)$$

Because the beam of light has been confined in the radial direction, it demonstrates in the radial direction the property of inertia (electromagnetic mass) and interacts with a gravitational field according to Newton's second law of motion. The whole Universe is in a perfect Equilibrium. Also at the "Event Horizon" of a Black Hole does exist a perfect equilibrium between the confining gravitational force of the Black Hole and the radial directed inertia force density of the confined electromagnetic radiation (Laser Beam confined by a Black Hole at the "Event Horizon"). To determine the "Event Horizon" of the Black Hole (Radius of the circular orbit of the Laser Beam), we have to find the perfect equilibrium between the inertia force densities of the electromagnetic energy densities of the Laser Beam and the confining gravitational force acting on the electromagnetic energy densities of the Laser Beam.

$$f_{GRAVITY} = f_{INERTIA}$$

$$\rho g = \frac{1}{c^2}\frac{\Delta (S)}{\Delta t} \quad (49)$$

From Figure (8) follows the relationship between de changing in the Poynting vector ΔS during the time interval Δt :

$$\operatorname{Tan}(\alpha) = \frac{c \Delta t}{R} = \frac{\Delta S}{S}$$

$$\frac{\Delta S}{\Delta t} = \frac{c S}{R} \quad (50)$$

$$\rho g = \frac{1}{c^2}\frac{\Delta (S)}{\Delta t} = \frac{1}{c^2}\frac{c S}{R} = \frac{1}{c}\frac{S}{R}$$

The Poynting vector $\overline{S}$ represents the total energy transport of the electromagnetic radiation per unit surface per unit time [J / m^2 s]. Which can be written as the cross product of the Electric Field intensity $\overline{E}$ and the magnetic Field intensity $\overline{H}$.

$$\overline{S} = \overline{E} \times \overline{H}$$
$$S = E\ H\ \text{Sin}\left(90^0\right) = E\ H \qquad (51)$$
$$S = E^2 \sqrt{\frac{\varepsilon}{\mu}}$$

Substituting equation (49) and (51) in (50) results in an equation for the Event Horizon at radius "R" of a Transversal Black Hole.

$$\rho\ g = \frac{1}{c}\ \frac{S}{R}$$
$$R = \frac{S}{\rho\ c\ g}$$
$$R = \frac{E^2 \sqrt{\frac{\varepsilon}{\mu}}}{\rho\ c\ g} = \frac{E^2 \sqrt{\frac{\varepsilon}{\mu}}}{\frac{\varepsilon}{c}\ E^2\ g} \qquad (52)$$
$$R = \frac{c^2}{g} \approx \frac{9\ 10^{16}}{g} \quad [m]$$

Equation (52) represents the perfect equilibrium between the inertia force densities of the electromagnetic mass $\frac{1}{c^2}\ \frac{\Delta\ S}{\Delta\ t}$ and the centripetal oriented gravitational force density $\frac{w}{c^2}\ \overline{g}$ acting on the electromagnetic mass. The perfect equilibrium direction [9,10,12,13] where the inertia forces due to the circular orbit of the beam of light are in a perfect balance with the attractive gravitational forces, exists at one defined radius "R" of the beam of light (LASER Beam), independent of the intensity of the beam of light and independent of the frequency of the beam of light. Only the acceleration "g" of the gravitational field determines the radius of equilibrium "R"

$$R \approx \frac{9\ 10^{16}}{g} \qquad (53)$$

In which "R" is the radius of the beam of light and "g" the acceleration of the gravitational field of the "Black Hole".

The x-y plane is oriented perpendicular on the z-direction. The speed of light towards the positive z-direction equals the speed of light (the constant "c = 300.000 km/s"). But the speed of light in the x-y plane has to be exactly zero [9,14,15]. Else the diameter of the laser beam would become larger and larger during the propagation along the positive z-direction. This is only possible because the Electromagnetic confining forces B-2, B-3, B-4 and B-5 in equation (34) compensate exactly the outward oriented radiation pressure towards the x-direction and the y-direction. The Radial Radiation Pressure has been compensated by the Coulomb Force Densities and the Lorentz Force Densities within the Laser Beam.

