Auto Confinements of Electromagnetic Field configurations with an infinite lifetime

Shortened Title: (Confinements of Electromagnetic fields)

J. W. VEGT
Fontys University
Department of Micro System Technology
Campus TUE Het Eeuwsel 2
Postbus 826 5600 AV Eindhoven The Netherlands
E-mail: J. Vegt@fontys.nl
PACS numbers: 41.20; 11.10; 03.50

Abstract

Quantum mechanical relationships like the Schrödinger- and the Dirac equation can be presented in a way similar as the divergence of the Energy Momentum Tensor for auto confined electromagnetic waves[3,4]. In this article the auto confinement of electromagnetic waves due to electromagnetic interaction with an infinite lifetime, indicated as AEONs (**A**uto Confined **E**lectr**o**magnetic E**n**tities) is discussed. New physical possible configurations of electromagnetic fields are presented in the last section.

1. Introduction

Combining the divergence of the Energy Momentum Tensor and relativity leads to fundamental quantum mechanical equations like the Schrödinger- and the relativistic Dirac equation[3,4,13] for confined electromagnetic fields. In the following sections this auto confinement will be discussed.

2. The Dynamic Equilibrium Equation:

Besides Gravitational Confinement (GEONs)[1] (**G**ravitational **E**lectr**o**magnetic E**n**tities) a second option for auto confined electromagnetic energy is a confinement due to the dynamic equilibrium of the internal electromagnetic forces in the confinement itself. In a way identical to the way that GEONS are described by the gravitational equilibrium equation[1,7,13,] (the Einstein Maxwell Equations) , EEONs (**E**lectro-Magneto-Static Confined **E**lectr**o**magnetic E**n**tities) are described by the Dynamic Equilibrium Equation (4).

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

The Maxwell tensor[9] equals:
in which F_{ab} are the elements of the Maxwell tensor defined by:

$$F_{ab} = \partial_b \varphi_a - \partial_a \varphi_b$$

The four-vector potential φ_a is given by: $\__a = \bar{\mathrm{p}} \left(i \_ \right)$, where φ is the electric scalar potential, c the speed of light in vacuum and A is the magnetic vector potential.

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

Substituting (2) in (1) results in the Energy Momentum Tensor:

The force density f^a follows from the divergence of the electromagnetic energy momentum[(9)] tensor (3). An electromagnetic field which is in a perfect equilibrium with its surrounding at any space and time coordinate , fulfills the necessary required requirements for the physical possibility of the existence of this field. Under that condition equation (3) transforms into the Dynamic Equilibrium Equation which expresses the force density of an electromagnetic field on itself and its surrounding in a perfect equilibrium. The part of the dynamic Equilibrium Equation, representing the equilibrium for the force densities in the radial direction equals:

$$\varepsilon_0\,\mu_0(\,r\,H_\varphi(r,\theta,\varphi,t)\frac{\partial}{\partial\,t}E_\theta(r,\theta,\varphi,t)+r\,H_\theta(r,\theta,\varphi,t)\frac{\partial}{\partial\,t}E_\varphi(r,\theta,\varphi,t)+$$

$$r\,E_\varphi(r,\theta,\varphi,t)\frac{\partial}{\partial\,t}H_\theta(r,\theta,\varphi,t)\quad r\,E_\theta(r,\theta,\varphi,t)\frac{\partial}{\partial\,t}H_\varphi(r,\theta,\varphi,t))$$

$$\varepsilon_0(2\,E_R(r,\theta,\varphi,t\,)^2\quad E_\theta(r,\theta,\varphi,t\,)^2\quad E_\varphi(r,\theta,\varphi,t\,)^2+Csc(\theta)\,E_\varphi(r,\theta,\varphi,t)\frac{\partial}{\partial\,\varphi}E_R(r,\theta,\varphi,t)+$$

