The Unified Field 4-Dimensional Relativistic Dirac Equation

The Origin of Mass, Electric Charge
and Magnetic Spin

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Calculations: All [Calculations](#) in [Mathematica 11.0](#) have been
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1.1 “Unified 4-Dimensional Hyperspace Equilibrium” beyond Einstein 4-Dimensional, Kaluza-Klein 5-Dimensional and Superstring 10- and 11 Dimensional Curved Hyperspaces

Albert Einstein, Lorentz and Minkowski published in 1905 the Theory of Special Relativity and Einstein published in 1915 his field theory of general relativity based on a curved 4-dimensional space-time continuum to integrate the gravitational field and the electromagnetic field in one unified field. Since then the method of Einstein’s unifying field theory has been developed by many others in more than 4 dimensions resulting finally in the well-known 10-dimensional and 11-dimensional “string theory”.

String theory is an outgrowth of S-matrix theory, a research program begun by Werner Heisenberg in 1943 (following [John Archibald Wheeler](#)’s⁽³⁾ 1937 introduction of the S-matrix), picked up and advocated by many prominent theorists starting in the late 1950’s.

Theodor Franz Eduard Kaluza (1885-1954), was a German mathematician and physicist well-known for the Kaluza–Klein theory involving field equations in curved five-dimensional space. His idea that fundamental forces can be unified by introducing additional dimensions re-emerged much later in the “String Theory”.

The original Kaluza-Klein theory was one of the first attempts to create an unified field theory i.e. the theory, which would unify all the forces under one fundamental law. It was published in 1921 by Theodor Kaluza and

extended in 1926 by Oskar Klein. The basic idea of this theory was to postulate one extra compactified space dimension and introduce nothing but pure gravity in a new (1 + 4)-dimensional space-time. Klein suggested that the fifth dimension would be rolled up into a tiny, compact loop on the order of 10^{-35} [m]

In classical unified field theory, the electromagnetic and gravitational interactions are defined by the field equations e.g.:

$$\partial_a F^{ab} - \xi R_a^b A^a = -4 \pi J^b \text{ with } \xi = -2 \quad (1.a)$$

where F^{ab} is the antisymmetric electromagnetic field tensor defined by the potential vector A^a , R_a^b is the Ricci curvature tensor of the hypersurface, and J^b is the electric current density vector. The electromagnetic field equation differs from the Einstein-Maxwell equation by a curvature-coupled term⁽¹⁾ $\xi R_a^b A^a$.

Till now the continuing of the method of Einstein's unifying field theory in a 4-dimensional curved space-time continuum in curved multi-dimensional hyperspaces has not resulted in a successful Grand Unified Field Theory which explains the discrete values for electric charge, magnetic spin and the mass of all known elementary particles.

The fundamental question is: Is a hyperspace curved multi-dimensional approach like the the 11-dimensional Superstring theory the only way to combine fundamentally

different fields into one Grand Unifying Theory. Or is there a different way?

In this new theory a fundamentally different path has been chosen. In the basic theory of the “Lorentz-Einstein-Minkovski” transformations (1905) two fundamentally different fields, the electric field and the magnetic field have been integrated into one 4-dimensional theory expressed by the electromagnetic potential 4-vector A^a .

Instead of defining the electric field and the magnetic field separately in a curved 6- or 7-dimensional hyperspace, both fields are integrated by the common fundamental effect of the force density f^a . The electric field and the magnetic field are fundamentally different but have “the same origin” A^a and “the same effect” of a force density f^a acting on an arbitrary electromagnetic field configuration (particle or field).

Instead of focusing on the differences in the separate fields and putting the differences in the separate fields in separate dimensions, this theory focusses on that what is in common. The “Origin” and the “Effect”.

There is only one Origin for all the different fields (gravitational field, electromagnetic field etc.). There is only one single common effect, the force density f^a acting on a field configuration (elementary particle or field).

This theory focusses on that what is in common. The resulting force densities f^a which have to equal zero at any time at any place in any direction to realize a Universe in Harmony and Equilibrium integrating in this way the very different fields in a Unified 4-dimensional Space-Time continuum.

In this new fundamentally different approach the different interactions (gravity, electromagnetic interaction etc.) has not been interpreted as a curvature of a hyperspace in a 5-, 10- or 11 dimensional space (string theory) .

The new theory has been based on the single concept of “Fundamental Harmony within the Universe”. A Unified Field Theory which results in the confinements of electromagnetic radiation (light) within dimensions smaller than 10^{-85} [m], carrying discrete values (positive or negative) for electric charge in monopole, di-pole or multipole configurations, carrying discrete values (positive or negative) for magnetic string in monopole, di-pole or multipole configurations and carrying (electromagnetic) mass with the property of inertia according Newton’s second law of motion.

The Unified Field Theory has been based on the fundamental question for the existence of light (electromagnetic radiation). What are the fundamental boundaries which are required for a stable electromagnetic field configuration in which light can exist?

There is only one boundary condition. **“The electromagnetic field has to be in a perfect equilibrium (balance) with itself and its surrounding.”** And when an electromagnetic field interacts with a gravitational field, weak interaction or strong interaction **exactly the same boundary condition is required**. That is the single and only requirement.

From this single requirement follows one single equation. [Equation \(5\)](#) (gravity excluded) and [Equation \(5-a\)](#) (gravity included) in this manuscript.

[John Archibald Wheeler](#) ⁽³⁾ introduced in 1953 the concept of [GEONS](#) (Gravitational Electr**O**-magnetic e**N**tities) in which electromagnetic radiation has been confined by its own gravitational field. To calculate the dimensions of these gravitational-electromagnetic confinements Wheeler based his calculations on the Einstein-Maxwell equations, the mathematical ground on which the Theory of General Relativity has been built and found electromagnetic-gravitational confinements with a diameter of several lightyears and a lifetime of several milliseconds. The results were very disappointing because an elementary particle with a diameter of several lightyears and a lifetime of a few milliseconds can hardly be considered as an elementary particle.

In the presented theory the electromagnetic-gravitational interaction has been grounded on Newton's third law. It has been grounded on the stability of electromagnetic-gravitational fields in a perfect equilibrium with itself and its surrounding. In table 1, electromagnetic-gravitational confinements have been presented for any harmonic (sinusoidal) frequency with an infinite lifetime and diameters varying from $<10^{-40}$ and $>10^{+40}$ [m] based on equation 5-a in a spherical coordinate system.

Because this fundamental approach in electromagnetic field configurations is different than the classical approach

by J. Maxwell and A. Einstein, a different result is expected. Instead of electromagnetic-gravitational confinements with a diameter of several lightyears and a lifetime of several milliseconds, presented by J. Wheeler in 1953, electromagnetic-gravitational confinements have been presented in Table 1 with diameters varying from $<10^{-40}$ [m] and $>10^{+40}$ [m] and an infinite lifetime for any harmonic frequency based on equation (5-a).

In a way comparable to the way that GEONS (Gravitational Electromagnetic entities) are described by J. Wheeler in General Relativity by the Gravitational-Electromagnetic Equilibrium Equation ^(1,7,8,13,35,38) (the Einstein-Maxwell Equations), Electromagnetic Confinements are described by the Dynamic Equilibrium Equation (5).

Newton's Third law has been generalized in all layers of Physics. There is no reason not to generalize Newton's third law also within electromagnetic fields. To generalize Newton's third law within Electromagnetic Field Configurations, the Divergence has been taken of the Stress Energy Tensor (3), which results in Equation (4) to calculate the force densities f within the Electromagnetic Field Configuration.

The Energy Momentum Tensor⁽⁹⁾ equals:

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

In which F_{ab} are the elements of the [Maxwell Tensor](#) defined by:

$$F_{ab} = \partial_b \varphi_a - \partial_a \varphi_b \quad (2)$$

The four-vector potential φ_a is defined by: $\varphi_a = \{i\varphi/c, \bar{A}\}$

where φ is the electric scalar potential, c the speed of light in vacuum and $\bar{A}$ is the magnetic vector potential^(1,2,3).

Substituting (2) in (1) results in the [Stress Energy Tensor](#)^(1,16,29) :

$$T^{ab} = \begin{bmatrix} w & -\frac{i}{c} S_x & -\frac{i}{c} S_y & -\frac{i}{c} S_z \\ -\frac{i}{c} S_x & \varepsilon_0 (E_x)^2 + \mu_0 (H_x)^2 - w & \varepsilon_0 E_x E_y + \mu_0 H_x H_y & \varepsilon_0 E_x E_z + \mu_0 H_x H_z \\ -\frac{i}{c} S_y & \varepsilon_0 E_y E_x + \mu_0 H_y H_x & \varepsilon_0 (E_y)^2 + \mu_0 (H_y)^2 - w & \varepsilon_0 E_y E_z + \mu_0 H_y H_z \\ -\frac{i}{c} S_z & \varepsilon_0 E_z E_x + \mu_0 H_z H_x & \varepsilon_0 E_z E_y + \mu_0 H_z H_y & \varepsilon_0 (E_z)^2 + \mu_0 (H_z)^2 - w \end{bmatrix} \quad (3)$$

In the absence of any Gravity, the force density f^a in the 3 directions of the 3 coordinates of the chosen 3-coordinate system follows from the (4-dimensional) Divergence of the (4-dimensional) [Stress Energy Tensor](#)^(8,9,38) (3).

The Divergence of a Vector equals a Scalar. The Divergence of a Tensor equals a Vector. The 4-dimensional

Divergence of the 4-dimensional [Stress Energy Tensor](#) (4)
equals the [4-dimensional Force-density Vector](#).

The first 3 terms of the 4-dimensional Force-density vector equal the force densities in the corresponding 3 dimensions of the chosen Coordinate System. The 4th component equals the [Electromagnetic Poynting's Theorhem](#) (4-a) (Continuity Equation).

To calculate the equilibrium conditions to present the force densities in the Electromagnetic Field Configuration, the first 3 terms of the 4-dimensional Force-density vector are being used.

By re-arranging the first 3 terms of the (4-dimensional Divergence) of the (4-dimensional) [Stress Energy Tensor](#) (3) an equation for the [3-dimensional force density](#) f^a within the Electromagnetic Field Configuration has been created. This Equation (4-b) represents the [3-dimensional force density](#) f^a in a coordinate-free vector equation in the absence of any Gravity:

$$\left(x_4 \right) \quad \nabla \cdot (\bar{E} \times \bar{H}) = - \frac{1}{2} \frac{\partial \left(\epsilon_0 (\bar{E} \cdot \bar{E}) + \mu_0 (\bar{H} \cdot \bar{H}) \right)}{\partial t} \quad (4-a) \quad (4)$$

$$\left(\begin{matrix} x_3 \\ x_2 \\ x_1 \end{matrix} \right) \quad - \frac{1}{c^2} \frac{\partial (\bar{E} \times \bar{H})}{\partial t} + \epsilon_0 \bar{E} (\nabla \cdot \bar{E}) - \epsilon_0 \bar{E} \times (\nabla \times \bar{E}) + \mu_0 \bar{H} (\nabla \cdot \bar{H}) - \mu_0 \bar{H} \times (\nabla \times \bar{H}) = \bar{f} \quad (4-b)$$

According the fundamental requirement of a perfect equilibrium at any place at any time in any direction, the algebraic sum of all the different force densities $\bar{f}$ have to

be equal zero for any physical possible electromagnetic field configuration (particles and fields).

It is fundamental to realize that 3 different kind of separate interactions of the force densities in (4-b) are being involved within this resulting equilibrium. Magnetic-Magnetic interaction (4th and 5th term in 4-b), Electric-Electric interaction (2nd and 3rd term in 4-b), Electric-Magnetic interaction and reverse (1st term in 4-b) which is time-dependent according the theory of special relativity.

An electromagnetic field which is in a perfect equilibrium with itself and its surrounding at any space and time in any direction, fulfills the necessary requirements for the physical possibility of the existence of this field. Under that condition [Equation \(4\)](#) transforms into the “Unified 4-Dimensional Hyperspace [Equilibrium](#) Equation” (5)

$$\begin{aligned}
 & - \frac{1}{c^2} \frac{\partial (\bar{\mathbf{E}} \times \bar{\mathbf{H}})}{\partial t} + \varepsilon_0 \bar{\mathbf{E}} (\nabla \cdot \bar{\mathbf{E}}) - \varepsilon_0 \bar{\mathbf{E}} \times (\nabla \times \bar{\mathbf{E}}) + \\
 & + \mu_0 \bar{\mathbf{H}} (\nabla \cdot \bar{\mathbf{H}}) - \mu_0 \bar{\mathbf{H}} \times (\nabla \times \bar{\mathbf{H}}) = 0
 \end{aligned} \tag{5}$$

To extend Field Equation (5) into an equilibrium within a multi-dimensional curved Space-Time continuum unifying different fields like gravity and electromagnetism, the transformation has been realized by the transformation of the resulting force-densities within the 4-Dimensional Space-Time continuum. The Unification of the Electromagnetic Fields with the Gravitational fields results in the Relativistic Gravitational Electro Magnetic

Equilibrium (RGEE) equation within a gravitational field $\vec{g}$ in the 3-dimensional (spatial) representation:

$$\begin{aligned}
 & - \frac{1}{c^2} \frac{\partial (\vec{E} \times \vec{H})}{\partial t} + \varepsilon_0 \vec{E} (\nabla \cdot \vec{E}) - \varepsilon_0 \vec{E} \times (\nabla \times \vec{E}) + \mu_0 \vec{H} (\nabla \cdot \vec{H}) - \\
 & - \mu_0 \vec{H} \times (\nabla \times \vec{H}) - \frac{1}{2} \varepsilon_0^2 \mu_0 (\vec{E} \cdot \vec{E}) \vec{g} - \frac{1}{2} \varepsilon_0 \mu_0^2 (\vec{H} \cdot \vec{H}) \vec{g} = \vec{0}
 \end{aligned} \tag{5-a}$$

It is fundamental to realize that Equation (5) is only a part of the 4-Dimensional Time-Space Continuum Equation.