The Origin of Electric Charge and Magnetic Spin in Discrete Values (The Introduction of Quantum Numbers)

3-Dimensional Space Domain

$$\begin{pmatrix} x_3 \\ x_2 \\ x_1 \end{pmatrix} \begin{matrix} -\frac{1}{c^2}\frac{\partial(\bar{E}\times\bar{H})}{\partial t} + \varepsilon_0\,\bar{E}\,(\nabla\cdot\bar{E}) - \varepsilon_0\,\bar{E}\times(\nabla\times\bar{E}) + \\ \\ +\mu_0\,\bar{H}\,(\nabla\cdot\bar{H}) - \mu_0\,\bar{H}\times(\nabla\times\bar{H}) + \frac{1}{2}\left(\varepsilon^2\mu\left(\bar{E}\cdot\bar{E}\right)+\varepsilon\,\mu^2\left(\bar{H}\cdot\bar{H}\right)\right)\bar{g} = \bar{0} \end{matrix} \tag{54}$$

The Gravitational-Electromagnetic Confinement for the elementary structure of the Confined Electromagnetic Radiation has been presented in equation (34). In which $\bar{g}$ represents the (radial oriented) gravitational acceleration caused by the electromagnetic mass density of the confined electromagnetic radiation. To find the origin of Electric Charge and Magnetic Spin we choose as an example a solution for (54) which equals:

$$\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f_1(r,\theta,\varphi,t)\ \mathrm{Sin}(\omega t) \\ -f_2(r,\theta,\varphi,t)\ \mathrm{Cos}(\omega t) \end{pmatrix} \qquad \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f_2(r,\theta,\varphi,t)\ \mathrm{Cos}(\omega t) \\ f_1(r,\theta,\varphi,t)\ \mathrm{Sin}(\omega t) \end{pmatrix} \tag{55}$$

$$w_{em} = \left(\frac{\mu_0}{2}\left(\bar{m}\cdot\bar{m}\right) + \frac{\varepsilon_0}{2}\left(\bar{e}\cdot\bar{e}\right)\right) = \varepsilon_0\, f(r)^2$$

In which $f[r]$, $f_1[r,\theta,\varphi,t]$, $f_2[r,\theta,\varphi,t]$ equals:

$$\begin{aligned} f[r] &= K\, e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\pi\log[r]}{8\pi}} \\ f_1[r,\theta,\varphi,t] &= K\, e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\pi\log[r]}{8\pi}}\, g_1[\theta,\varphi,t] \\ f_2[r,\theta,\varphi,t] &= \frac{K\, e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\pi\log[r]}{8\pi}}\sqrt{-g_1[\theta,\varphi,t]^2+\cos[2\,\omega\,t]\,g1[\theta,\varphi,t]^2+2h[\theta,\varphi]}}{\sqrt{2}} \end{aligned} \tag{56}$$

In which $g_1[\theta,\varphi,t]$ and $h[\theta,\varphi]$ are arbitrary function. The Electromagnetic Confinement has been described for the electric field intensity:

$$\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ K\, e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\pi\log[r]}{8\pi}}\, g1[\theta,\varphi,t]\sin[t\omega] \\ -\frac{K\, e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\pi\log[r]}{8\pi}}\sqrt{-g1[\theta,\varphi,t]^2+\cos[2\omega\,t]\,g1[\theta,\varphi,t]^2+2h[\theta,\varphi]}}{\sqrt{2}} \end{pmatrix} \tag{57}$$

The Electromagnetic confinement has been described for the magnetic field intensity:

$$\begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \sqrt{\frac{\varepsilon_0}{\mu_0}} \begin{pmatrix} 0 \\ \frac{K\, e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\pi\log[r]}{8\pi}}\sqrt{-g_1[\theta,\varphi,t]^2+\cos[2\omega\,t]\,g_1[\theta,\varphi,t]^2+2h[\theta,\varphi]}}{\sqrt{2}} \\ K\, e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\pi\log[r]}{8\pi}}\, g_1[\theta,\varphi,t]\sin[\omega t] \end{pmatrix} \tag{58}$$