$$E_\theta(r,\theta,\varphi,t)\frac{\partial}{\partial\,\theta}E_R(r,\theta,\varphi,t)+E_R(r,\theta,\varphi,t)(\,\mathrm{Cot}(\theta)\,E_\theta(r,\theta,\varphi,t)+$$

$$Csc(\theta)\frac{\partial}{\partial\,\varphi}E_\varphi(r,\theta,\varphi,t)+\frac{\partial}{\partial\,\theta}E_\theta(r,\theta,\varphi,t)+r\frac{\partial}{\partial\,r}E_R(r,\theta,\varphi,t))$$

$$r\,E_\theta(r,\theta,\varphi,t)\frac{\partial}{\partial\,r}E_\theta(r,\theta,\varphi,t)\quad r\,E_\varphi(r,\theta,\varphi,t)\frac{\partial}{\partial\,r}E_\varphi(r,\theta,\varphi,t))+$$

$$\mu_0(2\,Hr(r,\theta,\varphi,t\,)^2+\mathrm{Cot}(\theta)\,Hr(r,\theta,\varphi,t)\,H_\theta(r,\theta,\varphi,t)\quad H_\theta(r,\theta,\varphi,t\,)^2\quad H_\varphi(r,\theta,\varphi,t\,)^2+$$

$$Csc(\theta)\,H_\varphi(r,\theta,\varphi,t)\frac{\partial}{\partial\,\varphi}H_R(r,\theta,\varphi,t)+Csc(\theta)\,Hr(r,\theta,\varphi,t)\frac{\partial}{\partial\,\varphi}H_\varphi(r,\theta,\varphi,t)+$$

$$H_\theta(r,\theta,\varphi,t)\frac{\partial}{\partial\,\theta}H_R(r,\theta,\varphi,t)+H_R(r,\theta,\varphi,t)\frac{\partial}{\partial\,\theta}H_\theta(r,\theta,\varphi,t)+$$

$$r\,H_R(r,\theta,\varphi,t)\frac{\partial}{\partial\,r}H_R(r,\theta,\varphi,t)\quad r\,H_\theta(r,\theta,\varphi,t)\frac{\partial}{\partial\,r}H_\theta(r,\theta,\varphi,t)$$

$$r\,H_\varphi(r,\theta,\varphi,t)\frac{\partial}{\partial\,r}H_\varphi(r,\theta,\varphi,t))$$

The part of the dynamic Equilibrium Equation, representing the equilibrium for the force densities in the azimuthal direction equals:

$$
\begin{aligned}
&\varepsilon_0 \mu_0 (r\, H_\varphi(r,\theta,\varphi,t) \frac{\partial}{\partial t} E_R(r,\theta,\varphi,t) \;\; r\, Hr(r,\theta,\varphi,t) \frac{\partial}{\partial t} E_\varphi(r,\theta,\varphi,t) \\
&r\, E_\varphi(r,\theta,\varphi,t) \frac{\partial}{\partial t} H_R(r,\theta,\varphi,t) + r\, E_R(r,\theta,\varphi,t) \frac{\partial}{\partial t} H_\varphi(r,\theta,\varphi,t)) + \\
&\varepsilon_0 (3\, Er(r,\theta,\varphi,t)\, E_\theta(r,\theta,\varphi,t) + \mathrm{Cot}(\theta)\, E_\theta(r,\theta,\varphi,t\,)^2 \;\; \mathrm{Cot}(\theta)\, E_\varphi(r,\theta,\varphi,t\,)^2 + \\
&Csc(\theta)\, E_\varphi(r,\theta,\varphi,t) \frac{\partial}{\partial \varphi} E_\theta(r,\theta,\varphi,t) \;\; E_R(r,\theta,\varphi,t) \frac{\partial}{\partial \theta} E_R(r,\theta,\varphi,t) \;\; E_\varphi(r,\theta,\varphi,t) \frac{\partial}{\partial \theta} E_\varphi(r,\theta,\varphi,t) + \\
&E_\theta(r,\theta,\varphi,t)(Csc(\theta) \frac{\partial}{\partial \varphi} E_\varphi(r,\theta,\varphi,t) + \frac{\partial}{\partial \theta} E_\theta(r,\theta,\varphi,t) + \\
&r \frac{\partial}{\partial r} E_R(r,\theta,\varphi,t)) + r\, E_R(r,\theta,\varphi,t) \frac{\partial}{\partial\, r} E_\theta(r,\theta,\varphi,t)) + \\
&\mu_0 (3\, H_R(r,\theta,\varphi,t)\, H_\theta(r,\theta,\varphi,t) + \mathrm{Cot}(\theta)\, H_\theta(r,\theta,\varphi,t\,)^2 \;\; \mathrm{Cot}(\theta)\, H_\varphi(r,\theta,\varphi,t\,)^2 + \\
&Csc(\theta)\, H_\varphi(r,\theta,\varphi,t) \frac{\partial}{\partial \varphi} H_\theta(r,\theta,\varphi,t) + Csc(\theta)\, H_\theta(r,\theta,\varphi,t) \frac{\partial}{\partial \varphi} H_\varphi(r,\theta,\varphi,t) \\
&Hr(r,\theta,\varphi,t) \frac{\partial}{\partial \theta} H_R(r,\theta,\varphi,t) + H_\theta(r,\theta,\varphi,t) \frac{\partial}{\partial \theta} H_\theta(r,\theta,\varphi,t) \;\; H_\varphi(r,\theta,\varphi,t) \frac{\partial}{\partial \theta} H_\varphi(r,\theta,\varphi,t) + \\
&r\, H_\theta(r,\theta,\varphi,t) \frac{\partial}{\partial r} H_R(r,\theta,\varphi,t) + r\, H_R(r,\theta,\varphi,t) \frac{\partial}{\partial\, r} H_\theta(r,\theta,\varphi,t))
\end{aligned}
$$

The part of the dynamic Equilibrium Equation, representing the equilibrium for the force density in the tangential direction equals:

$$\varepsilon_0\,\mu_0(\;r\,H_\theta(r,\theta,\varphi,t)\frac{\partial}{\partial\;t}E_R(r,\theta,\varphi,t)+r\;H_R(r,\theta,\varphi,t)\frac{\partial}{\partial\;t}E_\theta(r,\theta,\varphi,t)+$$

$$r\;E_\theta(r,\theta,\varphi,t)\frac{\partial}{\partial\;t}H_R(r,\theta,\varphi,t)\;\;r\;E_R(r,\theta,\varphi,t)\frac{\partial}{\partial\;t}H_\theta(r,\theta,\varphi,t))+$$

$$\varepsilon_0(3\,Er(r,\theta,\varphi,t)\,E_\varphi(r,\theta,\varphi,t)+2\,\mathrm{Cot}(\theta)\,E_\theta(r,\theta,\varphi,t)\,E_\varphi(r,\theta,\varphi,t)$$

$$Csc(\theta)\,E_R(r,\theta,\varphi,t)\frac{\partial}{\partial\varphi}E_R(r,\theta,\varphi,t)\;\;Csc(\theta)\,E_\theta(r,\theta,\varphi,t)\frac{\partial}{\partial\varphi}E_\theta(r,\theta,\varphi,t)+$$

$$Csc(\theta)\,E_\varphi(r,\theta,\varphi,t)\frac{\partial}{\partial\varphi}E_\varphi(r,\theta,\varphi,t)+E_\varphi(r,\theta,\varphi,t)\frac{\partial}{\partial\theta}E_\theta(r,\theta,\varphi,t)+E_\theta(r,\theta,\varphi,t)\frac{\partial}{\partial\theta}E_\varphi(r,\theta$$

$$r\;E_\varphi(r,\theta,\varphi,t)\frac{\partial}{\partial r}E_R(r,\theta,\varphi,t)+r\;E_R(r,\theta,\varphi,t)\frac{\partial}{\partial\;r}E_\varphi(r,\theta,\varphi,t))+$$