The Divergence of the 4-Dimensional Stress-Energy Tensor (3) results in the 4-Dimensional Vector Equation. The first 3 terms of the vector Equation have been presented in (5). The 4th term presents the Continuum Equation. By introducing the complex field notations for the electric field and the magnetic field in [Equation \(39\)](#) the 4th term transforms into the well-known relativistic quantum mechanical Dirac Equation and at low velocities into the quantum mechanical Schrödinger Wave Equation.

The 4 Equations together (3 Equations for the separate space coordinates) and the Dirac/Schrödinger Equation describe the Unification in a perfect Equilibrium of the different Fields.

1.2 The 4th term in the Unified 4-Dimensional Hyperspace Equilibrium Equation

The 4-Dimensional Hyperspace Equilibrium Dirac Equation in the absence of gravity equals:

$$\begin{aligned}
 (x_4) \quad \nabla \cdot (\bar{\mathbf{E}} \times \bar{\mathbf{H}}) &= -\frac{1}{2} \frac{\partial (\varepsilon_0 (\bar{\mathbf{E}} \cdot \bar{\mathbf{E}}) + \mu_0 (\bar{\mathbf{H}} \cdot \bar{\mathbf{H}}))}{\partial t} \quad (5.P) \\
 &\quad (5) \\
 \begin{pmatrix} x_3 \\ x_2 \\ x_1 \end{pmatrix} &- \frac{1}{c^2} \frac{\partial (\bar{\mathbf{E}} \times \bar{\mathbf{H}})}{\partial t} + \varepsilon_0 \bar{\mathbf{E}} (\nabla \cdot \bar{\mathbf{E}}) - \varepsilon_0 \bar{\mathbf{E}} \times (\nabla \times \bar{\mathbf{E}}) + \\
 &\quad (5.F) \\
 &+ \mu_0 \bar{\mathbf{H}} (\nabla \cdot \bar{\mathbf{H}}) - \mu_0 \bar{\mathbf{H}} \times (\nabla \times \bar{\mathbf{H}}) = \bar{0}
 \end{aligned}$$

The Poynting Theorem (5.P) can be rewritten by introducing the vector functions $\bar{\phi}$ and the complex conjugated vector function $\bar{\phi}^*$ in which:

$$\bar{\phi} = \frac{1}{\sqrt{2}\mu} \left(\bar{\mathbf{B}} + i \frac{\bar{\mathbf{E}}}{c} \right) \quad (5.P.1)$$

$\bar{\mathbf{B}}$ equals the magnetic induction, $\bar{\mathbf{E}}$ the electric field intensity and c the speed of light. The complex conjugated vector function equals:

$$\bar{\phi}^* = \frac{1}{\sqrt{2}\mu} \left(\bar{\mathbf{B}} - i \frac{\bar{\mathbf{E}}}{c} \right) \quad (5.P.2)$$

The dot product equals the electromagnetic energy density w :

$$\bar{\phi} \cdot \bar{\phi}^* = \frac{1}{2\mu} \left(\bar{\mathbf{B}} + i \frac{\bar{\mathbf{E}}}{c} \right) \cdot \left(\bar{\mathbf{B}} - i \frac{\bar{\mathbf{E}}}{c} \right) = \frac{1}{2} \mu H^2 + \frac{1}{2} \varepsilon E^2 = w \quad (5.P.3)$$

The cross product is proportional to the Poynting vector
([ref. 29, page 202, equation 15](#)).

$$\bar{\phi} \times \bar{\phi}^* = \frac{1}{2\mu} \left(\bar{\mathbf{B}} + i \frac{\bar{\mathbf{E}}}{c} \right) \times \left(\bar{\mathbf{B}} - i \frac{\bar{\mathbf{E}}}{c} \right) = i \sqrt{\varepsilon \mu} \bar{\mathbf{E}} \times \bar{\mathbf{H}} = i \sqrt{\varepsilon \mu} \bar{\mathbf{S}} \quad (5.P.4)$$

Substituting (5.P.3) and (5.P.4) in Equation (5) results in
The 4-Dimensional Hyperspace Equilibrium Equation:

$$\left(x_4 \right) - \frac{i}{\sqrt{\varepsilon_0 \mu_0}} \nabla \cdot (\bar{\phi} \times \bar{\phi}) = - \frac{\partial \bar{\phi} \cdot \bar{\phi}^*}{\partial t} \quad (5.P.5)$$

(5.5)

$$\begin{pmatrix} x_3 \\ x_2 \\ x_1 \end{pmatrix} - \frac{1}{c^2} \frac{\partial (\bar{\mathbf{E}} \times \bar{\mathbf{H}})}{\partial t} + \varepsilon_0 \bar{\mathbf{E}} (\nabla \cdot \bar{\mathbf{E}}) - \varepsilon_0 \bar{\mathbf{E}} \times (\nabla \times \bar{\mathbf{E}}) + \mu_0 \bar{\mathbf{H}} (\nabla \cdot \bar{\mathbf{H}}) - \mu_0 \bar{\mathbf{H}} \times (\nabla \times \bar{\mathbf{H}}) = \bar{0} \quad (5.F.5)$$

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 ([Ref. 29 page 213, equation 99](#)) are introduced:

$$\bar{\alpha} = \begin{bmatrix} 0 & \sigma \\ \sigma & 0 \end{bmatrix} \quad \text{and} \quad \bar{\beta} = \begin{bmatrix} \delta_{ab} & 0 \\ 0 & -\delta_{ab} \end{bmatrix} \quad (5.P.6)$$

Then equation (5) can be written as the 4-Dimensional Hyperspace Equilibrium Dirac Equation:

$$(x_4) \quad \left(\frac{i m c}{h} \bar{\beta} + \bar{\alpha} \cdot \nabla \right) \psi = - \frac{1}{c} \frac{\partial \psi}{\partial t} \quad (5.P.7)$$

(5.7)

$$\begin{pmatrix} x_3 \\ x_2 \\ x_1 \end{pmatrix} \quad - \frac{1}{c^2} \frac{\partial (\bar{\mathbf{E}} \times \bar{\mathbf{H}})}{\partial t} + \epsilon_0 \bar{\mathbf{E}} (\nabla \cdot \bar{\mathbf{E}}) - \epsilon_0 \bar{\mathbf{E}} \times (\nabla \times \bar{\mathbf{E}}) + \mu_0 \bar{\mathbf{H}} (\nabla \cdot \bar{\mathbf{H}}) - \mu_0 \bar{\mathbf{H}} \times (\nabla \times \bar{\mathbf{H}}) = \bar{0} \quad (5.F.7)$$

The fourth term (x_4) equals the [relativistic Dirac equation](#) (5.P.7) which equals equation (102) page 213 in [Ref.29](#).

2. 1 EM Radiation within a Cartesian Coordinate System in the absence of gravity

The required [Electromagnetic Field Configuration](#) for a perfect Equilibrium in Space and Time follows from the dynamic equilibrium equation (5) and equals in Cartesian Coordinates $\{x, y, z, t\}$ for the Electric Field Components e (x, y, z, t):

$$\begin{pmatrix} e_x \\ e_y \\ e_z \end{pmatrix} = \begin{pmatrix} f(x, y) g \left(t - \left(\frac{K_1}{z} + 1 \right) z \sqrt{\epsilon_0 \mu_0} \right) \\ 0 \\ 0 \end{pmatrix} \quad (6)$$

The required Electromagnetic Field Configuration for a perfect Equilibrium in Space and Time follows from the dynamic equilibrium equation (5) and equals in Cartesian Coordinates $\{x, y, z, t\}$ for the Magnetic Field Components m (x, y, z, t):

$$\begin{pmatrix} m_x \\ m_y \\ m_z \end{pmatrix} = \sqrt{\frac{\epsilon_0}{\mu_0}} \begin{pmatrix} 0 \\ f(x, y) g \left(t - \left(\frac{K_1}{z} + 1 \right) z \sqrt{\epsilon_0 \mu_0} \right) \\ 0 \end{pmatrix} \quad (7)$$

In which K_1 is an arbitrary constant. For the divergence-free function $f(x, y) = 1$, the solutions (6) and (7) are also the solutions for the known Maxwell Equations. For the non-divergence-free functions $f(x, y)$, the solutions (6) and (7) are not solutions for the Maxwell Equations, which requires divergence-free electromagnetic waves, propagating with the speed of light $c = 1 / \sqrt{\epsilon_0 \mu_0}$, in the absence of any matter. But they are solutions of the [Dynamic Equilibrium Equation \(5\)](#) and clearly do exist in physics. Comparable with the projection of a slide with a beamer on a flat screen in the z-direction. In which the slide has an arbitrary intensity-division $f(x, y)$. The information $f(x, y)$ on the slide propagates with the speed of light $c = 1 / \sqrt{\epsilon_0 \mu_0}$ towards the screen in the z-direction in this example.

2. 1.1 Laser Beam with a Gaussian division in the x-y plane within a Cartesian Coordinate System in the absence of gravity

The required [Electromagnetic Field Configuration](#) for a perfect Equilibrium in Space and Time follows from the dynamic equilibrium equation (5).

Figure 1. Electromagnetic Field Intensity with a Gaussian division

The required [Electromagnetic Field Configuration](#) equals in Cartesian Coordinates $\{x, y, z, t\}$ for the Electric Field Components $e(x, y, z, t)$:

$$\begin{pmatrix} e_x \\ e_y \\ e_z \end{pmatrix} = \begin{pmatrix} K_1 e^{-K_2 (x^2+y^2)} \sin\left(\omega\left(t - z\sqrt{\varepsilon_0 \mu_0}\right)\right) \\ 0 \\ 0 \end{pmatrix} \quad (6)$$

The required Electromagnetic Field Configuration for a perfect Equilibrium in Space and Time follows from the dynamic equilibrium equation (5) and equals in Cartesian Coordinates $\{x, y, z, t\}$ for the Magnetic Field Components $m(x, y, z, t)$:

$$\begin{pmatrix} m_x \\ m_y \\ m_z \end{pmatrix} = \sqrt{\frac{\varepsilon_0}{\mu_0}} \begin{pmatrix} 0 \\ K_1 e^{-K_2 (x^2+y^2)} \sin\left(\omega\left(t - z\sqrt{\varepsilon_0 \mu_0}\right)\right) \\ 0 \end{pmatrix} \quad (7)$$

In which K_1 is an arbitrary constant. The Gaussian division is ***not a solution*** of the Maxwell Equations, because the divergence of the Electric field intensity ***does not equal zero***

$$\nabla \cdot \bar{E} = -2 e^{-K_2(x^2+y^2)} \times K_1 K_2 \sin\left(\left(t - z\sqrt{\varepsilon_0 \mu_0}\right) \omega\right) \quad (6.1)$$

And the divergence of the Magnetic field intensity ***does not equal zero***.

$$\nabla \cdot \bar{\mathbf{H}} = - \sqrt{\frac{\epsilon_0}{\mu_0}} \left(2 e^{-K_2(x^2+y^2)} y K_1 K_2 \sin\left(\left(t - z \sqrt{\epsilon_0 \mu_0}\right) \omega\right) \right) \quad (7.1)$$

For the non-divergence-free functions

$$f(x, y) = K_1 e^{-K_2(x^2+y^2)} \sin\left(\omega\left(t - z \sqrt{\epsilon_0 \mu_0}\right)\right),$$
 the

solutions (6) and (7) are not solutions for the Maxwell Equations, which requires divergence-free electromagnetic waves, propagating with the speed of light $c = 1 / \sqrt{\epsilon_0 \mu_0}$, in the absence of any matter. But they are solutions of the [Dynamic Equilibrium Equation \(5\)](#) and clearly do exist in physics. Comparable with the projection of a slide with a beamer on a flat screen in the z-direction. In which the slide has an arbitrary intensity-division $f(x, y)$ and the intensity is not [Divergence Free](#). The information $f(x, y)$ on the slide propagates with the speed of light $c = 1 / \sqrt{\epsilon_0 \mu_0}$ towards the screen in the z-direction in this example and is a real physical possibility and is not a solution of the Maxwell equations but is a solution of the [Dynamic Equilibrium Equation \(5\)](#) and clearly do exist in physics.