The following functions with the quantum numbers {m1, n1, p1, q1} have been chosen:

$$f[r]=K\, e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\,\pi\,\log[r]}{8\,\pi}}$$

$$g1(\theta,\varphi,t) = \sin(\omega\, t)\,(\sin(\pi\,\theta\, m_1)\sin(n_1\, 2\,\pi\,\varphi) + 1)$$

$$h(\theta,\varphi) = \sin(\pi\,\theta\, p_1)\,\sin(q_1\, 2\,\pi\,\varphi) + 1$$

$$g2(\theta,\varphi,t) = \frac{\sec(\omega\, t)\,\sqrt{\cos(2\omega\, t)\, g_1(\theta,\varphi,t)^2 - g_1(\theta,\varphi,t)^2 + 2\, h(\theta,\varphi)}}{\sqrt{2}} \tag{59}$$

$$f1[r,\theta,\varphi,t] = e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\,\pi\,\log[r]}{8\,\pi}}\, K\, g_1[\theta,\varphi,t]$$

$$f2[r,\theta,\varphi,t] = \frac{e^{-\frac{-\frac{G1\,\varepsilon_0\,\mu_0}{r}+8\,\pi\,\log[r]}{8\,\pi}}\, K\,\sqrt{-g_1[\theta,\varphi,t]^2+\cos[2\omega\, t]\, g_1[\theta,\varphi,t]^2\, 2h[\theta,\varphi]}}{\sqrt{2}}$$

Electromagnetic Confinement with Electric- and Magnetic Dipoles (Electric- and Magnetic Spin) {m1=0, n1=0, p1=0, q1=0}

The divergence of the electric field intensity (electric charge density ρ) equals:

$$\rho = \nabla.\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \frac{\sqrt{2}\, K1\, \cot(\theta)\, \sin^2(\omega\, t)\,\sqrt{1-\sin^4(\omega\, t)}\; e^{\frac{G_1\,\varepsilon_0\,\mu_0}{8\,\pi\, r}}}{r^2\,\sqrt{2-2\sin^4(t\omega)}} \tag{60}$$

$$\rho = \nabla.\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \frac{\frac{1}{2}\, K1\, \cot(\theta)\, e^{\frac{G_1\,\varepsilon_0\,\mu_0}{8\,\pi\, r}}}{r^2} \quad \text{(averaged over 1 period of time)}$$

The divergence of the magnetic field intensity (magnetic flux density ϕ) equals:

$$\phi = \nabla.\begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \frac{K1\,\sqrt{\varepsilon_0}\;\cot(\theta)\,\sqrt{2-2\,\sin^4(\omega\, t)}\;\; e^{\frac{G_1\,\varepsilon_0\,\mu_0}{8\,\pi\, r}}}{\sqrt{2}\,\sqrt{\mu 0}\, r^2} \tag{61}$$

$$\phi = \nabla.\begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \frac{K1\,\sqrt{\varepsilon_0}\;\cot(\theta)\,\sqrt{\frac{3}{4}}\;\; e^{\frac{G_1\,\varepsilon_0\,\mu_0}{8\,\pi\, r}}}{\sqrt{\mu 0}\, r^2} \quad \text{(averaged over 1 period of time)}$$

In which K1 is an arbitrary variable. Because of the $\mathrm{Cot}(\theta)$ function, the electric divergence as well as the magnetic divergence changes from sign when the angle θ varies between 0^0 until 360^0 forming electric dipoles (+ versus -) and magnetic dipoles (N versus S).

The Illusion of Quantum Mechanical Probability Waves

The physical concept of quantum mechanical probability waves has been created during the famous 1927 5th Solvay Conference. During that period there were several circumstances which came just together and made it possible to create a unique idea of material waves being complex (partly real and partly imaginary) and describing the probability of the appearance of a physical object (elementary particle). The idea of complex (probability) waves is directly related to the concept of confined (standing) waves. Characteristic for any standing wave is the fact that the velocity and the pressure (electric field and magnetic field) are always shifted over 90 degrees. The same principle does exist for the standing (confined) electromagnetic waves, For that reason every confined (standing) Electromagnetic wave can be described by a complex sum vector $\bar{\phi}$ of the Electric Field Vector $\bar{\mathrm{E}}$ and the Magnetic Field Vector $\bar{\mathrm{B}}$ ($\bar{\mathrm{E}}$ has 90 degrees phase shift compared to $\bar{\mathrm{B}}$). The vector functions $\bar{\phi}$ and the complex conjugated vector function $\bar{\phi}*$ will be written as:

$$\bar{\phi} = \frac{1}{\sqrt{2\,\mu}}\left(\bar{\mathrm{B}} + \mathrm{i}\,\frac{\bar{\mathrm{E}}}{c}\right) \tag{62}$$