$$\mu_0(3\,H_R(r,\theta,\varphi,t)\,H_\varphi(r,\theta,\varphi,t)+2\,\mathrm{Cot}(\theta)\,H_\theta(r,\theta,\varphi,t)\,H_\varphi(r,\theta,\varphi,t)$$

$$Csc(\theta)\,H_R(r,\theta,\varphi,t)\frac{\partial}{\partial\varphi}H_R(r,\theta,\varphi,t)\;\;Csc(\theta)\,H_\theta(r,\theta,\varphi,t)\frac{\partial}{\partial\varphi}H_\theta(r,\theta,\varphi,t)+$$

$$Csc(\theta)\,H_\varphi(r,\theta,\varphi,t)\frac{\partial}{\partial\varphi}H_\varphi(r,\theta,\varphi,t)+H_\varphi(r,\theta,\varphi,t)\frac{\partial}{\partial\theta}H_\theta(r,\theta,\varphi,t)+H_\theta(r,\theta,\varphi,t)\frac{\partial}{\partial\theta}H_\varphi(r,$$

$$r\;H_\varphi(r,\theta,\varphi,t)\frac{\partial}{\partial r}H_R(r,\theta,\varphi,t)+r\;H_R(r,\theta,\varphi,t)\frac{\partial}{\partial\;r}H_\varphi(r,\theta,\varphi,t))$$

3 Exact Solutions of the Dynamic Equilibrium Equation

As an introduction two well known solutions of (4) are given. An exact (simultaneous) solution of the three parts (4-R), (4-A) en (4-T) of the Dynamic Equilibrium Equations in spherical coordinates (r, θ,ν) describes the electric field of a proton or an electron in radial direction, known as the electric monopole. In terms of equilibrium aspects of the field there is no principal reason for the physical absence of the magnetic monopole. In (5) is the combination presented of an electric and a magnetic

$$\vec{E}(x,y,z,t) = \left(C\frac{1}{r^2}, 0, 0 \right); \qquad \vec{H}(x,y,z,t) = \left(C\frac{2}{r^2}, 0, 0 \right)$$

monopole which is an exact solution of (4).
where C1 and C2 are arbitrary constants. A second well known example of an exact solution of the

$$\vec{E}(x,y,z,t) = \left(0, \frac{f(\theta,\_)}{r} g\left(r - \frac{t}{\sqrt{\varepsilon_0 \mu_o}} \right), 0 \right); \vec{H}(x,y,z,t) = \sqrt{\frac{\varepsilon_0}{\mu_0}} \left(0, 0, \frac{f(\theta,\_)}{r} g\left(r - \frac{t}{\sqrt{\varepsilon_0 \mu_o}} \right) \right)$$

Dynamic Equilibrium Equation (4) equals:
where f(θ,ν) and g(r, t) are arbitrary functions of θ, ν and r, t respectively. The field presentation (6) describes a spherical electromagnetic wave propagating in the radial direction with the speed of light $c_0 = 1/\sqrt{\varepsilon_0 \mu_o}$.

3.1 Electromagnetic interaction

In the following, the possibilities will be described of the auto confinement of electromagnetic radiation due to the internal electromagnetic forces (Electromagnetic Controlled **E**lectr**o**magnetic E**n**tities (EEONs). This principle is based on the concept of electromagnetic interaction. Electromagnetic interaction is an aspect, fundamentally required for the theoretical possibility of EEONS. The principles of this concept will be described below.