2.2 EM Radiation within a Cartesian Coordinate System under the influence of a Longitudinal Gravitational Field g

The required [Electromagnetic Field Configuration](#) for a perfect Equilibrium in Space and Time for a Longitudinal Gravitational Field (The Light propagates in the same z-direction as the z-direction of the Gravitational Field) follows from the [Dynamic Equilibrium Equation \(5\)](#) and equals in Cartesian Coordinates $\{x, y, z, t\}$ for a gravitational field “g” for the Electric Field Components $e(x, y, z, t)$:

$$\begin{pmatrix} e_x \\ e_y \\ e_z \end{pmatrix} = \begin{pmatrix} e^{-\frac{1}{2} g \varepsilon_0 \mu_0 z} f(x, y) g(t - z\sqrt{\varepsilon_0 \mu_0}) \\ 0 \\ 0 \end{pmatrix} \quad (6 - a)$$

The required Electromagnetic Field Configuration for a perfect Equilibrium in Space and Time for a Longitudinal Gravitational Field (The Light propagates in the same z-direction as the z-direction of the Gravitational Field) follows from the Dynamic Equilibrium Equation (5-a) and equals in Cartesian Coordinates $\{x, y, z, t\}$ for a gravitational field “g” for the Magnetic Field Components $m(x, y, z, t)$:

$$\begin{pmatrix} m_x \\ m_y \\ m_z \end{pmatrix} = \sqrt{\frac{\epsilon_0}{\mu_0}} \begin{pmatrix} 0 \\ e^{-\frac{1}{2} g \epsilon_0 \mu_0 z} f(x, y) g\left(t - z\sqrt{\epsilon_0 \mu_0}\right) \\ 0 \end{pmatrix} \quad (7-a)$$

Equation (6-a) and (7-a) are solutions of [\(5-a\)](#) under the influence of a Longitudinal Gravitational field with field intensity “g” that acts along the z-direction while the electromagnetic wave is also propagating in the z-direction.

The electromagnetic wave is propagating with the unaltered speed of light $c = 1 / \sqrt{\epsilon_0 \mu_0}$, independently of the strength g of the gravitational field in the z-direction. However, the amplitude of the electromagnetic wave becomes dependently of the gravitational intensity “g” and the distance “z” and changes along the z-axis with the electromagnetic-gravitational interaction term $e^{-\frac{1}{2} g \epsilon_0 \mu_0 z}$.

In this example is chosen for e.g. a laser beam positioned vertically on the ground on earth, shining vertically against the gravitational field “g” of the earth. Because the laser beam presents electromagnetic energy, the beam has electromagnetic mass. The potential energy of the electromagnetic mass is increasing while the laser light is propagating upwards, against the direction of the gravitational field. Because of the law of conservation of Energy, the electromagnetic energy is decreasing over a distance “z” proportional with the same amount $e^{-\frac{1}{2} g \epsilon_0 \mu_0 z}$.

as the potential energy of the electromagnetic mass is increasing.

2. 3 The Real Light Intensity of the Sun, measured in our Solar System, including Electromagnetic Gravitational Conversion (EMGC)

When a beam of light leaves the surface of the sun, the light will travel in the radial direction of the radial gravitational field caused by the sun. The required [Electromagnetic Field Configuration](#) for a perfect Equilibrium in Space and Time for a Radial Gravitational Field (The Light propagates in the same radial-direction as the radial-direction of the Gravitational Field) follows from the [Dynamic Equilibrium Equation \(5\)](#) and equals in Spherical Coordinates $\{r, \theta, \varphi, t\}$ for a gravitational field “g(r)” for the Electric Field Components

$e(r, \theta, \varphi, t):$

$$\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \begin{pmatrix} \frac{1}{r} e^{\frac{G m_1 \varepsilon_0 \mu_0}{2 r}} & K1 & g(t - r \sqrt{\varepsilon_0 \mu_0}) \\ 0 & 0 & 0 \end{pmatrix} \quad (6-b)$$

The required [Electromagnetic Field Configuration](#) for a perfect Equilibrium in Space and Time for a Radial Gravitational Field (The Light propagates in the same radial-direction as the radial-direction of the Gravitational Field) follows from the [Dynamic Equilibrium Equation \(5\)](#) and equals in Spherical Coordinates $\{r, \theta, \varphi, t\}$ for a gravitational field “g(r)” for the Magnetic Field Components $m(r, \theta, \varphi, t):$

$$\begin{pmatrix} m_x \\ m_y \\ m_z \end{pmatrix} = \sqrt{\frac{\epsilon_0}{\mu_0}} \begin{pmatrix} 0 \\ \frac{1}{r} e^{\frac{G m_1 \epsilon_0 \mu_0}{2 r}} K 1 g(t - r \sqrt{\epsilon_0 \mu_0}) \\ 0 \end{pmatrix} \quad (7-b)$$

Equation (6-b) and (7-b) are solutions of [\(5-a\)](#) under the influence of a Radial Gravitational field with field a gravitational field intensity “g(r)” that acts along the radial-direction while the electromagnetic wave is also propagating in the radial-direction.

When a light beam leaves the surface of the sun, the intensity will decrease according (6-b). At earth, the measured intensity will be according [\(5-a\)](#) and (6-b):

$$I = \frac{I_0 e^{\frac{G m_1 \epsilon_0 \mu_0}{r}}}{4 \pi r^2} \quad (6-c)$$

A beam of light represents an amount of electromagnetic energy. Which equals an amount of electromagnetic mass. This amount of electromagnetic mass is moving with the speed of light in the opposite direction of a (radial) gravitational field and gains potential energy. Because the law of conservation of energy , a part of the electromagnetic energy of the light beam has to be converted into potential energy according equation (6-c).

Figure 2. Electromagnetic Gravitational Conversion

Term $e^{\frac{G m_1 \epsilon_0 \mu_0}{r}}$

For a radius of the sun equals 695,508 [km] and a distance from the sun to the earth of 149,600,000 [km], the Electromagnetic Gravitational Conversion (EMGC) term equals:

$$C_{EMGC} = \frac{e^{\frac{G m_1 \epsilon_0 \mu_0}{r_1}}}{e^{\frac{G m_1 \epsilon_0 \mu_0}{r_2}}} = \frac{e^{\frac{1}{r_1}}}{e^{\frac{1}{r_2}}} = 4.1877534 \quad (6-d)$$

This means that the **real intensity** of the light at the surface of the sun is about 4 times higher than the intensity which would have been calculated in a classical way from the

sunlight intensity measured on earth, due to
Electromagnetic Gravitational Conversion.

Equations (6-b) and (7-b) are solutions of (5-a) under the influence of a Radial Gravitational field with field intensity “g(r)” that acts along the radial-direction while the electromagnetic wave is also propagating in the same radial-direction. The electromagnetic wave is propagating with the unaltered speed of light $c = 1 / \sqrt{\epsilon_0 \mu_0}$, independently of the strength g(r) of the gravitational field in the radial-direction. However, the amplitude of the electromagnetic wave becomes dependently of the gravitational intensity “g(r)” and the distance “r” and changes along the radial direction due to the Electromagnetic-Gravitational Conversion term

$$C_{EMGC} = e^{\frac{G m_1 \epsilon_0 \mu_0}{r}} .$$

Because of the law of conservation of Energy, the electromagnetic energy of the light emitted by the sun is decreasing over a distance “r” proportional with the same

amount $E_{mGC} = e^{\frac{G m_1 \epsilon_0 \mu_0}{r}}$ as the potential energy of the electromagnetic mass of the light emitted by the sun is increasing.

2.4 The Boundaries of our Universe

When a mass , for example a ball, has been thrown into the air, the mass moves against the direction of the gravitational field of the earth and kinetic energy has been converted into potential energy. When the ball has reached the maximum height, the ball falls back towards the earth and the potential energy has been converted again into kinetic energy. The total sum of kinetic energy and potential energy remains constant.

The Cosmic Microwave Background Radiation (CMBR) is light (electromagnetic radiation) and represents an amount of electromagnetic energy. Which equals an amount of electromagnetic mass. This amount of electromagnetic mass is moving with the speed of light in the opposite direction of a (radial) gravitational field and gains potential energy. Because the law of conservation of energy , a part of the electromagnetic energy of the light beam has to be converted into potential energy according equation (6-c).

In a comparable way the Cosmic Microwave Background Radiation (CMBR) (light, electromagnetic) radiation moves away from the center of our Universe, gaining Potential Energy by moving against the (Radial) Gravitational field of our Universe. Until the Intensity of the light vanishes into zero at the boundaries of our Universe and has the potency to fall back towards its origin gaining an non-imaginable amount of light intensity by the conversion of potential energy into electromagnetic energy.

In this model of the Universe, the electromagnetic radiation within the universe, is locked up in its own gravitational field. And the whole Universe can be considered to be a gigantic Black Hole with a diameter over 5 billion lightyears.

Depending on the the electromagnetic stability at the boundaries of our Universe a periodic model of our Universe is possible like the ball being thrown into the air and falling back towards the location where it came from, or the universe finally disappearing into the infinite space.

These possibilities depend on the radial dependent electromagnetic intensity function of the Cosmic Microwave Background Radiation (CMBR) [Table 1](#) .

2.5 The Origin of Dark Matter

The Cosmic Microwave Background Radiation (CMBR) is the dominant radiation field in the Universe, and one of the most powerful cosmological tools that has yet been found, 25 years after its discovery by Penzias & Wilson (1965) .

Within a few years of the discovery of the CMBR, it was established the radiation field is close to isotropic, with a spectrum characterized by a single temperature, $T_{\text{rad}} \approx 2.7$ K. The specific intensity of the radiation is therefore close to:

$$I_f = \frac{2 h f^3}{c^2} \left(e^{hf/k_B T_{\text{rad}}} - 1 \right)^{-1} \quad (6-e)$$

which corresponds to a peak brightness $I_{\text{max}} \sim 3.7 \times 10^{-18} \text{ W m}^{-2} \text{ Hz}^{-1} \text{ sr}^{-1}$ at $f_{\text{max}} \sim 160 \text{ GHz}$ and an energy density $i_f \sim 4 \times 10^{-14} \text{ J m}^{-3}$, which can also be expressed as a mass density $\rho_{\text{em}} \sim 5 \times 10^{-31} \text{ kg m}^{-3}$.

When from the earth an [Electromagnetic Mass Density](#) has been measured which equals $\rho_{\text{em}} = 5 \times 10^{-36} \text{ kg/m}^3$, the [Total Mass of the Universe](#) can be roughly calculated without and with regarding the effect of Electromagnetic Gravitational Conversion.

At the Origin of the Universe, at the start of the Big Bang, a large amount of electromagnetic radiation has been blown into the universe, which has been measured on earth as the well-known CMBR. The radiation, traveling for billions of

years against the gravitational field of the origin of the universe and has gained during that time an enormous amount of potential energy. Because of the conversation of energy and the transfer of electromagnetic energy into potential energy, the intensity of the CMBR, measured on earth, has been much lower than the real intensity has been at the origin.

As an example a visible universe like a sphere has been chosen with a [radius](#) of $4.4 \cdot 10^{26}$ [m] and the earth located in the middle between the origin of the Big Bang and the outer boundaries of the visible Universe. As an example, two basic calculations have been done. The first one, calculating the total electromagnetic mass in the universe without taking into account the Electromagnetic-Gravitational Interaction.

$$M_{UNIVERSE} = \int_{R_1}^{R_2} \rho_{EM} 4 \pi r^2 dr = \int_{0.0113}^{4.4 \times 10^{26}} \frac{5 \times 10^{-36}}{(r / 2.2 \times 10^{26})^2} 4 \pi r^2 dr = \quad (6-f)$$

$$= 1.338 \cdot 10^{45} \text{ [kg]}$$

The second calculation has been done by taking into account the Electromagnetic-Gravitational Interaction, including the Electromagnetic-Gravitational Conversion

$$\text{term } C_{EMGC} = e^{\frac{G m_1 \varepsilon_0 \mu_0}{r}}.$$

$$M_{UNIVERSE} = \int_{R_1}^{R_2} \rho_{EM} e^{\frac{1}{r}} 4 \pi r^2 dr = \int_{0.0113}^{4.4 \times 10^{26}} \frac{5 \times 10^{-36}}{(r / 2.2 \times 10^{26})^2} \frac{e^{\frac{1}{r}}}{e^{\frac{1}{2.2 \times 10^{26}}}} 4 \pi r^2 dr = \quad (6-g)$$

$$= 1.077 \times 10^{53} \text{ [kg]}$$

Including the effect of Electromagnetic-Gravitational Conversion changes an almost negligible effect of the CMBR on the total mass of the Universe into an effect that can easily explain the total mass of the Universe while neglecting the influences of the mass of the galaxies. And makes the Theory of Dark Matter avoidable.

3. Electromagnetic Radiation within a Spherical Coordinate System

The Spherical Coordinate System $\{r, \theta, \varphi, t\}$ is parameterized by the radius r of the Sphere, the polar angle θ and the azimuthal angle φ and the time t .