$\bar{\mathrm{B}}$ equals the magnetic induction, $\bar{\mathrm{E}}$ the electric field intensity ($\bar{\mathrm{E}}$ has + 90 degrees phase shift compared to $\bar{\mathrm{B}}$) and c the speed of light.
The complex conjugated vector function equals:

$$\bar{\phi}* = \frac{1}{\sqrt{2\,\mu}}\left(\bar{\mathrm{B}} - \mathrm{i}\,\frac{\bar{\mathrm{E}}}{c}\right) \tag{63}$$

The dot product equals the electromagnetic energy density w:

$$\bar{\phi}\,.\,\bar{\phi}* = \frac{1}{2\,\mu}\left(\bar{\mathrm{B}} + \mathrm{i}\,\frac{\bar{\mathrm{E}}}{c}\right).\left(\bar{\mathrm{B}} - \mathrm{i}\,\frac{\bar{\mathrm{E}}}{c}\right) = \frac{1}{2}\,\mu\,\mathrm{H}^2 + \frac{1}{2}\,\varepsilon\,\mathrm{E}^2 = \mathrm{w} \tag{64}$$

Using Einstein's equation W = m c^2 ,the dot product equals the electromagnetic mass density w

$$\bar{\phi}\,.\,\bar{\phi}*\frac{1}{\mathrm{c}^2} = \frac{\varepsilon}{2}\left(\bar{\mathrm{B}} + \mathrm{i}\,\frac{\bar{\mathrm{E}}}{c}\right).\left(\bar{\mathrm{B}} - \mathrm{i}\,\frac{\bar{\mathrm{E}}}{c}\right) = \frac{1}{2}\varepsilon\,\mu^2\mathrm{H}^2 + \frac{1}{2}\varepsilon^2\mathrm{E}^2 = \rho\ [\mathrm{kg/m^3}] \tag{65}$$

The cross product is proportional to the Poynting vector (Vegt, 1995, p. 202, equation 15).

$$\bar{\phi} \times \bar{\phi}* = \frac{1}{2\,\mu}\left(\bar{\mathrm{B}} + \mathrm{i}\,\frac{\bar{\mathrm{E}}}{c}\right) \times \left(\bar{\mathrm{B}} - \mathrm{i}\,\frac{\bar{\mathrm{E}}}{c}\right) = \mathrm{i}\sqrt{\varepsilon\,\mu}\ \bar{\mathrm{E}} \times \bar{\mathrm{H}} = \mathrm{i}\sqrt{\varepsilon\,\mu}\ \bar{\mathrm{S}} \tag{66}$$

Newton's second law of motion has been described in 3 spatial dimensions, resulting in the fundamental equation for the electromagnetic field.

3-Dimensional Space Domain

$$\begin{pmatrix} x_3 \\ x_2 \\ x_1 \end{pmatrix} \quad \underbrace{-\frac{1}{c^2}\frac{\partial\,(\bar{\mathrm{E}} \times \bar{\mathrm{H}})}{\partial t}}_{\text{B-1}} + \underbrace{\varepsilon_0\,\bar{\mathrm{E}}\,(\nabla\,.\,\bar{\mathrm{E}})}_{\text{B-2}} - \underbrace{\varepsilon_0\,\bar{\mathrm{E}} \times (\nabla \times \bar{\mathrm{E}})}_{\text{B-3}} + \underbrace{\mu_0\,\bar{\mathrm{H}}\,(\nabla\,.\,\bar{\mathrm{H}})}_{\text{B-4}} - \underbrace{\mu_0\,\bar{\mathrm{H}} \times (\nabla \times \bar{\mathrm{H}})}_{\text{B-5}} + \underbrace{\frac{1}{2}\left(\varepsilon^2\mu\left(\bar{\mathrm{E}} \square \bar{\mathrm{E}}\right) + \varepsilon\,\mu^2\left(\bar{\mathrm{H}} \square \bar{\mathrm{H}}\right)\right)\bar{\mathrm{g}}}_{\text{B-6}} = \bar{0} \tag{67}$$