An exact solution[14] of the Dynamic Equilibrium Equation (4) in spherical coordinates is presented by (5). When C2 = 0, the field presentation in (5) describes an electric monopole where the radial component is proportional to $1/r^2$. A radial field intensity of $C1/r^3$ for the electric field component is clearly not a solution of the DEE (4). However it is possible to create a static electric field in radial direction, proportional to $1/r^3$ if the disturbance of the equilibrium is compensated by a second static

$$\vec{E}(x,y,z,t) = \begin{pmatrix} \sqrt{2}\, r^{-3} \sin(\theta) \\ 0 \\ 0 \end{pmatrix}; \qquad \vec{H}(x,y,z,t) = \sqrt{\frac{\varepsilon_0}{\mu_0}} \begin{pmatrix} 0 \\ r^{-3} \sin(\theta) \\ 0 \end{pmatrix}$$

magnetic field, also proportional to $1/r^3$ and dependent on θ.
Equation (7)[14] describes the electromagnetic interaction between the radial electric field and the

azimuthal oriented magnetic field component. Both fields cannot exist separately. Only in a simultaneously electromagnetic interaction between both fields, the required equilibrium at any point

$$\vec{E}(x,y,z,t)=\begin{pmatrix} \frac{C_1}{r^{n+2}}\sin(\theta)^n \\ 0 \\ 0 \end{pmatrix};\ \vec{H}(x,y,z,t)=\sqrt{\frac{\varepsilon_0}{\mu_0}}\begin{pmatrix} 0 \\ m\sqrt{\frac{n}{(n+1)}}\frac{C_1}{r^{n+2}}\sin(\theta)^n \\ 0 \end{pmatrix}$$

in space and time will exist A more general presentation of (7) equals[14]:
where m has the value +1 or - 1. C1 and n are arbitrary constants. For n = 0, the electromagnetic field configuration in (8) represents the spherical electric field of a proton or an electron, proportional to $1/r^2$. Another solution[14] of (4) which is an example of electromagnetic interaction is presented in (9), which describes the propagation of an electromagnetic pulse with the speed of light $c = 1/\sqrt{\varepsilon_0\mu_0}$ in the positive z-direction for C2 = 0, with a rising time of $C_1/\sqrt{\varepsilon_0\ \mu_0}$ [V/s]

$$\vec{E}(x,y,z,t)=\begin{pmatrix} -C1\, e^{C1\,x}\left(z-\frac{(1+C2)}{\sqrt{\varepsilon_0\mu_0}}t\right) \\ 0 \\ C2\, e^{C1\,x} \end{pmatrix};\ \vec{H}(x,y,z,t)=\sqrt{\frac{\varepsilon_0}{\mu_0}}\begin{pmatrix} 0 \\ C1\, e^{C1\,x}\left(z-\frac{(1+C2)}{\sqrt{\varepsilon_0\mu_0}}t\right) \\ 0 \end{pmatrix}$$

along the plane x = 0.

Both the electric and the magnetic field intensities are exponential functions of x. Applying a static electric field $E_0 = C_2\, E^{C_1 x}$ in the z-direction results in electromagnetic interaction that changes the speed of light. It follows from (9) that the electromagnetic pulse propagates in the z-direction with a

$$c_{var} = \frac{1+C_2}{\sqrt{\varepsilon_0\,\mu_0}}$$

variable speed of light, depending on C_2.
It follows from (10) that the propagation speed of the electromagnetic pulse, presented in (9), only depends on the magnitude of the exponential static electric field oriented in the z-direction. For C_2 = 0, the pulse propagates with the well known speed of light $c_{var} = 1/\sqrt{\varepsilon_0\,\mu_0}$. For a static electric field oriented in the positive z-direction, the electromagnetic interaction causes an increase of the speed of light, while a static electric field oriented in the negative z-direction effects a decrease of the speed of light. For C_2 = - 1, the propagation speed c_{var} in the positive z-direction reduces to zero,

which describes the theoretical possibility of confinement of the electromagnetic pulse. This idea was the basic concept for the described confinements in the next paragraph.

3.2 Auto Confined Electromagnetic Entities (AEONS)

The electromagnetic confinements described in the next section all are presented in spherical coordinates. The presented AEONs in the following paragraphs have a propagation speed zero in the radial direction. They present standing electromagnetic waves in spherical auto confinements.