Figure 3. Spherical Coordinate System

The required Electromagnetic Field Configuration for a perfect Equilibrium in Space and Time follows from equation (5) and equals in Spherical Coordinates $\{r, \theta, \varphi, t\}$ for the Electric Field Components $e(\theta, r, \varphi, t)$:

$$\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ \frac{1}{r} f(\theta, \varphi) g \left(t - \left(\frac{K_1}{r} + 1 \right) r \sqrt{\varepsilon_0 \mu_0} \right) \\ 0 \end{pmatrix} \quad (8)$$

The required Electromagnetic Field Configuration for a perfect Equilibrium in Space and Time follows from

equation (4) and equals in Spherical Coordinates $\{r, \theta, \varphi, t\}$ for the Magnetic Field Components $m(\theta, r, \varphi, t)$:

$$\begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \sqrt{\frac{\epsilon_0}{\mu_0}} \begin{pmatrix} 0 \\ 0 \\ \frac{1}{r} f(\theta, \varphi) g \left(t - \left(\frac{K_1}{r} + 1 \right) r \sqrt{\epsilon_0 \mu_0} \right) \end{pmatrix} \quad (9)$$

For the divergence-free function $f(\theta, \varphi) = 1$, the solutions (8) and (9) are also the solutions for the known Maxwell Equations. For the non-divergence-free functions $f(\theta, \varphi)$, the solutions (8) and (9) are no solutions for the Maxwell Equations, which require divergence-free electromagnetic waves in the absence of any matter. ^(29,35,36,37,38) They are however solutions of the DEE (5) and clearly they do exist in physics. Like the radiation of an inhomogeneous point light source like a LED.

4. Confined Electromagnetic Radiation within a Spherical Coordinate System through Electromagnetic-Gravitational Interaction

In physics it has been generally assumed that the speed of light $c = 1 / \sqrt{\epsilon_0 \mu_0}$ is a physical constant. In this paragraph the possibilities will be discussed of a variable speed of light ^(10,11,12) that can vary from zero until values higher than c .

The only requirement for the existence of an Electromagnetic Field Configuration will be the requirement of a perfect equilibrium in space-time for the chosen electromagnetic field configuration ^(13,14,15). This single unique requirement will always be a solution of the DEE (5).

The required Electromagnetic Field Configuration for a perfect Equilibrium in Space and Time ^(16,17,18,30,31,39) in respectively the θ -direction ($f_\theta = 0$) and the φ -direction ($f_\varphi = 0$) follows from equation (5).

In Spherical Coordinates $\{r, \theta, \varphi, t\}$ the solution for the DEE (5) for the Electric Field Components $e(\theta, r, \varphi, t)$ equals:

$$\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f(r) g(\theta) h(\varphi) \sin(\omega t) \\ -f(r) g(\theta) h(\varphi) \cos(\omega t) \end{pmatrix} \quad (10)$$

In Spherical Coordinates $\{r, \theta, \varphi, t\}$ the solution for the DEE (5) for the Magnetic Field Components $m(\theta, r, \varphi, t)$ in

respectively the θ -direction ($f_\theta = 0$) and the φ -direction ($f_\varphi = 0$) for the magnetic field components follows from equation (5) ^(29,30,31). and equals:

$$\begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f(r) g(\theta) h(\varphi) \cos(\omega t) \\ f(r) g(\theta) h(\varphi) \sin(\omega t) \end{pmatrix} \quad (11)$$

Equation (4) gives the 3-dimensional force density f^a of an Electro-Magnetic Field Configuration^(19,20,21). in a coordinate free vector equation.

$$\begin{pmatrix} f_r \\ f_\theta \\ f_\varphi \end{pmatrix} = \begin{pmatrix} \frac{2}{r} \varepsilon_0 g(\theta)^2 h(\varphi)^2 f(r) \left(f(r) + r \frac{d f(r)}{d r} \right) \\ 0 \\ 0 \end{pmatrix} \quad (12)$$

It follows from equation (4) that the radiation pressure in radial direction does not counterbalance and does not equal zero.

The energy-density w_m of the Electromagnetic Configuration is essential for the calculation of the inward bounded gravitational pressure. The electromagnetic field configuration (10) and (11) for the functions

$g(\theta) = 1$ and $h(\varphi) = 1$, results into the electromagnetic energy-density w_{em} :

$$\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f(r) \sin(\omega t) \\ -f(r) \cos(\omega t) \end{pmatrix} \quad \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f(r) \cos(\omega t) \\ f(r) \sin(\omega t) \end{pmatrix} \quad (13)$$

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

According to Einstein's mass-energy equivalent $W = m c^2$, the specific electromagnetic mass^(22,23,24,29). density ρ_{em} equals:

$$\rho_{em} = \frac{1}{c^2} \left(\frac{\mu_0}{2} (\bar{m} \cdot \bar{m}) + \frac{\varepsilon_0}{2} (\bar{e} \cdot \bar{e}) \right) = \varepsilon_0^2 \mu_0 f(r)^2 \quad (14)$$

The total electromagnetic mass^(25,6,27,29,38). M_{em} within a sphere with radius R equals:

$$M_{em} = 4 \pi \varepsilon_0^2 \mu_0 \int_0^R r^2 f(r)^2 dr \quad (15)$$

At a distance r from the center of the sphere, the total electromagnetic mass M_{em} within the sphere^(25,26,27,30). causes, according [Newton's Shell Theorem](#)^(28,29,30), a gravitational field strength g_{em} :

$$g_{em} = \frac{4}{r^2} \pi \varepsilon_0^2 \mu_0 G_1 \int_0^R r^2 f(r)^2 dr \quad (16)$$

In which G_1 is the gravitational constant and equals $G_1=6.67408 \cdot 10^{-11} \text{ [m}^3 \text{ kg}^{-1} \text{ s}^{-2}\text{]}$. The gravitational inwards bounded radiation pressure^(29,31,32,33). follows from (16):

$$f_{GRAV} = \rho_{em} g_{em} = \frac{4}{r^2} \pi \varepsilon_0^4 \mu_0^2 G_1 f(r)^2 \int_0^R r^2 f(r)^2 dr \quad (17)$$

When there is a perfect equilibrium between the outwards bounded electromagnetic radiation pressure f_{RAD} and the inward bounded gravitational pressure^(29,34,35,38,39). f_{GRAV} we find from (12) and (17) the radius of the boundary sphere of the enclosed radiation $R_{BOUNDARY}$. for the functions $g(\theta) = 1$ and $h(\varphi) = 1$,

$$\begin{aligned} f_{RAD} &= \frac{2}{r} \varepsilon_0 f(r) \left(f(r) + r \frac{df(r)}{dr} \right) = \\ &= \frac{4}{r^2} \pi \varepsilon_0^4 \mu_0^2 G_1 f(r)^2 \int^{R-BOUNDARY} r^2 f(r)^2 dr = f_{GRAV} \end{aligned} \quad (18)$$

In the following example we choose for the function $f(r)$

$$f(r) = K_1 r^n \quad (19)$$

Substituting (19) in (18) results in the equation for $R_{BOUNDARY}$:

$$\frac{8.019056 \times 10^{-94} K l^6 R_{BOUNDARY}^{1+6n}}{3+2n} = 1.7708376 \times 10^{-11} K l^2 (1+n) R_{BOUNDARY}^{-1+2n} \quad (20)$$

<u>Table 1:</u>				
Values for n	Values for K_1	R_{BOUNDARY} [m]	Frequenc y ω_0	Area
-10	1	0.000724227	2.6×10^{12}	Electromag netic Particle (<u>Electro-</u> <u>magneticall</u> <u>y</u> <u>Controlled</u>)
-4	1	$5.5940239 \times 10^{-10}$	3.37×10^{18}	
-2	1	$6.7798267 \times 10^{-28}$	2.78×10^{36}	
-2	2	$1.3559653 \times 10^{-27}$	1.39×10^{36}	
-2	10^{18}	$6.7798267 \times 10^{-10}$	2.78×10^{18}	
-1.6	1	$3.0622921 \times 10^{-45}$	6.15×10^{53}	
-1.51	1	$4.7888625 \times 10^{-52}$	3.94×10^{60}	
-1.51	10^{18}	$9.4264902 \times 10^{-17}$	2.0×10^{25}	
-1	1	Infinite		Solution of (5)
-0.9	1	$1.2126075 \times 10^{267}$	1.55×10^{-258}	Electromag netic Black Hole (<u>Gravitation</u> <u>ally</u> <u>Controlled</u>)
-0.5	1	2.1755186×10^{54}	8.66×10^{-46}	
-0.5	10^{18}			
-0.5	10^{36}			

5. The fundamental conflict between Causality and Probability

The beginning of the conflict between Causality and Probability in Physics started at the historic invitation-only “Conseil Solvay” in 1911. Since that conference Albert Einstein has always defended the fundamental concept of Causality and the logical grounds for Causality and Effect while Niels Bohr has always defended the fundamental concept of Probability in which there is no relationship between Causality and Effect. The most fundamental and famous conference was the October 1927 “Fifth Solvay International Conference on Electrons and Photons” where the newly formulated Quantum Theory, based on Probability, had been accepted. Since then Quantum Physics has grown in power and has always been grounded on the material waves, for the first time mathematically described by Erwin Schrödinger and designated to be probability waves.

In [Ref. \(29\)](#) page 206 the “law of continuity” for electromagnetic radiation has been presented in equation (42), By presenting the electromagnetic field in a complex configuration in equation (48) on page 207, the electromagnetic continuity equation (42) has been presented as the quantum mechanical Schrödinger wave equation (53) on page 207. However the function ψ in (53) does not represent the quantum mechanical probability function but represents the confined electromagnetic field with harmonic frequency ω_0 in which the magnetic part has been presented as the real function $\bar{B} / \mu$ and the electric part has been

presented as the imaginary function $i \bar{E} / c$. With “i” the imaginary number $\sqrt{-1}$. However as well as the electric part as the magnetic part of the confined electromagnetic field are both real.

The quantum mechanical wave function ψ is in real a vector function $\bar{\phi}$ which equals:

$$\bar{\phi} = \frac{1}{\sqrt{2} \mu} \left(\bar{B} + i \frac{\bar{E}}{c} \right) \quad (21.a)$$

and the complex conjugated vector function equals:

$$\bar{\phi}^* = \frac{1}{\sqrt{2} \mu} \left(\bar{B} - i \frac{\bar{E}}{c} \right) \quad (21.b)$$

And the dot product equals the electromagnetic energy density w:

$$\bar{\phi} \cdot \bar{\phi}^* = \frac{1}{2 \mu} \left(\bar{B} + i \frac{\bar{E}}{c} \right) \cdot \left(\bar{B} - i \frac{\bar{E}}{c} \right) = \frac{1}{2} \mu H^2 + \frac{1}{2} \varepsilon E^2 = w \quad (21.c)$$

The cross product is proportional to the Poynting vector ([ref. 29, page 202, equation 15](#)).

$$\bar{\phi} \times \bar{\phi}^* = \frac{1}{2 \mu} \left(\bar{B} + i \frac{\bar{E}}{c} \right) \times \left(\bar{B} - i \frac{\bar{E}}{c} \right) = i \sqrt{\varepsilon \mu} \bar{E} \times \bar{H} = i \sqrt{\varepsilon \mu} \bar{S} \quad (21.d)$$

In Ref. (29) on page 208 the “law of continuity” for electromagnetic radiation has been presented in equation (57). The vector function $\bar{\phi}$ represents the confined electromagnetic field with harmonic frequency ω_0 in which the magnetic part has been presented as the real vector

function $\bar{B}$ and the electric part has been presented as the imaginary vector function $i \bar{E} / c$. By substituting the complex vector function $\bar{\phi}$ in (57) and using the relativistic Lorentz transformations, the quantum mechanical relativistic Dirac equation has been derived in equation (102) on page 213. This has been published in 1995 in Physics Essays in A Continuous model of Matter (DOI: 10.13140/RG.2.2.25149.77281). (ref. 29).

This fundamental conflict is still going on and in this article mathematical results are presented in Table 1 in which the famous De Broglie waves, the material waves, designated as probability waves are electromagnetic waves with one harmonic frequency ω , confined by electromagnetic-gravitational interaction. Electromagnetic waves fully grounded on Causality and Effect.

Table 1 presents several values for the calculated Equilibrium Radius R_{BOUNDARY} (20) at different values K_1 and n in Equation (18), (19) and (20) for the harmonic Electromagnetic-Gravitationally confined Electromagnetic waves with frequency ω_0 :

6. Confined Electromagnetic Radiation within a Toroidal Coordinate System

The Toroidal Coordinate System $\{\theta, r, \varphi, R, t\}$ is parameterized by the large radius R of the Torus. The Toroidal Coordinate System is obtained by rotating bipolar coordinates $\{r, \varphi\}$ around an axis perpendicular to the axis connecting the two foci. The coordinate $\{\theta\}$ specifies the angle of rotation.