The formal mathematical way to describe the force density results from the 4-dimensional divergence of the 4-dimensional energy momentum tensor, resulting in a 4-dimensional Force vector. Dividing the 4-dimensional Force vector by the Volume results in the 4-dimensional force density vector. The 4-dimensional Electromagnetic Vector Potential has been defined by:

$$\bar{\varphi}^{4} = \begin{pmatrix} \varphi_4 \\ \varphi_3 \\ \varphi_2 \\ \varphi_1 \end{pmatrix} \xrightarrow{\text{CartesianCoordinateSystem}} \begin{pmatrix} \varphi_t \\ \varphi_z \\ \varphi_y \\ \varphi_x \end{pmatrix} \tag{68}$$

In which the term φ_a represents the 4-dimensional electromagnetic vector potential in the "a" direction while the indice "a" varies from 1 to 4. In a cartesian coordinate system the indices are chosen varying from the x,y,z and t direction. In which the indice "t" represents the time direction which has been considered to be the 4th dimension. The 4-dimensional Electromagnetic "Maxwell Tensor" has been defined by:

$$\mathrm{F}_{ab} = \partial_b \varphi_a - \partial_a \varphi_b \tag{69}$$

Where the indices "a" and "b" vary from 1 to 4. The 4-dimensional Electromagnetic "Energy Momentum Tensor" has been defined by:

$$T^{ab} = \frac{1}{\mu_0}\left[F_{ac} F^{cb} + \frac{1}{4}\delta_{ab} F_{cd} F^{cd} \right] \tag{70}$$

The 4-dimensional divergence of the 4-dimensional Energy Momentum Tensor equals the 4-dimensional Force Density 4-vector f^{a}:

$$f^{a} = \partial_b \mathrm{T}^{ab} \tag{71}$$

Substituting the electromagnetic values for the electric field intensity "E" and the magnetic field intensity "H" in (71) results in the 4-dimensional representation of Newton's second law of motion:

Energy-Time Domain

B-7

$$(f_4) \qquad \nabla \cdot (\bar{E} \times \bar{H}) + \frac{1}{2}\frac{\partial\left(\varepsilon_0 \left(\bar{E} \cdot \bar{E} \right) + \mu_0 \left(\bar{H} \cdot \bar{H} \right)\right)}{\partial t} = 0 \tag{72}$$

3-Dimensional Space Domain

B-1 B-2 B-3

B-4 B-5

$$\begin{pmatrix} f_3 \\ f_2 \\ f_1 \end{pmatrix} \quad \begin{aligned} & -\frac{1}{c^2}\frac{\partial (\bar{E} \times \bar{H})}{\partial t} + \varepsilon_0 \bar{E} (\nabla \cdot \bar{E}) - \varepsilon_0 \bar{E} \times (\nabla \times \bar{E}) + \\ & + \mu_0 \bar{H} (\nabla \cdot \bar{H}) - \mu_0 \bar{H} \times (\nabla \times \bar{H}) = \bar{0} \end{aligned}$$

In which f_1, f_2, f_3, represent the force densities in the 3 spatial dimensions and f_4 represent the force density (energy flow) in the time dimension (4th dimension). The 4th term in equation (72) can be written in the terms of the Poynting vector "S" and the energy density "w" representing the electromagnetic law for the conservation of energy.

Energy-Time Domain

Inner Energy

B-7

$$\left(f_4\right) \qquad \nabla \cdot \bar{S} + \frac{\partial w}{\partial t} = 0 \qquad (73.1)$$

(73)

3-Dimensional Space Domain

B-1 B-2 B-3

B-4 B-5

$$\begin{pmatrix} f_3 \\ f_2 \\ f_1 \end{pmatrix} \qquad -\frac{1}{c^2}\frac{\partial(\bar{E}\times\bar{H})}{\partial t} + \varepsilon_0\,\bar{E}\,(\nabla\cdot\bar{E}) - \varepsilon_0\,\bar{E}\times(\nabla\times\bar{E}) + \mu_0\,\bar{H}\,(\nabla\cdot\bar{H}) - \mu_0\,\bar{H}\times(\nabla\times\bar{H}) = \bar{0} \qquad (73.2)$$