AEON 1.1

Exact solutions of the Dynamic Equilibrium Equation (4) which describe auto confined electromagnetic entities are classified in types 1-, 2- or 3- with the resulting Poynting vector oriented in the 1-, 2-, or 3- direction respectively The Dynamic Equilibrium Equation (4) gives a variety of exact solutions with the Poynting vector oriented in the radial direction. One solution(14)

$$\overset{\rho}{E}(r,\theta,\_,t)=\frac{1}{r}\begin{pmatrix}0\\ -C1\ f(t)+C2\sqrt{C3-f(t)^{2}}\\ C2\ f(t)+C1\sqrt{C3-f(t)^{2}}\end{pmatrix}$$

is indicated as AEON 1.1 with the corresponding electric field intensity in spherical coordinates:

$$\overset{\rho}{H}(r,\theta,\_,t)=\frac{1}{r}\sqrt{\frac{\_0}{\mu 0}}\begin{pmatrix}0\\ -C2\ f(t)-C1\sqrt{C3-f(t)^{2}}\\ -C1\ f(t)+C2\sqrt{C3-f(t)^{2}}\end{pmatrix}$$

and the corresponding magnetic field intensity in spherical coordinates:
C1,C2 and C3 are arbitrary constants and f(t) is an arbitrary function of time. If we choose: f(t) =

$$\overset{\rho}{E}(r,\theta,\_,t)=\frac{1}{r}\begin{pmatrix}0\\ -C1\,\mathrm{Cos}(\omega t)+C2\,\mathrm{Sin}(\omega t)\\ C2\,\mathrm{Cos}(\omega t)+C1\,\mathrm{Sin}(\omega t)\end{pmatrix}$$

Cos(ωt) and C3 =1, AEON 1.1 can be presented as:

$$\overset{\rho}{H}(r,\theta,\_,t)=\frac{1}{r}\sqrt{\frac{\_0}{\mu 0}}\begin{pmatrix}0\\ -C2\,\mathrm{Cos}(\omega t)-C1\,\mathrm{Sin}(\omega t)\\ -C1\,\mathrm{Cos}(\omega t)+C2\,\mathrm{Sin}(\omega t)\end{pmatrix}$$

and
C1, C2 and ω are arbitrary constants. (13) and (14) represent an AEON with an infinite life time. If we choose C1 = 0, C2 and C3 arbitrary and f(t) = Cos(ω t) , AEON 1.1 is presented by:

$$\overset{\rho}{E}(r,\theta,\_,t)=\frac{C_2}{r}\begin{pmatrix}0\\ \sqrt{(C_3-\mathrm{Cos}(\omega t)^2}\\ \mathrm{Cos}(\omega t)\end{pmatrix};\ \overset{\rho}{H}(r,\theta,\_,t)=\frac{C_1}{r}\sqrt{\frac{\_0}{\mu 0}}\begin{pmatrix}0\\ -\mathrm{Cos}(\omega t)\\ \sqrt{(C_3-\mathrm{Cos}(\omega t)^2}\end{pmatrix}$$

For the AEON presented in (15), the electric charge density ρ_E equals:

$$\rho_E=\varepsilon_0\frac{C2}{r^2}\sqrt{C_3-\cos(\omega t)^2}\ \cot(\theta)$$

$$\rho_E=1.216\frac{C2}{r^2}\mathrm{Cot}(\theta)$$

Averaged over a period interval, the electric charge density for e.g. C3 =2 equals:
The magnetic charge density, averaged over a period interval, in this example equals zero.