Figure 4. Toroidal Coordinate System

The required Electromagnetic Field Configuration for a perfect Equilibrium in Space and Time equals in Toroidal Coordinates $\{\theta, r, \varphi, t\}$ for the Electric Field Components (θ, r, φ, t) :

$$\begin{pmatrix} e_\theta \\ e_r \\ e_\varphi \end{pmatrix} = \begin{pmatrix} (0) \\ \left(\frac{1}{\sqrt{2}} \text{Csch}(r)(\text{Cosh}(r) - \text{Cos}(\theta))^{3/2} \sqrt{K1 - f_{13}(\theta, r, \varphi, t)^2} \right) \\ \left(\frac{\text{Csch}(r)(\cosh(r) - \cos(\theta))f_{13}(\theta, r, \varphi, t)}{\sqrt{-K2 + \frac{1}{2} \text{Cos}(\theta) \left(h(\theta) - 2\text{Cot}(\theta) \text{Tan}^{-1} \left(\text{Tan} \left(\frac{\theta}{2} \right) \text{Coth} \left(\frac{r}{2} \right) \right) + r} \right) + h(\theta)} \right. \\ \left. - \frac{1}{2} \text{Cosh}(r) \left(h(\theta) - 2\text{Cot}(\theta) \text{Tan}^{-1} \left(\tan \left(\frac{\theta}{2} \right) \coth \left(\frac{r}{2} \right) \right) + r \right) + \text{Sinh}(r) \right) \end{pmatrix} \quad (22.a)$$

The required Electromagnetic Field Configuration for a perfect Equilibrium in Space and Time equals in Toroidal Coordinates $\{\theta, r, \varphi, t\}$ for the Magnetic Field Components $m(\theta, r, \varphi, t)$:

$$\begin{pmatrix} m_\theta \\ m_r \\ m_\varphi \end{pmatrix} = \sqrt{\frac{\epsilon_0}{\mu_0}} \begin{pmatrix} (0) \\ \frac{\left(\frac{-1}{\sqrt{2}} \text{Csch}(r) (\text{Cosh}(r) - \text{Cos}(\theta))^{3/2} f_{13}(\theta, r, \varphi, t) \right)}{\sqrt{h(\theta) - 2\text{Cot}(\theta) \text{Tan}^{-1} \left(\text{Tan} \left(\frac{\theta}{2} \right) \text{Coth} \left(\frac{r}{2} \right) \right) + r}} \\ \left(\begin{aligned} &\text{Csch}(r) (\cosh(r) - \cos(\theta)) \sqrt{K1 - f_{13}(\theta, r, \varphi, t)^2} \\ &\sqrt{-K2 + \frac{1}{2} \text{Cos}(\theta) \left(h(\theta) - 2\text{Cot}(\theta) \text{Tan}^{-1} \left(\text{Tan} \left(\frac{\theta}{2} \right) \text{Coth} \left(\frac{r}{2} \right) \right) + r \right) + h(\theta)} \\ &-\frac{1}{2} \text{Cosh}(r) \left(h(\theta) - 2\text{Cot}(\theta) \text{Tan}^{-1} \left(\tan \left(\frac{\theta}{2} \right) \coth \left(\frac{r}{2} \right) \right) + r \right) + \text{Sinh}(r) \end{aligned} \right) \end{pmatrix} \quad (22.b)$$

7. Confined Electromagnetic Radiation within a Toroidal Coordinate System through Electromagnetic-Gravitational Interaction in a non-linear Space-Time Continuum

The required Electromagnetic Field Configuration for a Gravitational-Electromagnetic Equilibrium in Space and Time equals in Toroidal Coordinates $\{\theta, r, \varphi, t\}$ for the Electric Field Components $e(\theta, r, \varphi, t)$:

$$\begin{pmatrix} e_\theta \\ e_r \\ e_\varphi \end{pmatrix} = \begin{bmatrix} (0) \\ \left(\text{Csch}(r) \text{fl}(\theta, r) (\text{Cosh}(r) - \text{Cos}(\theta))^{3/2} \sqrt{K1 - \text{fl}3(\theta, r, \varphi, t)^2} \right) \\ \left(\frac{\text{Csch}(r) (\text{Cosh}(r) - \text{Cos}(\theta)) \text{fl}3(\theta, r, \varphi, t)}{\sqrt{\text{Cos}(\theta) \text{fl}(\theta, r)^2 - \text{Cosh}(r) \text{fl}(\theta, r)^2 - g(r)}} \right) \end{bmatrix} \quad (23)$$

The required Electromagnetic Field Configuration for a Gravitational-Electromagnetic Equilibrium in Space and Time equals in Toroidal Coordinates $\{\theta, r, \varphi, t\}$ for the Magnetic Field Components $m(\theta, r, \varphi, t)$:

$$\begin{pmatrix} m_\theta \\ m_r \\ m_\varphi \end{pmatrix} = \sqrt{\frac{\epsilon_0}{\mu_0}} \begin{bmatrix} (0) \\ \left(\text{Csch}(r) \text{fl}(\theta, r) \left(-(\text{Cosh}(r) - \text{Cos}(\theta))^{3/2} \right) \text{fl}3(\theta, r, \varphi, t) \right) \\ \left(\frac{\text{Csch}(r) (\text{Cosh}(r) - \text{Cos}(\theta))}{\sqrt{\text{Cos}(\theta) \text{fl}(\theta, r)^2 - \text{Cosh}(r) \text{fl}(\theta, r)^2 - g(r)}} \sqrt{K1 - \text{fl}3(\theta, r, \varphi, t)^2} \right) \end{bmatrix} \quad (24)$$

The toroidal electromagnetic field configuration is in perfect equilibrium with itself and its surrounding in

respectively the θ - and the φ - direction. There is a resulting electromagnetic outward bounding force density in the r- direction, $\vec{J}(\theta, r, \varphi, t)$ indicated as the outward bounding radiation pressure of the toroidal electromagnetic confinement.

$$\vec{J}(\theta, r, \varphi, t) = \begin{bmatrix} 0 \\ -\frac{\varepsilon_0 K_i \text{Csch}^2(r) (\text{Cos}(\theta) - \text{Cosh}(r))' \left(4\text{fl}(\theta, r) \text{fl}^{(m)}(\theta, r) (\text{Cos}(\theta) - \text{Cosh}(r)) - g'(r) \right)}{2R} \\ 0 \end{bmatrix} \quad (25)$$

This resulting outward bounding radiation pressure has to be compensated by the inward bounding gravitational force density, to create the required equilibrium by electromagnetic-gravitational interaction.

In a comparable way as in the example presented in spherical coordinates in (13) and (14) , the electromagnetic mass-density from the energy density in the torus can be calculated. With these values the inward bounded gravitational radiation pressure can be derived. From the requirement that both force densities have to compensate each other, the Boundary Radius R_{BOUNDARY} for the toroidal confinement can be calculated.

8. The Origin of Electromagnetic Mass (Inertia)

When Erwin Schrödinger published in 1926 the well-known Schrödinger wave equation with the characteristic spherical and elliptical wave solutions, he found a mathematical presentation for “De Broglie-” or the Material Waves. When Bohr assigned these “De Broglie” waves as “Probability Waves”, he excluded “De Broglie-Waves” from any mass. The mass was for 100 % in the elementary particle itself and “De Broglie Waves” without any mass described the probability of the position of this elementary particle. A complete non logical approach.

A fundamental logical approach is to assign the mass to “De Broglie Waves”. And that is only possible when we “De Broglie Waves” are just “Confined Single Harmonic Electromagnetic Waves” (confined light). For this reason the mass of confined electromagnetic radiation has to be calculated. It will be clear that it is impossible to assign mass to free electromagnetic radiation. Because it is impossible to accelerate free electromagnetic radiation and the concept of mass if based on the inertia of mass by Newton’s second law. For this reason the inertia of “Confined Single Harmonic Electromagnetic Waves” (confined light) has to be calculated.

We measure the mass in [kg] by acceleration of the object according Newton’s second law of motion. In the theory of special relativity, the speed of light is a fundamental constant. But the intensity of the light will not be constant. Speed is relative. When we emit by a laser a beam of light, the intensity of the light will not change with the distance (without any divergence of the beam).

However there is a difference. When the speed of the observer has the same speed as the speed of the light source, then the observer and the light source are relative at rest. And the same light intensity will be measured at the location of the emitter and at the location of the observer.

When the observer moves towards the emitter, the intensity of the light at the location of the observer will increase with $\gamma (1 + v / c)$ according the Lorentz transformation in which “v” is the relative velocity between emitter and observer . At low velocities the term γ will equal 1.

When the observer moves away from the emitter, the intensity of the light at the location of the observer will decrease with $\gamma (1 - v / c)$ according the Lorentz transformation. At low velocities the term γ will equal 1.

When light is confined between two 100 % reflecting mirrors, then we can conclude that the speed of both mirrors will always be equal, relative to each other. And at uniform speed, the radiation pressures on both mirrors will be equal and both opposite directed radiation pressures will neutralize.

During acceleration, it will take time for the light to travel with the speed of light between both mirrors. When we consider one mirror as the emitter and the opposite mirror as the observer, we can conclude that the speed of the emitter will be different (when the beam of light leaves the emitter) than the speed of the observer (when the beam of light reaches the observer) because of the time interval, needed for the beam of light to propagate from emitter to observer during the acceleration.

During the acceleration, both opposite oriented radiation pressures on both mirrors will not be equal anymore and they will not neutralize each other anymore. During acceleration, there will be a resulting force according Newton's second law of motion caused by both different radiation pressures.

For the first step in this calculation an imaginary experiment has been used. Two 100 % reflecting mirrors B and A (both in the x-y plane and without any mass) are placed opposite each other at a distance Δx (ref 29, page 7, figure 1). A single harmonic electromagnetic wave has been confined between both mirrors. Between both mirrors a "Standing Electromagnetic Wave" appears which has been formed by two waves travelling in opposite directions along the z-axis.

The Poynting vector corresponding with the electromagnetic wave propagating along the z-axis in the + direction (positive direction of the z-axis) has been indicated as $\vec{S}^+ = \vec{E}^+ \times \vec{H}^+$ and the Poynting vector corresponding with the electromagnetic wave propagating along the z-axis in the - direction (opposite direction) has been indicated as $\vec{S}^- = \vec{E}^- \times \vec{H}^-$.

The system is at rest. The radiation pressures, caused by the confined electromagnetic radiation, on both mirrors A and B are opposite and equal in magnitude:

$$P_A = \frac{2 S_A}{c} = \frac{2 S_B}{c} = P_B \quad (26)$$

Einstein has formulated this very well. “Velocities are always relative” . To calculate the radiation pressure on Mirror A, the velocities, only relative to Mirror A for the waves with the respective Poynting vectors

$\bar{S}^+ = \bar{E}^+ \times \bar{H}^+$ and $\bar{S}^- = \bar{E}^- \times \bar{H}^-$, have to be calculated.

8.1.1 The radiation pressure on Mirror A, when Mirror A moves with a velocity v in the direction of the positive z -axis

When the system of “Two Mirrors B - A” moves in the direction of the positive z -axis, Mirror A moves in the direction of the positive z -axis and the Poynting vector $\bar{S}^+ = \bar{E}^+ \times \bar{H}^+$ will decrease according the Lorentz transformation ([ref. 29, page 23, A-57](#)).

$$\bar{S}_v^+ = \bar{E}_v^+ \times \bar{H}_v^+ = \gamma^2 \left(1 - \frac{v}{c} \right)^2 \left(\bar{E}^+ \times \bar{H}^+ \right) \quad (27)$$

When the system of “Two Mirrors B - A” moves in the direction of the positive z -axis, Mirror A moves in the direction of the positive z -axis the Poynting vector $\bar{S}^- = \bar{E}^- \times \bar{H}^-$ will increase according the Lorentz transformation ([ref. 29, page 222, A-57](#)).

$$\bar{S}_v^- = \bar{E}_v^- \times \bar{H}_v^- = \gamma^2 \left(1 + \frac{v}{c} \right)^2 \left(\bar{E}^+ \times \bar{H}^+ \right) \quad (28)$$

The total radiation pressure, caused by the confined electromagnetic radiation, on mirror A equals:

$$P_A = \frac{S_A^+ + S_A^-}{c} = \frac{\gamma^2 \left(\left(1 - \frac{v}{c} \right)^2 + \left(1 + \frac{v}{c} \right)^2 \right) \left(\bar{E}^+ \times \bar{H}^+ \right)}{c} \quad (29)$$

8.1.2 The radiation pressure on Mirror B when Mirror B moves with a velocity v in the direction of the positive z -axis

When the system of “Two Mirrors B - A” moves in the direction of the positive z -axis, Mirror B moves in the direction of the positive z -axis and the Poynting vector $\bar{S}^- = \bar{E}^- \times \bar{H}^-$ will increase according the Lorentz transformation (ref. 29, page 23, A-57).

$$\bar{S}_v^- = \bar{E}_v^- \times \bar{H}_v^- = \gamma^2 \left(1 + \frac{v}{c} \right)^2 \left(\bar{E}^+ \times \bar{H}^+ \right) \quad (30)$$

When the system of “Two Mirrors B - A” moves in the direction of the positive z -axis, Mirror A moves in the direction of the positive z -axis the Poynting vector $\bar{S}^+ = \bar{E}^+ \times \bar{H}^+$ will increase according the Lorentz transformation (ref. 29, page 23, A-57).

$$\bar{S}_v^+ = \bar{E}_v^+ \times \bar{H}_v^+ = \gamma^2 \left(1 - \frac{v}{c} \right)^2 \left(\bar{E}^+ \times \bar{H}^+ \right) \quad (31)$$

The total radiation pressure, caused by the confined electromagnetic radiation, on mirror B equals:

$$P_A = \frac{S_A^+ + S_A^-}{c} = \frac{\gamma^2 \left(\left(1 + \frac{v}{c} \right)^2 + \left(1 - \frac{v}{c} \right)^2 \right) \left(\bar{E}^+ \times \bar{H}^+ \right)}{c} \quad (32)$$

P_A and P_B are still equal in magnitude and both in opposite direction and still cancel each other. The system fulfils Newton's first law of motion.