The 4-Dimensional Dirac Equation

Substituting (64) and (66) in Equation (73) results in the 4-Dimensional Equilibrium Equation (74):

$$\left(x_4\right) \qquad -\frac{i}{\sqrt{\varepsilon_0\,\mu_0}}\nabla\cdot(\bar{\phi}\times\bar{\phi}^*) = -\frac{\partial\,\bar{\phi}\cdot\bar{\phi}^*}{\partial t} \qquad (74.1)$$

(74)

$$\begin{pmatrix} x_3 \\ x_2 \\ x_1 \end{pmatrix} \qquad -\frac{1}{c^2}\frac{\partial(\bar{E}\times\bar{H})}{\partial t} + \varepsilon_0\,\bar{E}\,(\nabla\cdot\bar{E}) - \varepsilon_0\,\bar{E}\times(\nabla\times\bar{E}) + \mu_0\,\bar{H}\,(\nabla\cdot\bar{H}) - \mu_0\,\bar{H}\times(\nabla\times\bar{H}) = \bar{0} \qquad (74.2)$$

To transform the electromagnetic vector wave function $\bar{\phi}$ into a scalar (spinor or one-dimensional matrix representation), the Pauli spin matrices σ and the following matrices (Vegt, 1995, p. 213, equation 99) are introduced:

$$\bar{\alpha} = \begin{bmatrix} 0 & \sigma \\ \sigma & 0 \end{bmatrix} \quad \text{and} \quad \bar{\beta} = \begin{bmatrix} \delta_{ab} & 0 \\ 0 & -\delta_{ab} \end{bmatrix} \qquad (75)$$

Then equation (74) can be written as the 4-Dimensional Hyperspace Equilibrium Dirac Equation:

$$\left(x_4\right) \qquad \left(\frac{i\,m\,c}{h}\bar{\beta} + \bar{\alpha}\cdot\nabla\right)\psi = -\frac{1}{c}\frac{\partial\psi}{\partial t} \qquad (76.1)$$

(76)

$$\begin{pmatrix} x_3 \\ x_2 \\ x_1 \end{pmatrix} \qquad -\frac{1}{c^2}\frac{\partial(\bar{E}\times\bar{H})}{\partial t} + \varepsilon_0\,\bar{E}\,(\nabla\cdot\bar{E}) - \varepsilon_0\,\bar{E}\times(\nabla\times\bar{E}) + \mu_0\,\bar{H}\,(\nabla\cdot\bar{H}) - \mu_0\,\bar{H}\times(\nabla\times\bar{H}) = \bar{0} \qquad (76.2)$$

The fourth term (x_4) equals the relativistic Dirac equation (76.1) which equals equation (102) in Vegt (1995, p. 213). Equation (76.1) represents the relativistic quantum mechanical Dirac Equation where ψ represents the quantum mechanical probability wave function. The mathematical evidence for the equivalent for (76.1) has been published by Vegt (1995, Equation (1) p. 201 to Equation (102) p. 213). The Electromagnetic Law for the conservation of Energy (73.1) and the Relativistic Dirac Equation (76.1) are identical but written in a different form. The law of conservation of Electromagnetic Energy can be written in an electromagnetic form (74.1) or in an identical way in a quantum mechanical form (76.1):

Energy-Time Domain

Inner Energy

B-7

$$\begin{aligned} &(f_4) \quad \nabla \cdot (\bar{\phi} \times \overline{\phi^*}) = - \frac{i}{c} \frac{\partial \bar{\phi} \cdot \bar{\phi}^*}{\partial t} \quad (74.1) \\ &(x_4) \quad \left(\frac{i\,m\,c}{h} \bar{\beta} + \bar{\alpha} \cdot \nabla \right) \psi = - \frac{1}{c} \frac{\partial \psi}{\partial t} \quad (76.1) \end{aligned} \tag{77}$$

The weakness in the Quantum Mechanical Relativistic Dirac Equation (77) is that the Dirac Equation is a 1-dimensional equation which will never be able to describe the 4-dimensional real physical world. From the equations (72) and (76) follows the 4-Dimensional Dirac equation. This equation is a 4-dimensional equation and is coherent with the 4-dimensional physical reality.