AEON 1.2

The Dynamic Equilibrium Equation (4) gives a variety of exact solutions with the Poynting vector oriented in the radial direction. Another option is indicated as AEON 1.2[(14)] which is a similar

$$\overset{\rho}{E}(r,\theta,\_,t)=\frac{1}{r}\begin{pmatrix}0\\ C1\ f(t)+C2\sqrt{C3-f(t)^2}\\ -C2\ f(t)+C1\sqrt{C3-f(t)^2}\end{pmatrix}$$

solution as (11) and (12) but differs in sign of the separate components:

$$\overset{\rho}{H}(r,\theta,\_,t)=\frac{1}{r}\sqrt{\frac{\_0}{\mu 0}}\begin{pmatrix}0\\ C2\ f(t)-C1\sqrt{C3-f(t)^2}\\ C1\ f(t)+C2\sqrt{C3-f(t)^2}\end{pmatrix}$$

and the corresponding magnetic field intensity in spherical coordinates:

C1,C2 and C3 are arbitrary constants and f(t) is an arbitrary function of time. If we choose: f(t) =

$$\vec{E}(r,\theta,\_,t) = \frac{1}{r}\begin{pmatrix} 0 \\ C1\,\mathrm{Cos}(\omega t) + C2\,\mathrm{Sin}(\omega t) \\ -C2\,\mathrm{Cos}(\omega t) + C1\,\mathrm{Sin}(\omega t) \end{pmatrix}$$

Cos(ωt) and C3 =1, AEON 1.2 can be presented as:

$$\vec{H}(r,\theta,\_,t) = \frac{1}{r}\sqrt{\frac{\_0}{\mu 0}}\begin{pmatrix} 0 \\ C2\,\mathrm{Cos}(\omega t) - C1\,\mathrm{Sin}(\omega t) \\ C1\,\mathrm{Cos}(\omega t) + C2\,\mathrm{Sin}(\omega t) \end{pmatrix}$$

And

3.5.2 AEONS of type 3

Another solution(14) of (4) presented in (22), is the auto confinement of electromagnetic waves, propagating in the φ-direction of a sphere, which forms a combination of standing electromagnetic waves:

$$\vec{E}(r,\theta,\_,t) = \begin{pmatrix} C1\,\frac{\mathrm{Sin}(\theta)^n}{r^{n+2}}\sqrt{C2 - f(t)^2} \\ C1\sqrt{\frac{n}{n+1}}\,\frac{\mathrm{Sin}(\theta)^n}{r^{n+2}}\,f(t) \\ 0 \end{pmatrix};\quad \vec{H}(r,\theta,\_,t) = \sqrt{\frac{\varepsilon_0}{\mu_0}}\begin{pmatrix} -C1\,\frac{\mathrm{Sin}(\theta)^n}{r^{n+2}}\,f(t) \\ C1\,\frac{\mathrm{Sin}(\theta)^n}{r^{n+2}}\sqrt{\frac{n}{n+1}}\sqrt{C2 - f(t)^2} \\ 0 \end{pmatrix}$$

Both fields have no component in the φ-direction . C_1, C_2 and n are arbitrary constants and f(t) is an arbitrary function of time. For C2 = 1 and f(t) = cos(ω t), equation (22) becomes:

$$\vec{E}(r,\theta,\_,t) = \begin{pmatrix} C1 \dfrac{\mathrm{Sin}(\theta)^n}{r^{n+2}} \mathrm{Sin}(\omega t) \\ C1 \sqrt{\dfrac{n}{n+1}} \dfrac{\mathrm{Sin}(\theta)^n}{r^{n+2}} \mathrm{Cos}(\omega t) \\ 0 \end{pmatrix} ; \quad \vec{H}(r,\theta,\_,t) = \begin{pmatrix} -C1 \dfrac{\mathrm{Sin}(\theta)^n}{r^{n+2}} \mathrm{Cos}(\omega t) \\ C1 \sqrt{\dfrac{n}{n+1}} \dfrac{\mathrm{Sin}(\theta)^n}{r^{n+2}} \mathrm{Sin}(\omega t) \\ 0 \end{pmatrix}$$

which is the presentation of an AEON with an infinite life time. For n = 1, C2 =1 and f(t) = sin(ωt), the total electric charge Q_{EA} of the auto confined radiation within two

$$Q_{EA} = -2\, \varepsilon_0\, C_1\, \pi \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

spheres with radii R_1 and R_2 respectively equals:
The total magnetic charge φ_{MA} between two concentric spheres with radii R1 and R2 respectively, averaged over a period time interval equals zero.