8.2 Newton's second Law of Motion (Inertia) for Confined Electromagnetic Radiation

When the system of “Two Mirrors B - A” accelerates, the velocity increases with Δv in a time interval Δt . At time t the radiation pressures on mirror A and mirror B are presented in (29) and (32). At time $t + \Delta t$ the radiation pressures on Mirror A and Mirror B will different:

The radiation pressure at time $t + \Delta t$ caused by the confined electromagnetic radiation, on mirror A equals:

$$P_A = \frac{S_A^+ + S_A^-}{c} = \frac{\gamma^2 \left(\left(1 + \frac{v}{c} \right)^2 + \left(1 - \frac{v + \Delta v}{c} \right)^2 \right) (\bar{E}^+ \times \bar{H}^+)}{c} \quad (33)$$

Because the wave with Poynting vector $\bar{S}^+ = \bar{E}^+ \times \bar{H}^+$ has left Mirror B at “ t ” and during the time interval Δt the magnitude of $\bar{E}_t^+ = \left(1 + \frac{v}{c} \right) \bar{E}^+$ and $\bar{H}_t^+ = \left(1 + \frac{v}{c} \right) \bar{H}^+$ has not changed.

The radiation pressure at time $t + \Delta t$ caused by the confined electromagnetic radiation, on mirror B equals:

$$P_B = \frac{S_B^+ + S_B^-}{c} = \frac{\gamma^2 \left(\left(1 + \frac{v + \Delta v}{c} \right)^2 + \left(1 - \frac{v}{c} \right)^2 \right) (\bar{E}^+ \times \bar{H}^+)}{c} \quad (34)$$

Because the wave with Poynting vector $\vec{S}^- = \vec{E}^- \times \vec{H}^-$ has left Mirror A at “t” and during the time interval Δt the magnitude of $\vec{E}_t^- = \left(1 + \frac{v}{c}\right) \vec{E}^-$ and $\vec{H}_t^- = \left(1 + \frac{v}{c}\right) \vec{H}^-$ has not changed.

The radiation pressures on Mirror A and Mirror B do not counterbalance each other anymore and the resulting radiation pressure equals:

$$P_B - P_A = \frac{\gamma^2 \left(4 \frac{\Delta v}{c}\right) S}{c^2} \quad (35)$$

Equation (35) can be written as:

$$P_B - P_A = \frac{\gamma^2 \left(4 \frac{\Delta v}{c}\right) S}{c^2} = \frac{\gamma^2 \left(4 \frac{\Delta v}{\Delta t}\right) S \Delta t}{c^2} = \gamma^2 \frac{W}{c^2} a = \gamma^2 m a \quad (36)$$

In which the acceleration $a = \frac{\Delta v}{\Delta t}$ and the inertia $m = \frac{W}{c^2}$

. At non relativistic velocities $\gamma = 1$ and (36) turns into the Newton's second law of motion. From (36) also Einstein's famous equation $W = m c^2$ follows. In (36) W is the total confined electromagnetic mass.

Now we can consider electromagnetic confinements without mirrors but electromagnetic confinements through electromagnetic gravitational interaction. By superposition and integration over arbitrary surfaces it is possible to prove that all confined electromagnetic radiation equals (36) and

has electromagnetic mass and follow Newton's second law of motion.

9. Quantum Mechanical Entanglement

One of the first answers every Quantum Physicist will give you when you doubt the Holy Grail of the “Particle-Wave Duality” in Quantum Physics is [Bell’s Theorem](#). But the “Particle-Wave Duality” can never explain the laws in Quantum Mechanics. In special the “Particle-Wave Duality” cannot explain “Entanglement”.

In the new model of the “Particle-Wave-Mass” Tri-Unity , the concept of a particle on itself has completely disappeared. A particle itself does not exist anymore. The “Particle-Wave-Mass” is a wave of confined light (Electromagnetic Radiation) with a “particle aspect” and a “mass aspect”. And sometimes we observe only one of the three aspects.

To demonstrate this, a simple model of a string in a music instrument like a piano, will be used. As soon the string has been excited, we will hear a tune (frequency spectrum). Along the string a pattern of “[standing \(stationary\) transversal waves](#)” occurs. When we observe one single harmonic frequency we observe that along the string a pattern occurs of nodes and anti-nodes occurs. The nodes as well as the anti-nodes are connected together in an “Entanglement” And because the information travels along the string simultaneously in both directions, it gives the impression that the information travels with an infinite speed. Because the sound wave in the string has been confined between the two ends of the string, Entanglement occurs.

[Entanglement](#) is only possible within the confinement of wave patterns. Because only then the wave pattern can mathematically be considered as the superposition of waves propagating in opposite directions and forming “[standing](#)

[\(stationary\) waves](#)” It does not matter if the “[standing \(stationary\) waves](#)” occur because of the confinement by the ends of the string or a confinement of an electromagnetic field due to “Electromagnetic-Gravitational Interaction”.

Now we consider the creation of an “[electron-anti electron](#)” pair. Both have been created at the same location. That is the exact location where the string has been excited in the example. When the electron-anti electron pair moves away from each other, it is still in the essence “one confined wave pattern”. And only through Gravitational-Electromagnetic Interaction this wave pattern has been confined and the area of confinement becomes only larger when both particles move apart. The electron/anti-electron pair is still one stationary confined harmonic electromagnetic wave pattern, which is the superposition of a complex nodes-anti nodes pattern. Confined by its own “Electromagnetic-Gravitational Field “[Entanglement](#)” will occur in a comparable way how it occurs in the string of a music instrument. Confinement is the necessary requirement for the existence of “Entanglement”.

Entanglement is the fundamental evidence that the “Particle-Wave Duality” in Classical Quantum Mechanics is not able to explain “[Entanglement](#)”. Particles can not be at the same place simultaneously. The weakness in Classical Quantum Mechanics is the “particle”. Not the “wave”. Modern experiments crumble down the “Particle-Wave-Duality” model of Niels Bohr more and more. How is it possible to make a photo of a complex probability wave? How is “Entanglement” possible? How can a photon create an electron/anti-electron pair?

Classical Quantum Physics needs a make-over. A new concept that does not crumble down further by every new

experiment. And the particle concept is the weakness in Classical Quantum Mechanics. We come closer and closer to the final conclusion that particles do not exist.

“Elementary particles” is a concept that worked very well for the last 2000 years. But it does not work anymore. We have to give up a way of thinking in the way we are already thinking for more than 2000 years since [Plato](#) introduced the concept of “Elementary particle”.

Times are changing and it is time for us to leave the ancient safe roads of the Greek Philosophers and give up the safety of our illusions. It is time to move on and let the “particle” go.

Let us build a new model. A new model without particles. A model free from the ancient Greek Philosophers. A model just grounded only on the wave.

And that is what I am offering. A new model without particles. In which the property of matter will be carried only by the wave. And the wave is already given to us since the creation of our Universe. The Light Wave. The Light Wave which carries the ability to confine itself and manifest itself like a particle. The Light wave which carries the ability to confine itself and manifest itself in the property of inertia and carries mass. The confined light wave that is in fundamental essence just only a wave but carries the 3-unity in itself of particle -wave – mass. The Particle-Wave-Mass 3-Unity.

10.1 A Gravitational-Electromagnetic model beyond the Superstring

Calculations in [Mathematica 11.0.nb](#) file and in [PDF file](#).

Figure 5 First Image of the Hydrogen Atom's [Orbital structure](#)

"De Broglie Waves" are real and do exist. Schrödinger" and as well Dirac both have written the simple well-known (electromagnetic) Continuity Equation ([ref. 29, page 208, equation 57](#)), in a complex form. What they have really found are electromagnetic waves. Single harmonic and confined. The Schrödinger Solution of a Spherical Probability wave around the nucleus has been interpreted wrong. It is not a complex probability wave. It is a real electromagnetic wave in which the real part is the solution for the electric part and the imaginary part is the magnetic part, just written with an "i" index before the term. The quantum mechanical wave function ψ is in real a vector function $\bar{\phi}$ which equals:

$$\bar{\phi} = \frac{1}{\sqrt{2\mu}} \left(\bar{B} + i \frac{\bar{E}}{c} \right) \quad (37)$$

and the complex conjugated vector function equals:

$$\bar{\phi}^* = \frac{1}{\sqrt{2\mu}} \left(\bar{B} - i \frac{\bar{E}}{c} \right) \quad (38)$$

And the dot product equals the electromagnetic energy density w:

$$\bar{\phi} \cdot \bar{\phi}^* = \frac{1}{2\mu} \left(\bar{B} + i \frac{\bar{E}}{c} \right) \cdot \left(\bar{B} - i \frac{\bar{E}}{c} \right) = \frac{1}{2} \mu H^2 + \frac{1}{2} \varepsilon E^2 = w \quad (39-a)$$

The cross product is proportional to the Poynting vector ([ref. 29, page 202, equation 15](#)).

$$\bar{\phi} \times \bar{\phi}^* = \frac{1}{2\mu} \left(\bar{B} + i \frac{\bar{E}}{c} \right) \times \left(\bar{B} - i \frac{\bar{E}}{c} \right) = i \sqrt{\varepsilon\mu} \bar{E} \times \bar{H} = i \sqrt{\varepsilon\mu} \bar{S} \quad (39-b)$$

The Gravitational-Electromagnetic Confinement for the elementary structure beyond the “[superstring](#)” is presented in equation (5-a).

$$\begin{aligned} & - \frac{1}{c^2} \frac{\partial (\bar{E} \times \bar{H})}{\partial t} + \varepsilon_0 \bar{E} (\nabla \cdot \bar{E}) - \varepsilon_0 \bar{E} \times (\nabla \times \bar{E}) + \mu_0 \bar{H} (\nabla \cdot \bar{H}) - \\ & - \mu_0 \bar{H} \times (\nabla \times \bar{H}) - \frac{1}{2} \varepsilon_0^2 \mu_0 (\bar{E} \cdot \bar{E}) \bar{g} - \frac{1}{2} \varepsilon_0 \mu_0^2 (\bar{H} \cdot \bar{H}) \bar{g} = \bar{0} \end{aligned} \quad (5-a)$$

In which $\bar{g}$ represents the (radial oriented) gravitational acceleration caused by the electromagnetic mass density of the confined electromagnetic radiation.

The solution for equation (5-a) equals:

$$\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f(r) \sin(\omega t) \\ -f(r) \cos(\omega t) \end{pmatrix} \quad \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f(r) \cos(\omega t) \\ f(r) \sin(\omega t) \end{pmatrix} \quad (40)$$

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

In which $f(r)$ equals:

$$f[r] = K e^{-\frac{-\frac{G I \varepsilon_0 \mu_0}{r} + 8 \pi \log[r]}{8 \pi}} \quad (41)$$

10.1.1 A Gravitational-Electromagnetic Confinement Type 1

($\text{emm} = 10^{-4} \text{ [kg]}$; radius = $2 \times 10^{-35} \text{ [m]}$):

The chosen values equal:

$$f[r] = K e^{-\frac{G1 \text{ emm } \varepsilon_0 \mu_0}{r} + 8 \pi \log[r]} \quad (42)$$

$$G1 = 6.6740810^{-11}$$

$$\text{emm} = 10^{-4}$$

$$\varepsilon_0 = 8.8510^{-12}$$

$$\mu_0 = 1.256637061435917210^{-6}$$

In which “emm” equals the electromagnetic mass of the confinement located at the center according [Newton’s Shell Theorem](#).

For an electromagnetic mass of the confinement type (1): $\text{emm} = 10^{-4} \text{ [kg]}$, the radius of the confinement equals approximately $2 \times 10^{-35} \text{ [m]}$. This is in 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 (7) and figure (8):

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

Figure 6 PlotGraph of the Electric Field Intensity $f(r)$ for the region $10^{-36} < r < 10^{-25}$ 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 [Newton's Shell Theorem](#).

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

Figure 7 PlotGraph of the Electric Field Intensity $f(r)$ for the region $10^{-36} < r < 10^{-35}$ 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 [Newton's Shell Theorem](#).

It follows from Figure 8 that the radius of the stable gravitational electromagnetic confinement equals approximately 2×10^{-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.