$$\begin{aligned} &(x_4) \quad \nabla \cdot (\bar{\phi} \times \bar{\phi}) = - \frac{i}{c} \frac{\partial \bar{\phi} \cdot \bar{\phi}^*}{\partial t} \\ &\begin{pmatrix} x_3 \\ x_2 \\ x_1 \end{pmatrix} \quad \frac{i}{c} \frac{\partial (\bar{\phi} \times \bar{\phi}^*)}{\partial t} - \left(\bar{\phi} \times (\nabla \times \overline{\phi^*}) + \overline{\phi^*} \times (\nabla \times \bar{\phi}) \right) + \left(\bar{\phi} \, (\nabla \cdot \overline{\phi^*}) + \overline{\phi^*} \, (\nabla \cdot \bar{\phi}) \right) = 0 \end{aligned} \tag{78}$$

In which the Quantum Mechanical Complex Probability Vector Function $\bar{\phi}$ and the complex conjugated vector function $\overline{\phi^*}$ equals:

$$\begin{aligned} \bar{\phi} &= \bar{B} + \frac{i}{c} \bar{E} = \mu \bar{H} + \frac{i}{c} \bar{E} \\ \overline{\phi^*} &= \bar{B} - \frac{i}{c} \bar{E} = \mu \bar{H} - \frac{i}{c} \bar{E} \end{aligned} \tag{79}$$

A particular solution for (78) has been presented by the Gravitational-Electromagnetic Confinement for a sinusoidal frequency ω.

$$\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f(r)g(\theta)\,h(\varphi)\,\text{Sin}(\omega t) \\ \text{-}f(r)g(\theta)\,h(\varphi)\,\text{Cos}(\omega t) \end{pmatrix} \quad \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f(r)g(\theta)\,h(\varphi)\,\text{Cos}(\omega t) \\ f(r)g(\theta)\,h(\varphi)\,\text{Sin}(\omega t) \end{pmatrix} \quad \bar{g} = \begin{pmatrix} \frac{G_1}{4\pi r^2} \\ 0 \\ 0 \end{pmatrix}$$

$$w_{em} = \left(\frac{\mu_0}{2}(\bar{m} \cdot \bar{m}) + \frac{\varepsilon_0}{2}(\bar{e} \cdot \bar{e}) \right) = \varepsilon_0\, f(r)^2 = \frac{1}{2\mu_0}\, \bar{\phi} \cdot \overline{\phi^*} \tag{80}$$

$$\bar{\phi} = \bar{B} + \frac{i}{c}\,\bar{E} = \begin{pmatrix} 0 \\ \frac{1}{c}\, f(r)\,\text{Cos}\,(p\,\theta)\,\text{Sin}\,(q\,\varphi)\, e^{i\,\omega\,t} \\ -\frac{i}{c}\, f(r)\text{Cos}\,(p\,\theta)\,\text{Sin}\,(q\,\varphi)\, e^{i\,\omega\,t} \end{pmatrix}$$

$$\bar{\phi} = \frac{1}{c}\begin{pmatrix} 0 \\ 1 \\ -i \end{pmatrix} f(r)\,\text{Cos}\,(p\,\theta)\,\text{Sin}\,(q\,\varphi)\, e^{i\,\omega\,t} = \frac{1}{c}\begin{pmatrix} 0 \\ 1 \\ -i \end{pmatrix} \psi$$

$$\overline{\phi^*} = \bar{B} - \frac{i}{c}\,\bar{E} = \begin{pmatrix} 0 \\ \frac{1}{c}\, f(r)\,\text{Cos}\,(p\,\theta)\,\text{Sin}\,(q\,\varphi)\, e^{-i\,\omega\,t} \\ \frac{i}{c}\, f(r)\,\text{Cos}\,(p\,\theta)\,\text{Sin}\,(q\,\varphi)\, e^{-i\,\omega\,t} \end{pmatrix}$$

$$\overline{\phi^*} = \frac{1}{c}\begin{pmatrix} 0 \\ 1 \\ i \end{pmatrix} f(r)\,\text{Cos}\,(p\,\theta)\,\text{Sin}\,(q\,\varphi)\, e^{-i\,\omega\,t} = \frac{1}{c}\begin{pmatrix} 0 \\ 1 \\ i \end{pmatrix} \psi^*$$

Quantum Numbers: (p = 0,1,2,3....) and (q = 0,1,2,3.....)