4. Validity of the Dynamic Equilibrium Equation:

The solutions of the dynamic equilibrium equation (4) cover a wider range than the classical solutions for electromagnetic fields. It will be demonstrated in the following that (4) transforms into the well-known set of four Maxwell Equations for divergence free

electromagnetic waves. Equation (4) is split into two parts:
The vector functions on the left-hand side of (25) are perpendicular tot the vector functions on the right hand side of (25). The only solutions for these vector functions are the vector functions zero which implies that the electromagnetic field has to be divergence free under that condition and (25)

$$\Delta \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \qquad \Delta \bullet \vec{E} = 0$$

$$\Delta \times \vec{H} = \frac{\partial \vec{D}}{} \qquad \Delta \bullet \vec{B} = 0$$

transforms into the set of four Maxwell Equations in the absence of any matter.

.

4. Concluding Remarks

Because of the high energy density of self-confined electromagnetic radiation by gravitational forces, the radiation pressure is extremely high (depending on the method of self-confinement). For gravitational confinement it varies in magnitude roughly about 10^{70} [N/m^2] as a result of which self-confined electromagnetic radiation behaves as a virtually non-deformable particle in experiments. Electromagnetic self confinements with an infinite lifetime[1,4,5], based on photon-photon interaction (electromagnetic interaction), require energy densities of a considerably lower value than confinements based on gravitational forces. In this electromagnetic model of AEONs, the behavior is unified in such a way that the electromagnetic wave phenomenon itself carries mass, charge and interaction.

Acknowledgment

This work has been made possible by the contributions of many to whom I am indebted and Lynn, Antonia, Julian and my family in particular.

References

1 Wheeler J 1955, *Geons*, Phys. Rev. **97** 511.
2 Elbaz C 1988, *On Self-Field Electromagnetic Properties for Extended Material Particles*, Phys. Lett. A **127** 308.
3 Vegt J W, 1995, *A continuous model of matter based on AEONs*, Physics Essays, **8-2**, 201.
4 Vegt J W, 1994, *A particle free model of matter based on Electromagnetic Self-confinement*, Les Annales de Louis de Broglie.
5 Kaku M 1988, *Introduction to Superstrings*, Springer Verlag, New York.
6 Barbashov B and Nesterenko V 1990, *Introduction to the relativistic string theory*, World Scientific Publishing, London.
7 Arias P 1989, *Matter coupling in 16/16 super gravity*, Karlsruhe Universität, Karlsruhe.
8 Yaghjian A D 1989, *A classical electro-gravitational model of a point charge with a finite mass*, Proc. of the URSI (Int. Union of Radio Science) Int. Symposium on Electromagnetic Theory, **14 - 17**, 322.
9 Rosser W G V, 1968, *Classical Electromagnetism via Relativity*, (Butterworths, London), p. 134.
10 Zaluzny M, 1985, *On the optical properties of quasi-two-dimensional electrons*, Physica B **128** 171
11 Petrich W, 1994, *Behavior of atoms in a compressed magneto-optical trap*, Journal of the optical society of America B, **11-8**, 1332
12 Ovchinnikov Y B, 1994, *Resonant light pressure on atoms in a bichromatic standing wave*, Optics and Spectroscopy, **76-2**, 188
13 **Laporte O and Uhlenbeck G 1931**, *Application of spinor analysis tot the Maxwell and Dirac Equations*, **Physical Review Vol. 37** 1380
14 **Wolfram Research** 1999, Mathematica 4.0, Cambridge University Press.