10.1.2 A Gravitational-Electromagnetic Confinement Type 2 ($\text{emm} = 10^{-12}$ [kg]; radius = 2.5×10^{-43} [m]):

For an electromagnetic mass of the confinement type (2): $\text{emm} = 10^{-12}$ [kg], the radius of the confinement equals approximately 2.5×10^{-43} [m]. This is much smaller than [Planck's Length](#) and has been indicated as “sub Planck 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 (9)_ and figure (10):

$$\text{Plot} \left[e^{-\frac{-\frac{G1 \varepsilon_0 \mu_0}{r} + 8 \pi \log[r]}{8 \pi}}, \{r, 10^{-43}, 10^{-40}\} \right]$$

Figure 8 PlotGraph of the Electric Field Intensity $f(r)$ for the region $10^{-36} < r < 10^{-25}$ 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 [Newton's Shell Theorem](#).

$$\text{Plot} \left[e^{-\frac{G1 \varepsilon_0 \mu_0}{r} + 8 \pi \log[r]} , \{r, 10^{-43}, 10^{-42}\} \right]$$

Figure 9 PlotGraph of the Electric Field Intensity $f(r)$ for the region $10^{-43} < r < 10^{-42}$ in which the gravitational field acceleration has been chosen accordingly an electromagnetic mass of 10^{-12} [kg] located at the center of the confinement, according [Newton's Shell Theorem](#).

10.1.3 A Gravitational-Electromagnetic Confinement Type 3 ($m = 1.6726 \times 10^{-27}$ [kg]; radius = 3×10^{-58} [m]):

For an electromagnetic mass of the confinement type (3): $m = 1.6726 \times 10^{-27}$ [kg] (mass of proton), the radius of the confinement equals approximately 3×10^{-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 (11) and figure (12):

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

Figure 10 PlotGraph of the Electric Field Intensity $f(r)$ for the region $10^{-59} < r < 10^{-55}$ in which the gravitational field acceleration has been chosen accordingly an electromagnetic mass of 1.6726×10^{-27} [kg] located at the center of the confinement, according [Newton's Shell Theorem](#).

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

Figure 11 PlotGraph of the Electric Field Intensity $f(r)$ for the region $10^{-59} < r < 10^{-57}$ in which the gravitational field acceleration has been chosen accordingly an electromagnetic mass of 1.6726×10^{-27} [kg] located at the center of the confinement, according [Newton's Shell Theorem](#).

The fundamental question is: How it is possible to create confinements from “visible light” (with a wave length between 3.9×10^{-7} [m] until 7×10^{-7} [m]) within dimensions smaller than Planck's Length?

This is only possible when the wave length of the confined radiation is smaller than the 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 transformation during the collapse of the radiation

when the confinement has been formed (implosion of visible light).

10.2 The Origin of Electric Charge and Magnetic Spin in discrete values

The Gravitational-Electromagnetic Confinement for the elementary structure of the “[superstring](#)” is presented in equation (5-a).

$$\begin{aligned}
 & -\frac{1}{c^2} \frac{\partial (\bar{E} \times \bar{H})}{\partial t} + \varepsilon_0 \bar{E} (\nabla \cdot \bar{E}) - \varepsilon_0 \bar{E} \times (\nabla \times \bar{E}) + \mu_0 \bar{H} (\nabla \cdot \bar{H}) - \mu_0 \bar{H} \times (\nabla \times \bar{H}) - \frac{1}{2} \varepsilon_0^2 \mu_0 (\bar{E} \cdot \bar{E}) \bar{g} - \frac{1}{2} \varepsilon_0 \mu_0^2 (\bar{H} \cdot \bar{H}) \bar{g} = \bar{0} \quad (5-a)
 \end{aligned}$$

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 [the solution for equation \(5-a\)](#) which equals:

$$\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f1(r, \theta, \varphi, t) \sin(\omega t) \\ -f2(r, \theta, \varphi, t) \cos(\omega t) \end{pmatrix} \quad \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ f2(r, \theta, \varphi, t) \cos(\omega t) \\ f1(r, \theta, \varphi, t) \sin(\omega t) \end{pmatrix} \quad (43)$$

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

In which $f[r]$, $f1[r, \theta, \varphi, t]$, $f2[r, \theta, \varphi, t]$ equals:

$$\begin{aligned}
f[r] &= K e^{-\frac{G1 \varepsilon_0 \mu_0 + 8 \pi \log[r]}{r}} \\
f1[r, \theta, \varphi, t] &= K e^{-\frac{G1 \varepsilon_0 \mu_0 + 8 \pi \log[r]}{r}} g1[\theta, \varphi, t] \\
f2[r, \theta, \varphi, t] &= \frac{K e^{-\frac{G1 \varepsilon_0 \mu_0 + 8 \pi \log[r]}{r}} \sqrt{-g1[\theta, \varphi, t]^2 + \cos[2 t \omega] g1[\theta, \varphi, t]^2 + 2h[\theta, \varphi]}}{\sqrt{2}}
\end{aligned} \tag{44}$$

In which $g1[\theta, \varphi, t]$ and $h[\theta, \varphi]$ are arbitrary function.

The “sub Max Planck’s length” confinement has been described for the electric field intensity:

$$\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ K e^{-\frac{G1 \varepsilon_0 \mu_0 + 8 \pi \log[r]}{r}} g1[\theta, \varphi, t] \sin[t\omega] \\ -\frac{K e^{-\frac{G1 \varepsilon_0 \mu_0 + 8 \pi \log[r]}{r}} \sqrt{-g1[\theta, \varphi, t]^2 + \cos[2t\omega] g1[\theta, \varphi, t]^2 + 2h[\theta, \varphi]}}{\sqrt{2}} \end{pmatrix} \tag{45}$$

The “sub Max Planck’s length” confinement has been described for the magnetic field intensity:

$$\begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \sqrt{\frac{\varepsilon_0}{\mu_0}} \begin{pmatrix} 0 \\ \frac{K e^{-\frac{G1 \varepsilon_0 \mu_0 + 8 \pi \log[r]}{r}} \sqrt{-g1[\theta, \varphi, t]^2 + \cos[2t\omega] g1[\theta, \varphi, t]^2 + 2h[\theta, \varphi]}}{\sqrt{2}} \\ K e^{-\frac{G1 \varepsilon_0 \mu_0 + 8 \pi \log[r]}{r}} g1[\theta, \varphi, t] \sin[t\omega] \end{pmatrix} \tag{46}$$

10.3 The 5 Types of "Sub Max Planck Length Gravitational-Electromagnetic Confinements" resulting in Electric Charge and Magnetic Spin

The following functions with the quantum variables $\{m_1, n_1, p_1, q_1\}$ have been chosen:

$$f[r] = K e^{-\frac{G_1 \varepsilon_0 \mu_0 + 8 \pi \log[r]}{r}} \frac{1}{8 \pi}$$

$$g_1(\theta, \varphi, t) = \sin(t \omega) (\sin(\pi \theta m_1) \sin(n_1 2 \pi \varphi) + 1)$$

$$h(\theta, \varphi) = \sin(\pi \theta p_1) \sin(q_1 2 \pi \varphi) + 1 \quad (47)$$

$$g_2(\theta, \varphi, t) = \frac{\sec(t \omega) \sqrt{\cos(2 t \omega) g_1(\theta, \varphi, t)^2 - g_1(\theta, \varphi, t)^2 + 2 h(\theta, \varphi)}}{\sqrt{2}}$$

$$f_1[r, \theta, \varphi, t] = e^{-\frac{G_1 \varepsilon_0 \mu_0 + 8 \pi \log[r]}{r}} \frac{1}{8 \pi} K g_1[\theta, \varphi, t]$$

$$f_2[r, \theta, \varphi, t] = \frac{e^{-\frac{G_1 \varepsilon_0 \mu_0 + 8 \pi \log[r]}{r}} K \sqrt{-g_1[\theta, \varphi, t]^2 + \cos[2 t \omega] g_1[\theta, \varphi, t]^2 + 2 h[\theta, \varphi]}}{\sqrt{2}}$$

10.3.1 Type 1 of "Sub Max Planck Length Gravitational-Electromagnetic Confinements" (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) equals:

$$\nabla \cdot \begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \frac{\sqrt{2} K1 \cot(\theta) \sin^2(t \omega) \sqrt{1 - \sin^4(t \omega)} e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}}}{r^2 \sqrt{2 - 2 \sin^4(t \omega)}} \quad (48)$$

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

The divergence of the magnetic field intensity (magnetic monopole) equals:

$$\nabla \cdot \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \frac{K1 \sqrt{\varepsilon_0} \cot(\theta) \sqrt{2 - 2 \sin^4(t \omega)} e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}}}{\sqrt{2} \sqrt{\mu_0} r^2} \quad (49)$$

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

In which K1 is an arbitrary variable. Because of the $\cot(\theta)$ function, the electric divergence as well as the magnetic divergence changes from sign when the angle θ varies

between 0° until 360° forming electric dipoles (+ versus -) and magnetic dipoles (N versus S).

10.3.2 Type 2 of "Sub Max Planck Length Gravitational-Electromagnetic Confinements" (Electric- and Magnetic Dipoles, Electric- and Magnetic Spin) {m1=1, n1=0, p1=0, q1=0}

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

$$\nabla \cdot \begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \frac{\sqrt{2} K1 \cot(\theta) \sin^2(t\omega) \sqrt{1 - \sin^4(t\omega)} e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}}}{r^2 \sqrt{2 - 2 \sin^4(t\omega)}} \quad (50)$$

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

The divergence of the magnetic field intensity (magnetic monopole) equals:

$$\nabla \cdot \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \frac{K1 \sqrt{\varepsilon_0} \cot(\theta) \sqrt{2 - 2 \sin^4(t\omega)} e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}}}{\sqrt{2} \sqrt{\mu_0} r^2} \quad (51)$$

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

In which K1 is an arbitrary variable. Because of the $\cot(\theta)$ function, the electric divergence as well as the magnetic divergence changes from sign when the angle θ varies

between 0° until 360° forming electric dipoles (+ versus -) and magnetic dipoles (N versus S).

10.3.3 Type 3 of "Sub Max Planck Length Gravitational-Electromagnetic Confinements" {m1=1, n1=1, p1=0, q1=0}

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

$$\begin{aligned} \nabla \cdot \begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} &= \frac{K1 \sin^2(t\omega) e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}} \left(\cos(\varphi)(\sin(\theta)\sin(\varphi)+1)\sin^2(t\omega) \right)}{r^2 \sqrt{1 - (\sin(\theta)\sin(\varphi)+1)^2 \sin^4(t\omega)}} + \\ &\frac{K1 \sin^2(t\omega) e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}} \left((2 \cos(\theta)\sin(\varphi) + \cot(\theta)) \sqrt{1 - (\sin(\theta)\sin(\varphi)+1)^2 \sin^4(t\omega)} \right)}{r^2 \sqrt{1 - (\sin(\theta)\sin(\varphi)+1)^2 \sin^4(t\omega)}} \quad (52) \\ \nabla \cdot \begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} &= \frac{K1 e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}} \left(\frac{1}{2} \cos(\varphi)(\sin(\theta)\sin(\varphi)+1) \right)}{2 r^2 \sqrt{1 - \frac{1}{4} (\sin(\theta)\sin(\varphi)+1)^2}} + \\ &\frac{K1 e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}} \left((2 \cos(\theta)\sin(\varphi) + \cot(\theta)) \sqrt{1 - \frac{1}{4} (\sin(\theta)\sin(\varphi)+1)^2} \right)}{2 r^2 \sqrt{1 - \frac{1}{4} (\sin(\theta)\sin(\varphi)+1)^2}} \quad (\text{averaged over 1 period of time}) \end{aligned}$$

The divergence of the magnetic field intensity (magnetic monopole) equals:

$$\begin{aligned}
 \nabla \cdot \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} &= \frac{-K1 \sqrt{\varepsilon_0} e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}} \left(\sin(\varphi) \sin^4(t\omega) (\sin(2\theta) \sin(\varphi)) \right)}{\sqrt{\mu_0} r^2 \sqrt{1 - (\sin(\theta) \sin(\varphi) + 1)^2 \sin^4(t\omega)}} + \\
 &\frac{K1 \sqrt{\varepsilon_0} e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}} \left(3 \cos(\theta) + \cos(\varphi) \sin^2(t\omega) \sqrt{1 - (\sin(\theta) \sin(\varphi) + 1)^2 \sin^4(t\omega)} - \cot(\theta) (\sin^4(t\omega) - 1) \right)}{\sqrt{\mu_0} r^2 \sqrt{1 - (\sin(\theta) \sin(\varphi) + 1)^2 \sin^4(t\omega)}} \quad (53) \\
 \nabla \cdot \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} &= \frac{-K1 \sqrt{\varepsilon_0} e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}} \left(\sin(\varphi) \frac{1}{4} (\sin(2\theta) \sin(\varphi) + 3 \cos(\theta)) \right)}{\sqrt{\mu_0} r^2 \sqrt{1 - \frac{1}{4} (\sin(\theta) \sin(\varphi) + 1)^2}} + \\
 &\frac{K1 \sqrt{\varepsilon_0} e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}} \left(\frac{1}{2} \cos(\varphi) \sqrt{1 - \frac{1}{4} (\sin(\theta) \sin(\varphi) + 1)^2} + \frac{3}{4} \cot(\theta) \right)}{\sqrt{\mu_0} r^2 \sqrt{1 - \frac{1}{4} (\sin(\theta) \sin(\varphi) + 1)^2}} \quad (\text{averaged over 1 period of time})
 \end{aligned}$$

In which K1 is an arbitrary variable with a Positive (positive charge) or a Negative (negative charge) value.