The functions ψ and ψ^* are the classical quantum mechanical scalar probability functions and represent the solutions for the classical 1-dimensional Dirac Equation (x_4). The 4-Dimensional Dirac equation represents the Newtonian Perfect Equilibrium in the 4-Dimensional Space-Time Continuum en has been represented by 4 separate equations. The first one represents the well-known relativistic quantum mechanical Dirac Equation in the Time-Energy domain x_4. The 3 quantum mechanical equations in the space-momentum domain represents the Newtonian Perfect Equilibrium for the force densities in the domains (x_1 ,x_2 ,x_3)

$$(x_4) \qquad \nabla \cdot (\bar{\phi} \times \overline{\phi^*}) = -\frac{i}{c}\frac{\partial\, \bar{\phi} \cdot \overline{\phi^*}}{\partial t}$$

$$\begin{pmatrix} x_3 \\ x_2 \\ x_1 \end{pmatrix} \quad \frac{i}{c}\frac{\partial\,(\bar{\phi} \times \overline{\phi^*})}{\partial t} - \left(\bar{\phi} \times (\nabla \times \overline{\phi^*}) + \overline{\phi^*} \times (\nabla \times \bar{\phi}) \right) + \left(\bar{\phi}\,(\nabla \cdot \overline{\phi^*}) + \overline{\phi^*}\,(\nabla \cdot \bar{\phi}) \right) = 0 \tag{81}$$

Newton Lorentz Coulomb

Newtonian Perfect Equilibrium

$$\frac{1}{c^2}\,\bar{\phi} \cdot \overline{\phi^*} = \rho\ [\text{kg/m}^3]$$

These results lead to the conclusion that a new Copenhagen Interpretation is needed.

Classic Copenhagen versus New Interpretation

Copenhagen Interpretation	New Theory
The Universe has been built out of elementary particles	The Universe has been built out of Confined Electromagnetic Field Configurations
Elementary Particles are the fundamental building elements in the Universe	Confined Electromagnetic Field Configurations are the fundamental building elements in the Universe
Fundamental properties of matter like mass, charge and spin are carried by elementary particles	Fundamental properties of matter like mass, charge and spin are carried by Confined Electromagnetic Field Confinements
Probability waves describe the location of the particles	Probability Waves do not exist. Confined electromagnetic radiation carries electromagnetic mass, electric charge and magnetic spin.
Probability waves are complex waves	Confined Electromagnetic waves are not complex. The phase shift of 90 degrees between the electric standing wave and the magnetic standing wave can be written in a complex function describing simultaneously the electric field and the magnetic field.
The product of the probability function ψ and the complex conjugated function ψ^* equals the probability	The dot product $\overline{\phi} \,.\, \overline{\phi^*} = \rho$ in which ρ equals the mass density of the confined electromagnetic radiation

Conclusions

The generally accepted idea of the Physical World existing of elementary particles which location in time and space has been described by a non-real (complex) quantum mechanical probability wave function is the inversion of the "Real Physical World". The "Real Physical World" in which elementary particles are only the illusionary effect to locate mass, electric charge and magnetic spin while the quantum mechanical probability waves are representing the Real Physical World. Quantum mechanical probability waves are not complex (a mathematical name for the combination of a real part and an imaginary part). The complexity has been introduced by the 90 degrees phase shift between the electric and the magnetic components of the standing (confined) electromagnetic waves. The quantum mechanical Probability Waves are not complex and are no probability waves but are "Real Electromagnetic Waves" carrying mass, electric charge and magnetic spin. The discrete values for mass, electric charge and magnetic spin are controlled by the boundary conditions for the electromagnetic confinements. Confined Light (Confined Electromagnetic Radiation) is the Inception of the Modern Physics in which the ancient concept of Elementary Particles, like the Concept of the Atom introduced by the Greek Philosopher Democritus in 427 B.C., has been left behind and be replaced by the New Physics. The New Physics in which Confined Light (Confined Electromagnetic Radiation) is the Medium for the Physical Reality and represents the be carrier for mass (inertia) electric charge and magnetic spin.It is coherent with the fact that the introduction of new modern and highly advanced Measuring Techniques result only in the measurement (perception) of waves and never in the measurement (perception) of elementary particles.

Data Availability

All the Data and all the Calculations to provide evidence to this 'New Theory about

Light' have been published in the 'Open Source Framework (OSF)': https://osf.io/gbn4p/ (https://doi.org/10.31219/osf.io/gbn4p) (Calculations in Mathematica 11.0), pp. 1–33).

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