10.3.4 Type 4 of "Sub Max Planck Length Gravitational-Electromagnetic Confinements" (Electric- and Magnetic Dipoles, Electric- and Magnetic Spin) $\{m1=0, n1=0, p1=1, q1=0\}$

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

$$\nabla \cdot \begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \frac{e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}} K1 \cot[\theta] \sin[t\omega]^2}{r^2} \quad (54)$$

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

In which K1 is an arbitrary variable with a Positive (positive charge) or a Negative (negative charge) value.

Figure 12. Equation (54). Averaged over 1 period of time. Electric Charge Density Plot in a range from 10^{-37} [m] until 10^{-35} [m].

The divergence of the magnetic field intensity (magnetic monopole) equals:

$$\nabla \cdot \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \frac{e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}} K1 \sqrt{\varepsilon_0} \cot[\theta] \sqrt{1 - \sin^2[\theta]}}{r^2 \sqrt{\mu_0}} \quad (55)$$

$$\nabla \cdot \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \frac{e^{\frac{G_1 \varepsilon_0 \mu_0}{8 \pi r}} K1 \sqrt{\varepsilon_0} \cot[\theta]}{2 r^2 \sqrt{\mu_0}} \text{ (averaged over 1 period of time)}$$

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

13.3.5 Type 5 of "Sub Max Planck Length Gravitational-Electromagnetic Confinements" {m1=0, n1=0, p1=1, q1=1}

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

$$\nabla \cdot \begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \frac{e \frac{G_1 \varepsilon_0 \mu_0}{8 \pi r} K1 \left(2 \cot[\theta] \sin[t\omega]^2 - \frac{\cos[\varphi]}{\sqrt{1 + \sin[\theta] \sin[\varphi] - \sin[t\omega]^4}} \right)}{2 r^2} \quad (56)$$

$$\nabla \cdot \begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \frac{e \frac{G_1 \varepsilon_0 \mu_0}{8 \pi r} K1 \left(\cot[\theta] - \frac{\cos[\varphi]}{\sqrt{\frac{3}{4} + \sin[\theta] \sin[\varphi]}} \right)}{2 r^2} \quad (\text{averaged over 1 period of time})$$

The divergence of the magnetic field intensity (magnetic monopole) equals:

$$\nabla \cdot \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \frac{e \frac{G_1 \varepsilon_0 \mu_0}{8 \pi r} K1 \sqrt{\varepsilon_0} \left(3 \cos[\theta] \sin[\varphi] - 2 \cot[\theta] (-1 + \sin[t\omega]^4) \right)}{2 r^2 \sqrt{\mu_0} \sqrt{1 + \sin[\theta] \sin[\varphi] - \sin[t\omega]^4}} \quad (57)$$

$$\nabla \cdot \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \frac{e \frac{G_1 \varepsilon_0 \mu_0}{8 \pi r} K1 \sqrt{\varepsilon_0} \left(3 \cos[\theta] \sin[\varphi] + \frac{3}{2} \cot[\theta] \right)}{2 r^2 \sqrt{\mu_0} \sqrt{\frac{3}{4} + \sin[\theta] \sin[\varphi]}} \quad (\text{averaged over 1 period of time})$$

In which K1 is an arbitrary variable with a Positive (positive charge) or a Negative (negative charge) value.

10.4 Type II of "Sub Max Planck Length Gravitational-Electromagnetic Confinements"

The "sub Max Planck's length" Type II confinement has been described for the electric field intensity:

$$\begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \begin{pmatrix} 0 \\ \frac{e^{\frac{G1}{8\pi\tau} \frac{\epsilon_0}{\mu_0}} h[\theta, \varphi] \sin[\omega t]^2 \sin[r \sqrt{\epsilon_0 \mu_0} \omega]^2}{r} \\ - \frac{e^{\frac{G1}{8\pi\tau} \frac{\epsilon_0}{\mu_0}} h[\theta, \varphi] \sqrt{K1 - \sin[\omega t]^4} \sin[r \sqrt{\epsilon_0 \mu_0} \omega]^4}{r} \end{pmatrix} \quad (58)$$

The "sub Max Planck's length" confinement has been described for the magnetic field intensity:

$$\begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \sqrt{\frac{\epsilon_0}{\mu_0}} \begin{pmatrix} 0 \\ \frac{e^{\frac{G1}{8\pi\tau} \frac{\epsilon_0}{\mu_0}} h[\theta, \varphi] \sqrt{K1 - \sin[\omega t]^4} \sin[r \sqrt{\epsilon_0 \mu_0} \omega]^4}{r} \\ \frac{e^{\frac{G1}{8\pi\tau} \frac{\epsilon_0}{\mu_0}} h[\theta, \varphi] \sin[\omega t]^2 \sin[r \sqrt{\epsilon_0 \mu_0} \omega]^2}{r} \end{pmatrix} \quad (59)$$

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

$$\nabla \cdot \begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \frac{e^{\frac{G1\epsilon}{8\pi r}} \sqrt{K1 - \sin[t \omega]^4} \sin[r \sqrt{\epsilon_0 \mu_0} \omega]^4 h^{(0,1)}[\theta, \varphi]}{r} + \frac{e^{\frac{G1\epsilon}{8\pi r}} \sin[t \omega]^2 \sin[r \sqrt{\epsilon_0 \mu_0} \omega]^2 h^{(1,0)}[\theta, \varphi]}{r} \quad (60)$$

In which K1 is a positive constant equal or larger than 1.

The divergence of the magnetic field intensity (magnetic monopole) equals:

$$\nabla \cdot \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \frac{e^{\frac{G1 \epsilon_0 \mu_0}{8 \pi r}} \sqrt{\epsilon_0} \sin[t \omega]^2 \sin[r \sqrt{\epsilon_0 \mu_0} \omega]^2 h^{(0,1)}[\theta, \varphi]}{r \sqrt{\mu_0}} + \frac{e^{\frac{G1 \epsilon_0 \mu_0}{8 \pi r}} \sqrt{\epsilon_0} \sqrt{K1 - \sin[t \omega]^4} \sin[r \sqrt{\epsilon_0 \mu_0} \omega]^4 h^{(1,0)}[\theta, \varphi]}{r \sqrt{\mu_0}} \quad (61)$$

The function has been chosen:

$$h[\theta, \varphi] = \sin[n \theta] \cos[m \varphi] \quad (62)$$

In which the integers $n = 0, \frac{1}{2}, 1\frac{1}{2}, 2, 2\frac{1}{2}, 3, 3\frac{1}{2}, \dots$ And $m = 0, \frac{1}{2}, 1\frac{1}{2}, 2, 2\frac{1}{2}, 3, 3\frac{1}{2}, \dots$:

$$\rho = \epsilon_0 \nabla \cdot \begin{pmatrix} e_r \\ e_\theta \\ e_\varphi \end{pmatrix} = \frac{n \epsilon_0 e^{\frac{G1\epsilon}{8\pi r}} \cos(n \theta) \cos(m \varphi) \sin(t \omega)^2 \sin(r \sqrt{\epsilon_0 \mu_0} \omega)^2}{r} \quad (63)$$

According to [Gauss's law](#) the electric charge density ρ equals for $m = 0$ and $n = 1$ for an electric monopole.

Equation (63) represents a di-pole function for the electric charge density.

For the corresponding magnetic di-pole flux density ϕ (spin) equals for $n = 0$ and $m = + \frac{1}{2}$ (spin up) and $m = - \frac{1}{2}$ (spin down):

$$\phi = \mu_0 \nabla \cdot \begin{pmatrix} m_r \\ m_\theta \\ m_\varphi \end{pmatrix} = \frac{m \sqrt{\epsilon_0 \mu_0} e^{\frac{G1\epsilon}{8\pi r}} \cos(n \theta) \cos(m \varphi) \sin(r \sqrt{\epsilon_0 \mu_0} \omega)^2}{r} \quad (64)$$

Equation (64) represents a di-pole function for the magnetic flux density (spin).

Figure 13 Equation (56): PlotGraph of the Electric Field Intensity $f(r)$ for the region $10^{-85} < r < 10^{-80}$ with a frequency of $\omega = 10^{90} [\text{s}^{-1}]$ in which the gravitational field acceleration has been chosen accordingly an electromagnetic mass of $1.6726 \times 10^{-27} [\text{kg}]$ located at the center of the confinement, according [Newton's Shell Theorem](#).

Figure 14 Equation (56): PlotGraph of the Electric Field Intensity $f(r)$ for the region $10^{-85} < r < 10^{-84}$ with a frequency of $\omega = 10^{90}$ in which the gravitational field acceleration has been chosen accordingly an electromagnetic mass of 1.6726×10^{-27} [kg] located at the center of the confinement, according [Newton's Shell Theorem](#).

11. Concluding Remarks

The example of Gravitational-Electromagnetic Interaction, presented in table 1 shows two types of confinement.

1. For values $0 < n < -1$, the Gravitational-Electromagnetic Confinement will be Gravitationally controlled (Table 1). This means that for values for $r > R_{\text{BOUNDARY}}$ the inward bounded Gravitational force will be larger than the outward bounded Electromagnetic Radiation pressure. Electromagnetic Radiation will be attracted by Gravity towards the confinement at the surface R_{BOUNDARY} . Because for values $r < R_{\text{BOUNDARY}}$ the outward bounded radiation pressure is higher than the inward bounded gravitational pressure, all the radiation will be forced to be confined at equilibrium just at the surface of the spherical sphere with radius R_{BOUNDARY} . The confinement can be considered as an Electromagnetic Black Hole.
2. For values $-1 < n < -\infty$, the Gravitational-Electromagnetic Confinement will be Electromagnetically controlled (Table 1). This means that for values for $r > R_{\text{BOUNDARY}}$ the inward bounded Gravitational force will be smaller than the outward bounded Electromagnetic Radiation pressure. Electromagnetic Radiation will be scattered by the Radiation Pressure away from the confinement at the surface R_{BOUNDARY} . Because for

values $r < R_{\text{BOUNDARY}}$ the outward bounded radiation pressure is smaller than the inward bounded gravitational pressure, all the radiation will be confined within the sphere with radius R_{BOUNDARY} . The confinement can be considered as an Electromagnetic Particle.

3. For values $n = -1$, the inward bounded Gravitational pressure equals the outward bounded Electromagnetic Radiation pressure at any distance r . The calculated value for R_{BOUNDARY} becomes

$$R_{\text{BOUNDARY}} \rightarrow \infty.$$

Because of the extremely high-energy densities within electromagnetic-gravitational confinements and the extremely small dimensions, the radiation pressure at small densities will be extremely high. For this reason, single harmonic (monochromatic) electromagnetic-gravitational confinements will behave like nondeformable particles in experiments.

[Table 1](#) demonstrates that the mass density division within the Electromagnetic Gravitational Confinement determines a wide range of diameters of the Confinements varying from 10^{-52} [m] (which is 10^{-42} times smaller than the diameter of the atom) until 10^{54} [m] (which is 10^{27} times larger than the diameter of the observable universe).

The exact solution for a Gravitational Electromagnetic Confinement results in diameters much smaller than Planck's Length ($1.616229 \cdot 10^{-35}$ [m]).

The fundamental question is: How it is possible to create confinements from "visible light" (with a wave length

between 3.9×10^{-7} [m] until 7×10^{-7} [m]) within dimensions smaller than Planck's Length?

This is only possible when the wave length of the confined radiation is smaller than the 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 transformation during the collapse of the radiation when the confinement has been formed (implosion of visible light).

15. Three fundamental Equations in Qantum Physics

Taking the 4-dimensional Divergence of the 4-dimensional Stress Energy Tensor^(1,16,29) ([Equation 3](#)) results in a 4-dimensional 4-vector with 4 components, which can be presented as 3 fundamentally different Electromagnetic/ Quantum Mechanical equations.

- 1) The 4th component of this 4-vector equals Poynting's Theorem. Evidence has been presented that the Schrödinger Wave Equation is a complex notation for Poynting's Theorem ([equation 42](#), [Ref. 29](#)) rewritten in a complex way ([equation 55](#), [Ref.29](#))
- 2) [The 4th component](#) of this 4-vector equals Poynting's Theorem. Evidence has been presented that the relativistic Dirac Equation is a complex notation for Poynting's Theorem ([equation 57](#), [Ref. 29](#)) rewritten in a complex way ([equation 102](#), [Ref.29](#))
- 3) [The first 3](#) components of this 4-vector result in the 3-Dimensional Vector Equations ([5](#)) and ([5-a](#)) describing the “Unified 4-Dimensional Hyperspace Equilibrium” (beyond Einstein 4-Dimensional, Kaluza-Klein 5-Dimensional and Superstring 10- and 11 Dimensional Curved Hyperspaces). The fourth component of this 4-vector results in the relativistic [Dirac Equation](#) (5.P).

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